October 17, 2003

MEMORANDUM TO: Chairman Diaz

FROM: Hubert T. Bell
Inspector General **/RA/**

SUBJECT: NRC'S OVERSIGHT OF DAVIS-BESSE BORIC ACID LEAKAGE AND CORROSION DURING THE APRIL 2000 REFUELING OUTAGE (CASE NO. 03-02S)

Attached is an Office of the Inspector General (OIG), U.S. Nuclear Regulatory Commission (NRC) Event Inquiry that addresses the NRC's oversight of operations at the Davis-Besse Nuclear Power Station pertaining to boric acid leakage and corrosion between April 1999 and the refueling outage in April 2000.

Please call me if you have any questions regarding this Event Inquiry. This report is furnished for whatever action you deem appropriate. Please notify this office within 90 days of what action, if any, you take based on the results of the Event Inquiry.

Attachment: As stated

cc w/attachment:
Commissioner McGaffigan
Commissioner Merrifield
W. Travers, EDO

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(Event Inquiry: ML032930385, Attachments: ML032901116)

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OFFICE OF THE INSPECTOR GENERAL
EVENT INQUIRY

NRC'S OVERSIGHT OF DAVIS-BESSE
BORIC ACID LEAKAGE AND CORROSION
DURING THE APRIL 2000 REFUELING OUTAGE

Case No. 03-02S

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Cheryl Montgomery-White,
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NRC'S OVERSIGHT OF DAVIS-BESSE BORIC ACID LEAKAGE AND CORROSION DURING THE APRIL 2000 REFUELING OUTAGE

Case No. 03-02S October 17, 2003

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BASIS AND SCOPE

This Office of the Inspector General (OIG) Event Inquiry was initiated in response to a Congressional request that OIG determine the circumstances surrounding the receipt by the U.S. Nuclear Regulatory Commission (NRC) of a Condition Report[1] (CR 2000-0782) prepared in April 2000, concerning the Davis-Besse Nuclear Power Station (Davis-Besse). This Condition Report with attached photographs, which was prepared by a Davis-Besse engineer at the beginning of the Davis-Besse twelfth refueling outage (12 RFO), described red-brown boric acid deposits resulting from cracking and leakage from the reactor vessel head. The Congressional request also asked OIG to determine how NRC handled CR 2000-0782 and whether the information in the Condition Report was considered by the NRC in its November 2001, decision to allow Davis-Besse to continue operating until February 16, 2002, rather than cease operations to assess the plant's susceptibility to cracking and leakage from its reactor vessel head penetration nozzles. The NRC, in Bulletin 2001-01, had requested all nuclear power plant licensees to conduct this assessment by December 31, 2001.

In response to the Congressional request, OIG examined how information available to NRC Region III related to reactor vessel head penetration nozzle cracking and resulting boric acid leakage and corrosion at Davis-Besse was used as the Region prepared for and conducted inspection activities during the Davis-Besse 12 RFO in April 2000. This outage provided the NRC staff a good opportunity to evaluate the licensee's handling of boric acid leakage and corrosion prior to the actual discovery of reactor vessel head degradation at Davis-Besse in March 2002.

It should be noted that on September 30, 2002, the NRC Davis-Besse Reactor Vessel Head Degradation Lessons-Learned Task Force issued a report following its comprehensive, historical review of NRC's regulatory activities that were intended to assure reactor vessel head integrity at Davis-Besse and other nuclear power plants. For this reason, this Event Inquiry focused on NRC's knowledge and regulatory activities relating to boric acid corrosion at Davis-Besse one year prior to and during 12 RFO in April 2000.

[1] Condition reports are electronic or hard copy documents used by licensee staff to identify conditions that need management attention. Condition reports, which can number in the hundreds per year, are usually numbered sequentially: first noted is the year followed by the number of that particular report.

BACKGROUND

Description of Davis-Besse

Davis-Besse Nuclear Power Station (Davis-Besse), a pressurized water reactor (PWR)[2] manufactured by Babcock and Wilcox, is located in northern Ohio, approximately 20 miles east of Toledo. Davis-Besse began operating commercially in July 1978. FirstEnergy Nuclear Operating Company (FENOC) became the NRC license holder for Davis-Besse in 1997. NRC's Region III[3] provides oversight for Davis-Besse.

Like other PWRs, Davis-Besse uses water containing dissolved boric acid as the primary reactor coolant and as a moderator to control the nuclear reaction. And, like other PWRs, Davis-Besse is constructed with several barriers between the radioactive material in the reactor and the environment surrounding the plant. The first barrier is the fuel cladding: sealed metal tubes that contain ceramic pellets of low-enriched uranium fuel. The second barrier is the plant's reactor coolant pressure boundary which consists of the heavy steel reactor pressure vessel (RPV) and the primary coolant system piping. The reactor coolant pressure boundary, which should not leak, serves as a barrier to protect the environment from the highly radioactive reactor core and primary reactor coolant. The third barrier is the containment building, a heavily reinforced structure of concrete and steel up to 4-feet thick that surrounds the reactor and is designed to contain radioactivity that might be released to the environment if a compromise of the reactor coolant pressure boundary were to occur.

The reactor vessel head, which is part of the RPV, is an integral part of the reactor coolant pressure boundary. The vessel head resembles a round cap that is bolted to the vessel and is approximately 15-feet in diameter. It is constructed of 6-inch thick carbon steel[4] with a 1/4- to 3/8-inch thick stainless steel inner cladding. The stainless steel cladding is essential because the water inside the RPV contains dissolved boric acid (used to assist in reactivity control), and boric acid corrodes carbon steel but not stainless steel. The reactor vessel head typically contains 65 to 70 holes into which vertical tubes called vessel head penetration (VHP) nozzles are placed. These nozzles are permanently implanted into the reactor vessel head and are welded tight to maintain the integrity of the reactor coolant pressure boundary. Most of the VHP nozzles support and guide control rods. Control rods are used to control the reactor power level by adjusting the rate of the nuclear reaction, and they are relied upon to shut down the reactor. These nozzles are called control rod drive mechanism (CRDM) nozzles.

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[2] A Pressurized Water Reactor (PWR) is a light-water reactor in which water is used as a moderator and coolant and is kept under pressure preventing it from boiling at normal temperatures.

[3] NRC has four regional offices that conduct inspections of nuclear reactors within regional boundaries. NRC's Region III provides regulatory oversight for Davis-Besse and other nuclear facilities in the north central region of the United States.

[4] Carbon steel: Carbon steels used in reactor pressure vessels are high-strength, low-alloy steels that contain iron and small amounts of alloying materials to improve its mechanical properties.

Overview of NRC Regulatory Activities

Technical Specifications

NRC requires all nuclear power plants to operate in accordance with Technical Specifications[5] that are an important part of an NRC operating license. PWR licenses include Technical Specifications pertaining to the integrity of the reactor coolant pressure boundary. One of the Technical Specifications requires a plant to have zero leakage from the reactor coolant pressure boundary. Another Technical Specification allows no more than one gallon per minute of unidentified leakage. If this limit is exceeded, the plant must implement pre-established shutdown procedures and initiate corrective actions.

NRC Inspections

NRC inspectors based at regional offices perform inspections periodically at plants in their region. NRC conducts inspections to ensure licensees meet their operating license and NRC regulatory requirements. NRC inspections are conducted in accordance with guidance in NRC's Inspection Manuals, and inspection results are documented in inspection reports. Inspections range from routine, baseline inspections[6] to special inspections that are performed in response to a specific event or problem that may arise at a plant. Some inspections can be conducted while a plant is operating; others, including inspections of the reactor vessel head, can be performed only when a plant is shut down, for example, during a refueling outage. Approximately every 18-24 months, nuclear power plants enter into a scheduled outage to refuel the reactor and to perform maintenance. Additional outages may be scheduled, as needed, for plant maintenance (i.e., mid-cycle outages), while other outages may be unscheduled, or forced, due to equipment performance problems that must be addressed to safely operate the plant.

While NRC conducts inspections to verify licensee adherence to NRC requirements, licensees are responsible for operating power plants safely and for identifying and correcting problems on a daily basis. Licensees are required to have a corrective action program[7] to identify, prioritize,

[5] Technical Specifications are part of an NRC license that establishes requirements for items such as safety limits, limiting safety systems settings, limiting control settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls.

[6] Baseline Inspections are common to all nuclear power plants. NRC's baseline inspections are an integral part of NRC's reactor oversight process and are the routine inspections performed at all operating nuclear power plants. Baseline inspections focus on plant activities that are "risk significant" that is, those activities and systems that have a potential to trigger an accident, can mitigate the effects of an accident, or increase the consequences of a possible accident.

[7] Nuclear power plants are responsible for identifying and correcting problems on a daily basis. Plants are required to have a corrective action program (CAP) to identify, prioritize, and address events, conditions, or issues with the intent of improving plant performance. When conditions are identified, they are often documented in condition reports, which describe particular plant conditions in need of repair or management attention. These condition reports are entered into the plant's CAP and are prioritized and addressed by the licensee based on safety significance.

and address events, conditions, or issues with the intent of improving plant and human performance. When adverse conditions are identified by the licensee, they are often documented in Condition Reports which are entered into the corrective action program.

NRC Resident Inspectors

NRC resident inspectors are stationed onsite at nuclear power plants to continuously monitor licensee activities in accordance with the baseline inspection program. Normally, NRC assigns a Senior Resident Inspector and a Resident Inspector to each site. Responsibilities of resident inspectors include daily interface with licensee staff, review of licensee corrective action reports to determine appropriateness of corrective actions taken to address problems, support of special inspections conducted by NRC Headquarters and regional staff, and daily communication with their NRC regional office on the status of plant operations.

NRC Generic Communications

While NRC relies on inspection reports to communicate NRC inspection results to individual licensees, the agency's primary means of communicating information industry-wide is through "generic communications." Generic communications allow NRC to publicize industry experiences and concerns to applicable groups of licensees and other interested stakeholders. One type of industry wide communication is NRC Generic Letters (GL).

Over the past 15 years, NRC has issued a number of Generic Letters associated with reactor coolant pressure boundary leakage. Significantly, on March 17, 1988, NRC issued GL 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants," and on April 1, 1997, NRC issued GL 97-01, "Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations." These GLs required all PWR licensees to provide NRC with specific information concerning their programs for addressing boric acid corrosion, reactor coolant leaks that are smaller than the technical specification limit, and for ensuring the timely inspection of CRDM and other vessel head penetrations.

Discovery of RPV Head Degradation at Davis-Besse

On February 16, 2002, Davis-Besse began a refueling outage that included inspections of the plant's VHP nozzles. These inspections were conducted in response to NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," which requested PWR licensees to provide specific information concerning the structural integrity of the VHP nozzles for their respective facilities. Although NRC Bulletin 2001-01 required certain licensees to conduct these inspections prior to December 31, 2001, NRC allowed Davis-Besse to operate until February 16, 2002, before shutting down to conduct the inspections.

While conducting these inspections, Davis-Besse identified 5 CRDM nozzles that had a total of 24 cracks, 9 of which were through-wall cracks[8] sufficient enough to allow leakage of reactor coolant water. In March 2002, during the repair of these cracks, Davis-Besse identified a large

[8] A through-wall crack is one which extends completely from the inner wall to the outer wall of a pressure-retaining boundary.

cavity in the RPV head on the side of one CRDM nozzle. Follow up examinations revealed that the carbon steel RPV head adjacent to the nozzle had corroded and that the affected area was approximately 5 inches long, up to 4 to 5 inches wide, and 6 inches deep. The remaining thickness of the RPV head in the wastage area was approximately 3/8-inch, which was the stainless steel cladding on the inside surface of the RPV head. The stainless steel cladding was the only material preventing a complete breach of the reactor coolant pressure boundary and a major release of radioactive coolant into the containment building.

Following the discovery of the degraded condition of the RPV head, an NRC Augmented Inspection Team (AIT) conducted an inspection at Davis-Besse to determine the circumstances related to the degradation of the RPV head. In its May 3, 2002, inspection report, the AIT concluded that the cavity in the RPV head was caused by boric acid corrosion resulting from leaks of borated water through the control rod drive mechanism nozzles onto the reactor vessel head. The AIT found that the borated water leaking from the through-wall cracks of the nozzle material, which caused corrosion of the carbon steel on the exterior surface of the RPV head, went undetected for an extended period of time. The AIT further concluded that based on corrosion products observed on the reactor vessel head and in the containment air coolers and radiation monitor filters, that the corrosion process had been in progress for at least 4 years.

DETAILS

NRC'S AWARENESS OF BORIC ACID LEAKAGE AT DAVIS-BESSE PRIOR TO TWELFTH REFUELING OUTAGE (12 RFO)

OIG reviewed reactor coolant system activities related to boric acid leakage and reactor vessel head corrosion at Davis-Besse to ascertain the nature of the information available to the Region III staff as they planned and conducted oversight activities during the Davis-Besse 12 RFO.

NRC Generic Letters

Generic Letter (GL) 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants"

On March 17, 1988, GL 88-05 was issued by NRC. The Generic Letter discussed a number of incidents where leaking reactor coolant had caused significant corrosion. The Generic Letter described one incident at a nuclear power station where leakage from the seal weld on one of the instrument penetrations corroded the reactor vessel head surface 0.36 inches. The Generic Letter noted that in many cases, licensees had detected the existence of leaks but had not evaluated their significance or taken prompt corrective action. The Generic Letter requested all PWR license holders to provide NRC with assurances that each licensee had implemented a program for addressing reactor coolant leaks that were below technical specification limits and ensure that boric acid corrosion did not lead to degradation of the reactor coolant pressure boundary. This Boric Acid Corrosion Prevention Program should include procedures for locating small coolant leaks and establishing the potential path of the leaking coolant and the reactor pressure boundary components it was likely to contact.

On May 27, 1988, and June 26, 1989, the Toledo Edison Company, the former NRC license holder for Davis-Besse, submitted responses to GL 88-05 which described a boric acid leakage monitoring and corrosion prevention program for Davis-Besse.

In a February 8, 1990, letter, the NRC Office of Nuclear Reactor Regulation[9] (NRR) advised Toledo Edison that it had reviewed the Davis-Besse's Boric Acid Corrosion Prevention Program and determined that the program was adequate for monitoring small primary coolant leakage to prevent boric acid corrosion of carbon steel components. While the NRC advised Toledo Edison that its program was acceptable and that NRC considered the issue closed, the letter noted that the licensee's Boric Acid Corrosion Prevention Program lacked appropriate written

[9] NRC Office of Nuclear Reactor Regulation (NRR) is responsible for ensuring the public health and safety through licensing and inspection activities at all nuclear power reactor facilities in the United States; responsible for the oversight of all aspects of licensing and inspection of manufacturing, production, and utilization facilities and receipt, possession, and ownership of source, byproduct, and special nuclear material used or produced at facilities licensed under 10 CFR Part 50; develops policy and inspection guidance for programs assigned to the regional offices and assesses the effectiveness and uniformity of the region's implementation of those programs.

procedures to fully implement program requirements. The letter also noted that licensee engineers conducting boric acid leak inspections should have formal training in this area and that such inspections should be formally documented.

As a follow up to GL 88-05, on August 1, 1991, NRC issued Inspection Procedure (IP) 62001, Boric Acid Corrosion Prevention Program. This inspection procedure was not part of the NRC baseline inspection program but was available to NRC inspectors for use in verifying implementation of a licensee's boric acid corrosion prevention program. When performing IP 62001, NRC inspectors were to verify that a licensee: (1) had a documented program for prevention of corrosion caused by boric acid solution leaking out from boric acid containing systems, as required by GL 88-05; (2) had prepared procedures, which provided clear guidance for performing activities required by the program; and (3) was implementing the program in accordance with written procedures by performing plant walk down inspections and inspecting systems containing boric acid.

OIG learned that while Region III staff conducted IP 62001 at one plant , D.C. Cook, Region III never performed this procedure at Davis-Besse. OIG also learned that after issuing GL 88-05, NRR did not issue instructions directing the Regions to implement IP 62001 or to review licensee's implementation of boric acid leakage and corrosion prevention programs.

Generic Letter (GL) 97-01, "Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations"

On April 1, 1997, NRC issued GL 97-01, which required all PWR license holders to provide NRC within 120 days a written description of their program for ensuring timely inspection of CRDM and other vessel head penetrations. NRC issued this Generic Letter due to ongoing concerns about cracking in domestic and foreign reactor vessel head penetrations. The NRC staff was particularly interested in enhanced leakage detection methods for discovering small leaks during plant operation. As stated in GL 97-01:

> . . .In the long term, however, degradation of the CRDM and other VHPs is an important safety consideration that warrants further evaluation. The vessel closure head provides the vital function of maintaining reactor pressure boundary. Cracking in the VHPs has occurred and is expected to continue to occur as plants age. The NRC staff considers cracking of VHPs to be a safety concern for the long term based on the possibility of (1) exceeding the American Society of Mechanical Engineers (ASME) Code for margins if the cracks are sufficiently deep and continue to propagate during subsequent operating cycles, and (2) eliminating a layer of defense in depth for plant safety.

The Generic Letter advised licensees that to ensure that the safety significance of VHP cracking remained low, the NRC staff continued to believe that a long-term program, which included periodic inspections and monitoring of VHPs, was necessary.

On November 29, 1999, NRC staff provided its final assessment of FENOC responses to GL 97-01 involving cracking of VHP nozzles at Davis-Besse. The NRC noted that it reviewed the licensee's proposed program, which was based on an integrated, industry-wide inspection program developed in 1997, and concluded that the program was an acceptable approach for evaluating the structural integrity of VHPs.

NRC Oversight of Davis-Besse Prior to 12 RFO

NRC Inspections During the Year Prior to 12 RFO

OIG reviewed NRC Region III inspection activities regarding Davis-Besse for the one year period between April 1999, when Davis-Besse entered into a mid-cycle maintenance outage, and April 2000, the beginning of 12 RFO. OIG found that Region III issued five inspection reports that specifically addressed matters related to reactor coolant leakage and the effects of boric acid accumulation and corrosion on reactor components.

OIG learned that although originally scheduled to begin on May 9, 1999, Davis-Besse began the mid-cycle maintenance outage[10] in April 1999. The outage began two weeks early because the plant was anticipating exceeding its 1 gallon per minute (gpm) Technical Specifications limit for unidentified reactor coolant system leak rate which would have required Davis-Besse to shut down. NRC Inspection Report 50-346/99004, dated June 7, 1999, which covered a period just prior to and during the mid-cycle outage, reflected that Davis-Besse shut down two weeks early to address the upward trend in reactor coolant system leakage. The report documented that this unidentified leakage caused plant personnel to enter the containment building periodically (every 10 to 14 days) to address fouling of the containment air coolers with accumulations of boric acid which degraded containment air cooler performance.

OIG reviewed another NRC Inspection Report number 50-346/99008, dated July 20, 1999, which reported FENOC's efforts to determine sources of the higher than normal unidentified reactor coolant system leakage during the outage. Inspection Report 50-346/99008, documented that licensee efforts both "somewhat reduced" and "effectively reduced" the unidentified leakage rates. However, this Inspection Report also noted that problems persisted with elevated unidentified reactor coolant system leakage in containment following the mid-cycle outage and that periodically the amount of boric acid residue in containment clogged the filters in both containment radiation monitoring systems. Because the Davis-Besse Technical Specifications required both of the containment radiation monitoring systems to be operable, this condition caused the plant to enter into a Limiting Condition for Operation[11] which required the plant to shut down within 6 hours of identifying the problem. According to the report, in all cases, Davis-Besse repaired the required radiation monitors in time for continued plant operation.

Following the mid-cycle outage, NRC Inspection Reports 50-346/99009, dated August 20, 1999, and 50-346/99010, dated October 8, 1999, documented Region III's oversight of FENOC's efforts to identify the source and content of the reactor coolant system leakage that was causing the radiation monitor filters to become clogged. Inspection Report 50-346/99009 noted that the licensee identified that the residue clogging the radiation monitor filters was primarily composed of iron oxide, a product of corrosion. This Inspection Report also noted that

[10] The Davis-Besse mid-cycle maintenance outage was initiated on April 23, 1999, to perform major work items including repair of reactor coolant system unidentified leakage sources, bearing work, and replace a containment air cooler(CAC) fan motor. The outage was initiated to increase plant reliability for anticipated summer power demand and ended on May 10, 1999.

[11] Limiting Conditions for Operation (LCO) are operational requirements pertaining to plant components or systems which are imposed via Technical Specifications. Failure to satisfy the LCOs or maintain the conditions required by the LCO requires the licensee to take compensatory actions in accordance with requirements of the applicable LCO, which may include plant shutdown.

the licensee's efforts to identify the source of the clogging of the radiation monitor filters were documented in Davis-Besse CR 1999-1300. OIG's review of CR 1999-1300 noted that while FENOC had not identified the exact source of the rust (iron oxide), the frequent clogging of the filters required filter changes every 24 to 48 hours. OIG learned that prior to these problems, such filter changes were required at Davis-Besse about once a month. Analysis documented in the Condition Report also noted that the iron oxide that was causing the filters to clog was an indicator of corrosion from an iron base component. OIG noted that NRC Inspection Report 50-346/99010 and CR 1999-1300, documented licensee plans to conduct thorough inspections and walk downs of the containment building during the upcoming 12 RFO to locate the source of the iron oxide. CR 1999-1300 also discussed issuing an action plan for the removal of the rust during 12 RFO.

A fifth NRC Inspection Report, number 50-346/98021, dated June 4, 1999, reviewed by OIG, addressed the complete boric acid corrosion of two retaining nuts and the partial corrosion of one nut on a pressurizer spray valve discovered in 1998 and reported in 1999. According to the Inspection Report, the licensee determined that boric acid corrosion was the most likely cause of the three corroded nuts. Inspection Report 50-346/98021 noted a weakness in the licensee's Boric Acid Corrosion Prevention Program and maintenance practices associated with verification and installation of appropriate materials subject to boric acid corrosion. This NRC Inspection Report also noted that subsequent to the motor operated valve corrosion event, the licensee had a greater sensitivity to the effects of boric acid corrosion on plant equipment. However, the Inspection Report also noted that the plant's maintenance practices related to boric acid control required improvement, more oversight, and more assessment.

NRR Project Manager Inquires About Davis-Besse Boric Acid Corrosion

OIG learned that concurrent with Davis-Besse implementing its action plan to identify the source of the iron oxide that was fouling the radiation monitor filters and Region III documenting leakage issues in inspection reports, FENOC requested a license amendment from NRC. On July 26, 1999, FENOC submitted license amendment request (LAR 99-0002) to NRC that proposed line item changes to the Davis-Besse Technical Specifications. These changes were intended to bring Davis-Besse into alignment with the Improved Standard Technical Specification (ITS) consistent with NRC recommendations and guidance for Babcock and Wilcox manufactured nuclear plants. One of the proposed changes was to revise the requirements of the Standard Technical Specifications to reduce the number of operable containment radiation monitors needed for plant operations and to provide compensatory actions if these monitors were inoperable.

OIG learned that during the approximate 4-month period between FENOC's request and NRC's approval of the license amendment, the Davis-Besse Licensing Manager and the NRR Project Manager (PM)[12] for Davis-Besse engaged in a series of telephone calls concerning the status of LAR 99-0002. OIG learned that during several of these telephone conversations, the Licensing Manager told the PM that Davis-Besse's containment radiation monitors had become unreliable and had occasionally become inoperable due to boric acid deposits and iron oxide clogging the filters. The Licensing Manager told the NRR PM that these problems required the filters to be frequently changed. The Licensing Manager explained to the PM that approval of

[12] NRR established Headquarters-based Project Manager (PM) positions to assist in licensing and monitoring the nation's commercial nuclear power plants. The PM is a multi-purpose position which has resulted in PMs being responsible for a wide range of duties, such as performing licensing actions and inspection and assessment of licensee performance.

LAR 99-0002 which reduced the number of monitors required to be operable — from two of two to one of two — would be consistent with the Improved Standard Technical Specifications and would help avoid a potential plant shutdown.

In response to the comments by the Davis-Besse Licensing Manager, the PM commented that while employed as a nuclear engineer at a nuclear power plant, prior to his employment at NRC, the plant experienced problems with iron in the containment atmosphere similar to those at Davis-Besse. He explained that when that plant shut down, they found corrosion of some carbon steel bolts on the reactor vessel head penetrations. The PM recounted that boron corrosion of those bolts had caused corroded iron to enter containment and be deposited on the containment radiation monitor filters.

OIG learned that in October 1999, as a result of the conversations between the NRR PM and the FENOC Licensing Manager, the PM questioned the Davis-Besse Senior Resident Inspector and the Chief, Reactor Projects Branch 4, Region III about their knowledge of the boric acid leakage problems at Davis-Besse specifically related to the repeated fouling of the radiation monitor filters. The PM told OIG that based on daily conference calls with the Senior Resident Inspector and the Reactor Projects Branch 4 Chief, he was aware that FENOC had been experiencing problems with unidentified reactor coolant system leakage, fouling of containment air coolers with boric acid residue, and fouling of radiation monitor filters with iron oxide. The PM told OIG that he recalled during that October 1999, conference call, he specifically questioned the Senior Resident Inspector and the Reactor Projects Branch 4 Chief about the source of the unidentified reactor coolant system leakage and the fouling of the containment air coolers and radiation monitor filters. The PM told OIG that the Davis-Besse Senior Resident Inspector told him that he was aware of the boric acid issues at Davis-Besse and that the licensee had identified the source of the problem. According to the PM, the Senior Resident Inspector assured him that he had conducted “walk down” inspections of the containment building and had learned that the boric acid problems were being caused by leakage from a pressurizer code safety relief valve. The PM told OIG that he did not further question the Senior Resident Inspector or the Branch Chief because he was confident that the Senior Resident Inspector had a good understanding of these issues. He said that both the Reactor Projects Branch 4 Chief and the Senior Resident Inspector assured him that the licensee was tracking the boric acid problems.

On November 16, 1999, NRC approved the Davis-Besse LAR 99-0002 and issued License Amendment (LA) No. 234.

Communication Between Davis-Besse Resident Inspectors and Region III Managers

OIG learned that various routine activities conducted by the Region III staff provided opportunities for the staff to discuss information regarding Davis-Besse operating conditions. These included:

(1) Daily telephone conference calls involving the resident inspectors at the plant, the Reactor Projects Branch 4 Chief, and NRR representatives were conducted to report daily plant operating status and significant events occurring at each nuclear power station. These daily conference calls were considered part of Region III’s routine oversight;

(2) Daily morning management meetings were conducted during which information learned during the morning telephone conference calls with resident inspectors was shared with Region III managers and NRC Headquarters personnel.

Daily Conference Calls Between Plant and NRC

OIG learned that every weekday morning, the Davis-Besse Senior Resident Inspector or Resident Inspector engaged in a telephone call with the Reactor Projects Branch 4 Chief[13], and the PM or other NRR representative. During these conversations, the resident inspectors reported daily plant operating status and conditions at Davis-Besse. OIG learned that the Reactor Projects Branch 4 Chief or a designee maintained a logbook in which he recorded the daily operating plant status of Davis-Besse as reported by the resident inspectors. The Branch Chief told OIG that he initiated and maintained the logbook to enable him or anyone else to review previous events at the plant to identify trends.

The former Davis-Besse Senior Resident Inspector told OIG he believed it was his duty to communicate to Region III management salient information concerning plant operating status and conditions. During the daily conference calls, the Senior Resident Inspector communicated what he believed were the important issues. On numerous occasions he reported the reactor coolant system leakage and the symptoms of the unidentified reactor coolant system leakage to Region III. He said he reported these issues to his managers to give them the opportunity to direct more Regional inspection resources toward the issues or to instruct resident inspectors to conduct more focused oversight.

OIG reviewed the logbook maintained by the Reactor Projects Branch 4 Chief and found for the period April 1999 through April 2000, a total of 38 entries documenting reports by the Davis-Besse resident inspectors of boric acid deposits, accumulation, boric acid leakage, and its effects on reactor components at the site.

Specifically, the logbook entries documented:

- Sixteen instances of unidentified reactor coolant system leakage approaching Technical Specifications limits of 1 gallon per minute (gpm). For example, the logbook cited that on April 12, 1999, the unidentified leak rate jumped to .95 gpm and 4 hours later reduced to .88gpm. Subsequent to the mid-cycle maintenance outage, the logbook noted on June 7, 1999, an unidentified reactor coolant system leakage rate was steady at .3 gpm.

- Six instances of licensee staff entering the containment building while the reactor was operating to clean containment air coolers which had fouled with boric acid residue. The June 9 and 10, 1999, logbook entries noted that while the plant was operating at 100% power, the licensee entered containment to clean the air coolers and try to locate a .3 gpm unidentified leak.

- Sixteen instances of radiation monitor filter fouling. On July 7, 1999, the logbook entry noted finding discoloration of the filters on the radiation monitors and on August 20, 1999, the logbook entry reflected that radiation monitor filters were being changed every other day.

[13] The Region III, Branch Chief, Division of Reactor Projects (DRP), Branch 4 from September 199, until June 2001, is no longer in that position.

Region III Morning Meetings

OIG learned that every morning, following the telephone conference call between the resident inspectors, the Reactor Projects Branch 4 Chief, and NRC Headquarters PM or other NRR representative, Region III held a management meeting to discuss operating conditions at each plant within their oversight responsibility. Typically, the Regional Administrator, Deputy Regional Administrator, division directors, and branch chiefs attended the daily morning meetings. NRR staff (normally the applicable PMs) also participated in the Region III morning meetings via telephone conference. During these morning meetings, no concerns were raised by the Region III management staff regarding the boric acid leakage or its effects on reactor components at Davis-Besse.

Plant Performance Reviews (PPR)

Plant Performance Reviews (PPR) are conducted at each Region office approximately every 6 months to develop an integrated overview of the safety performance of each operating nuclear power plant. NRC Region III routinely held PPR meetings for all power plants under its jurisdiction to review plant performance since the last PPR and to determine, based on information assessed and discussed, how to allocate inspection resources for the plant over the following 6 months. Region III PPR meetings were usually chaired by the Regional Administrator and were typically attended by senior managers including division directors and branch chiefs from the Division of Reactor Projects (DRP) and Division of Reactor Safety (DRS). Information was provided telephonically by resident inspectors.

OIG learned that on September 1, 1999, and March 7, 2000, NRC Region III conducted PPR meetings concerning Davis-Besse. In a letter dated September 30, 1999, NRC Region III informed the FENOC of the results of the PPR meeting on September 1, 1999. The letter advised the licensee that a historical listing of plant issues, referred to as the Plant Issues Matrix (PIM), was considered during the PPR process to arrive at the integrated review of Davis-Besse's performance trends. The PIM included items summarized from NRC inspection reports (including those previously discussed in this OIG Report) or other correspondence between NRC and FENOC from September 1, 1998 through August 31, 1999. According to the letter, during the PPR greater emphasis was placed on those issues identified in the past 6 months. The letter advised FENOC that NRC only documented issues that the NRC believed warranted management attention or represent noteworthy aspects of performance. Consequently, the letter identified several areas that warranted increased NRC attention. OIG noted that the September 30, 1999, letter did not include any mention of unidentified reactor coolant system leakage or the effects of boric acid on reactor components.

In a letter dated March 31, 2000, Region III informed FENOC of the results of the Davis-Besse PPR conducted on March 7, 2000. As in the previous PPR letter, Region III advised the licensee that the PIM was considered during the PPR process to arrive at the integrated review of Davis-Besse's performance trends. The PIM included items summarized from NRC inspection reports (including those previously discussed in this OIG Report) or other correspondence up until January 31, 2000. According to the letter, this PPR evaluated inspection results and safety performance information for the period February 1, 1999, to January 31, 2000, but emphasized the last 6 months, to ensure the assessment reflected the licensee's current performance. The March 31, 2000, letter advised the licensee that no significant performance or inspection findings were identified during the period reviewed, and it made no mention of directing Region III inspection resources toward examining boric acid leakage or corrosion issues during 12 RFO.

NRC REGULATORY OVERSIGHT DURING DAVIS-BESSE 12 RFO

During refueling outages, licensees refuel the reactor for the next operating cycle (typically 18-24 months) and perform various inspections and maintenance activities. Also during refueling outages, numerous condition reports documenting plant problems may be written by licensee staff to identify and correct adverse conditions that could not be addressed while the reactor was operating. Refueling outages also give NRC the opportunity to conduct baseline, in-service, and other specialized inspections and to observe whether licensees are conducting their activities in accordance with NRC requirements.

From April 1 through May 18, 2000, Davis-Besse conducted its 12 RFO to perform scheduled maintenance and refueling. During 12 RFO, Region III conducted inspections at Davis-Besse.

Davis-Besse Issues Condition Reports During 12 RFO

OIG learned that during 12 RFO, Davis-Besse prepared the following three condition reports which addressed boric acid leakage: (1) CR 2000-0781, dated April 6, 2000, documented that boric acid leakage from the control rod drive prevented examination of the reactor vessel head studs and that the boric acid deposits would have to be removed before the examination could occur; (2) CR 2000-0782, dated April 6, 2000, documented that inspection of the reactor flange area indicated boric acid leakage from the reactor vessel head insulation structure weep holes that was red/brown in color; and (3) CR 2000-1037, dated April 17, 2000, described accumulation of boron in the area of the CRD nozzle penetrations through the reactor head. According to CR 2000-1037, the apparent cause of the boron accumulation was from CRD leakage at five control rod drive mechanism locations. Both CR 2000-0781 and CR 2000-1037 reported that CR 2000-0782 would address the CRD leakage.

Davis-Besse Condition Report 2000-0782

On April 6, 2000, 5 days after the start of 12 RFO, CR 2000-0782 was entered into the Davis-Besse's corrective action program. A Davis-Besse service water systems engineer initiated CR 2000-0782 following his inspection of the RPV head. This Condition Report documented the discovery of accumulated boric acid deposits on the RPV head flange and noted that the leakage from the head was not evident during the last refueling outage. The Condition Report described the condition of the RPV head flange as:

> Inspection of the Reactor flange indicated Boric Acid from the weep holes (see attached picture and inspection record). The leakage is brown in color. The leakage is worst on the east side weep holes. The worst leakage from one of the weep holes is approx. 1.5 inches thick on the side of the head and pooled on top of the flange. . . . The leakage on the flange are small flakes of Boric Acid that has spalled off from the top of the flow streams and from some of the clumps within the weep holes. The total estimated quantity of leakage through the weep holes and resting on the flange is approx. 15 gallons. All leakage appears to be dry . . . . Preliminary inspection of the head through the weep holes indicates clumps of Boric Acid are present on the east and south sides.

Attached to CR 2000-0782 were seven color photographs [see attachment to this report] which depicted red rusty boric acid deposits and iron oxide on the reactor vessel flange discovered during the licensee's inspection on April 6, 2000. These photographs, which evidenced heavy red/brown leakage, were taken from the north and south sides of the reactor vessel head.

OIG Interview of Davis-Besse Engineer

The Davis-Besse service water systems engineer told OIG that he inspected the RPV head to identify any erosion and corrosion of the head. He said that he purposely worded the description of the RPV head in CR 2000-0782 to ensure that a "reasonable person concerned with safety issues would read the Condition Report and be obliged to acknowledge that there was a significant problem on the RPV head." He said he also attached color photographs of the affected portions of the RPV head to CR 2000-0782 to convey a visual representation of the significance of the boric acid accumulation.

The service water systems engineer told OIG that during the same morning he wrote CR 2000-0782, he discussed with the Davis-Besse Resident Inspector his discovery of the boric acid on the RPV head. He stated that he described the accumulation of boric acid on the RPV head to the Resident Inspector as "molten, lava-like, rust colored boric acid debris." The engineer said that as he described the condition of the RPV head to the Resident Inspector, he printed a copy of the Condition Report along with color copies of the photographs which depicted the boric acid accumulation and gave them to the Resident Inspector.

The Davis-Besse engineer told OIG he recalled that the Resident Inspector read CR 2000-0782 and reviewed the color photographs in his presence. He also recalled that the Resident Inspector expressed surprise upon reading the Condition Report and viewing the color photographs. The engineer told OIG that the Resident Inspector then left the engineer's work area to attend the licensee's morning management meeting. The engineer said he did not personally give the Condition Report to any other NRC inspector.

NRC Region III Conducts an Inservice Inspection (ISI) during 12 RFO

OIG learned that from April 17 through April 21, 2000, an inspector from the Region III Mechanical Engineering Branch, Division of Reactor Safety (DRS), conducted an announced routine ISI at Davis-Besse to assess the effectiveness of the licensee's program for monitoring degradation of the reactor coolant pressure boundary, risk significant piping system boundaries, and the containment boundary. According to Inspection Report, IR 50-346/2000005, dated April 27, 2000, during the ISI the Region III inspector observed the licensee's performance of three types of nondestructive examinations that included ultrasonic and magnetic particle examinations of reactor flange welds, located on the RPV head flange, and high pressure injection system pipe to elbow welds.

OIG review of Inspection Report 50/346/200005 revealed that the ISI Inspector assessed the licensee's identification and resolution of ISI problems by reviewing nine condition reports. One of the condition reports documented in the Inspection Report as being reviewed by the ISI Inspector was CR 2000-0781. This Condition Report described the licensee's examination of the reactor vessel head which resulted in the identification of boric acid residue on the reactor vessel head. This Condition Report also documented that leakage from the control rod drive

structure caused boric acid residue to accumulate on reactor vessel head studs and nuts. According to the Condition Report, the boric acid residue prevented a visual examination of the reactor vessel head studs. OIG noted that CR 2000-0781 referred the reader to CR 2000-0782 to address resolution of the control rod drive flange leakage condition.

OIG noted that the ISI Inspection Report did not identify any significant findings in the areas of reactor safety including, initiating events, mitigating systems, and barrier integrity.

OIG Interviews Region III Mechanical Engineering Branch Chief

The Chief of Mechanical Engineering Branch, the supervisor of the ISI Inspector, told OIG that typically an inspection plan is completed by the inspector prior to an ISI. However, he did not recall reviewing or discussing an inspection plan for the ISI conducted at Davis-Besse during 12 RFO. The Branch Chief said that prior to the start of 12 RFO, he was unaware of the boric acid leakage issues at Davis-Besse, including its effects on the containment air coolers and the radiation monitor filters. The Branch Chief stated that the Mechanical Engineering Branch did not typically review reactor coolant system leakage issues. His branch normally reviewed issues involving corrosion of metal components. For example, during an ISI, the inspector would review licensee testing of ISI related metals and reactor systems to ensure the tests are performed in compliance with American Society of Mechanical Engineers (ASME) codes.

The Branch Chief told OIG that if the Region III Division of Reactor Projects (DRP) staff had "flagged" boric acid issues and requested his branch to look at these specific issues, he might have directed inspection resources to that area. The Mechanical Engineering Branch Chief stated that if the boric acid issues were not called to the attention of DRS staff, ISI Inspectors would not address these issues unless they were discovered during the conduct of the ISI.

OIG Interviews ISI Inspector

The Mechanical Engineering Branch inspector who performed the ISI between April 17 and 21, 2000, told OIG that prior to arriving at Davis-Besse, he was not aware of any issues concerning unidentified reactor coolant system leakage or boric acid corrosion. He said he did not receive direction from Region III managers to focus his inspection activities on these issues, and he was not familiar with NRC Generic Letters pertaining to boric acid and corrosion issues (GL 88-05 and GL 97-01). According to the inspector, it was his decision as to where to focus his inspection activities after arriving at Davis-Besse during 12 RFO. He explained that after reviewing licensee condition reports and planned corrective actions and other planned licensee ISI activities, he decided to focus his inspection on the licensee's testing procedures for integrity of reactor vessel head weld and piping components.

The ISI Inspector recalled that while conducting the ISI, he observed a light coating of boric acid throughout the Davis-Besse containment area. He questioned the Senior Resident Inspector about the source of the boric acid residue, and the Senior Resident Inspector explained to him that for at least 2 years there had been problems at Davis-Besse involving leakage from either the pressurizer code safety relief valves or control rod drive mechanism flanges. The ISI Inspector told OIG that the Senior Resident Inspector informed him that the ongoing leakage had caused the layer of boric acid residue to form throughout the containment building. The ISI Inspector told OIG that because the Senior Resident Inspector appeared to have an understanding of the source of the leakage, he did not further question the Senior Resident Inspector.

The ISI Inspector told OIG that he did not specifically recall reviewing CR 2000-0782. However, he commented that he may have reviewed the Condition Report in preparation for the ISI. Nevertheless, the inspector noted that even if he had read CR 2000-0782, he probably would not have considered the boric acid accumulation on the RPV head within the scope of his inspection. The ISI Inspector did not recall seeing photographs attached to any of the condition reports he reviewed. The ISI Inspector acknowledged that he recalled reviewing CR 2000-0781, which addressed visual examinations of the reactor vessel head studs. However, based on the Senior Resident Inspector's explanation of the source of the boric acid leakage on the reactor vessel head studs, the ISI Inspector did not further question the plant condition described in CR 2000-0781.

OIG Interviews Former Davis-Besse Senior Resident Inspector

OIG interviewed the former Davis-Besse Senior Resident Inspector who was responsible for conducting NRC oversight activities during the Davis-Besse 12 RFO. He explained to OIG that the licensee performed thousands of activities during the outage, and he typically provided regulatory oversight of selected licensee activities to ensure that the activities were being conducted in a quality manner.

The Senior Resident Inspector told OIG that during 12 RFO, he usually attended licensee daily outage management meetings to discuss the plant's operating status which were conducted at the 12-hour personnel shift changes. If he or the Resident Inspector could not attend the management meetings, they reviewed the licensee's documentation of those meetings. He noted that condition reports were generated on a daily basis and presented at the daily management meetings. He said that Davis-Besse condition reports were also posted at the plant to allow the NRC resident inspectors to review them. The Senior Resident Inspector reviewed all condition reports issued by the licensee on a daily basis prior to attending daily management meetings to understand plant conditions and to determine whether the licensee properly categorized the safety significance of the conditions.

The Senior Resident Inspector told OIG that he did not recall specifically reviewing CR 2000-0782 or the photographs depicting the boric acid on the RPV head. However, the Senior Resident Inspector acknowledged that because he reviewed all condition reports issued by the licensee, it was quite possible that he read CR 2000-0782. He said that regardless of his direct knowledge of CR 2000-0782, near the start of 12 RFO he was aware that boric acid had been found on the reactor vessel head. The Senior Resident Inspector further commented that even if he had reviewed CR 2000-0782 and the attached photographs, he would not have considered the matter safety significant for two reasons. First, he explained, at the time the Condition Report was issued the plant was shut down; therefore, the condition of the RPV head would not have posed an immediate safety concern. Second, because the Condition Report was written early in the outage and included a corrective action plan to clean the RPV head, he would have concluded that the licensee would correct the matter prior to plant startup. Additionally, the Senior Resident Inspector speculated that even if he had read the Condition Report, he probably would not have focused on this issue because of his other inspection activities and responsibilities during 12 RFO.

The Senior Resident Inspector told OIG that, during 12 RFO, he believed that the source of the boric acid residue identified on the reactor vessel head was from control rod drive mechanism flange leakage. He said he was aware that the licensee planned to clean and inspect the reactor vessel head, but he added that the licensee's explanation concerning the source of the leakage seemed credible based on his knowledge of the plant's history with CRDM flange

leakage. He noted that he was aware that the licensee had cleaned the RPV head during previous outages and had found no significant degradation. The Senior Resident Inspector believed that the licensee was sensitive to boric acid corrosion based on inspection violations issued by NRC in 1998 concerning three missing or corroded nuts on the motor operated valve. Nevertheless, the Senior Resident Inspector told OIG that during 12 RFO he did not verify that the Davis-Besse reactor vessel head had been cleaned.

The Senior Resident Inspector told OIG that his responsibility included assessing information he received from the licensee and communicating important items to NRC Region III management. He said he often reported boric acid leakage issues to Region III managers, but no Region III managers instructed him, during 12 RFO or any other time, to review the causes of the unidentified reactor coolant system leakage or corrosion issues at Davis-Besse.

OIG Interviews the Davis-Besse Resident Inspector

The NRC Resident Inspector assigned to Davis-Besse during 12 RFO told OIG that he did not specifically recall the Davis-Besse service water systems engineer giving him CR 2000-0782 or the attached color photographs depicting boric acid deposits. However, he stated he had no reason to doubt what the Davis-Besse engineer stated, and he acknowledged that he may have been provided CR 2000-0782 by the engineer. The Resident Inspector said that in April 2000, he had been assigned at Davis-Besse for only 6 months, and he was not sufficiently trained to recognize the significance of boric acid on the RPV head or the red/brown rust deposits depicted in the photographs. According to the Resident Inspector, at that time, he was unaware of the significance of rust indications on the reactor pressure vessel head and the likelihood that they were symptoms of corrosion of carbon steel components. He explained that he probably did not recall reviewing CR 2000-0782 with the attached color photographs because, at that time, he would not have considered the described condition significant.

OIG Interviews Region III Headquarters Staff

The Chief, Reactor Projects Branch 4, DRP told OIG that based on his daily conversations with the Davis-Besse resident inspectors, he knew that the licensee had a long-term problem with unidentified reactor coolant system leakage, boric acid accumulation on the containment air coolers, and containment radiation monitor filter fouling which required frequent filter changes. The Branch Chief acknowledged that he documented these plant conditions in the logbook he maintained; however, until after the 2002 discovery of the degradation at Davis-Besse, he had never reviewed his logbook to identify trends.

The Reactor Projects Branch 4 Chief told OIG that based on reports he received from the Senior Resident Inspector, by the time Davis-Besse entered 12 RFO he was aware that the licensee had discovered boric acid corrosion on the RPV head and that the licensee had attributed the corrosion to control rod drive mechanism flange leakage. It was his understanding that the leakage had very little safety significance. The Branch Chief believed that the licensee told the Senior Resident Inspector that the RPV head had been cleaned and no problems were found. Therefore, he did not expect the Senior Resident Inspector to follow up on this issue.

The Reactor Projects Branch 4 Chief explained that during the morning management meetings at Region III, he reported what he perceived to be the more important operating conditions at Davis-Besse. He said that as a result, Region III senior managers were aware of those conditions. He did not relay all reports involving Davis-Besse boric acid issues because the

conditions did not always rise to a level that warranted discussion. However, he said he always mentioned incidents of unidentified reactor coolant system leakage trending up, containment entries to clean the containment air coolers, and filters being clogged by corrosive products (iron oxide).

The Reactor Projects Branch 4 Chief related to OIG that he did not recall if, during the September 1, 1999, and March 31, 2000, PPR meetings, unidentified reactor coolant system leakage or corrosion issues were discussed. He said that Region III managers did not consider the boric acid leakage or corrosion safety significant; therefore, managers did not direct inspection activities in these areas. However, he acknowledged that, in hindsight, the NRC's assessment of the significance of the boric acid leakage and corrosion was wrong. The Branch Chief believed the mistake was not that the staff was unaware of the symptoms of boric acid leakage and corrosion but that the staff did not comprehend the safety significance of these symptoms.

The Director, Division of Reactor Projects (DRP), Region III told OIG that he normally attended the daily morning management meetings where plant conditions were discussed. He said he did not recall any discussions during these meetings about repeated boric acid leakage or corrosion issues at Davis-Besse. He also said that he did not recall being briefed by the DRP staff regarding unidentified reactor coolant system leakage, licensee plans to shut down due to the unidentified reactor coolant system leak rate approaching technical specification limits, or boric acid residue affecting reactor components.

The DRP Director told OIG that he was aware of GL 88-05 and GL 97-01 and the issues they addressed. However, he said he was unaware of any Region III inspections at Davis-Besse to track the licensee's compliance with these Generic Letters. He noted that historically, because few problems were identified at Davis-Besse, the plant received a good rating from NRC which resulted in the licensee receiving minimum inspection oversight.

The Director, Division of Reactor Safety (DRS), Region III told OIG that he did not recall discussions during morning management meetings specifically involving unidentified reactor coolant system leakage or boric acid corrosion at Davis-Besse. He added that the Region III staff is now aware that the problems with the containment radiation monitor filters fouling with iron oxide and numerous entries into containment to clean the containment air coolers were significant indicators of corrosion.

In addition, the DRS Director stated that he was not aware of GL 88-05 until after the discovery of the degradation at Davis-Besse in 2002. He said that because the Office of Nuclear Reactor Regulation did not specify any follow up of this Generic Letter, that area was not incorporated into the routine Region inspection program. Regarding his knowledge of GL 97-01, he added that his first awareness of vessel head cracking issues was in 2001. The DRS Director told OIG he was unaware of any Region III inspections at Davis-Besse to track the licensee's compliance with these Generic Letters. The Director DRS added that over the years Davis-Besse had good operational performance; therefore, it received less NRC inspection resources and attention.

OIG Interviews Region III Administrator

The Region III Regional Administrator (RA) told OIG that he transferred from Region IV to become the Region III RA in January 1999. The RA observed that when he arrived at Region III, the Region had a number of facilities with problems that the regional staff was fully occupied in managing. Additionally, although Davis-Besse had been considered a good performer, by 1999 the plant's performance had been trending down. In light of the various resource challenges confronting Region III at that time, regional managers did not take the time to examine the significance of the boric acid leakage and corrosion at Davis-Besse.

The RA noted that he normally attended the daily morning management meetings; however, he was unaware of the boric acid leakage and corrosion at Davis-Besse at the time these issues were occurring. The RA said he was not aware that plant conditions at Davis-Besse had caused multiple entries to be made into containment to clean the containment air coolers or that in April 1999 the licensee had entered a limiting condition for operation and had initiated plans to shut down because the unidentified reactor coolant system leak rate was approaching Technical Specification limits. He told OIG that if Davis-Besse was approaching its Technical Specification limits for unidentified reactor coolant system leakage and planning to shutdown, he would expect this condition to be raised during the morning management meetings. Alternatively, he said that he would expect to be briefed on the matter if he did not attend the morning meeting. The RA acknowledged that although he did not recall this issue being brought to his attention, it is possible the Region III staff discussed it with him.

The RA told OIG that he would expect the Davis-Besse resident inspectors and the ISI Inspector to have questioned the condition if they reviewed CR 2000-0782 and the photographs depicting the boric acid on the vessel head. The RA commented that had CR 2000-0782 and the attached photographs been raised to Region III management, he believed Region III would have interjected itself in the agency's discussions concerning Davis-Besse following the issuance of NRC Bulletin 2001-01 (this Bulletin requested PWR licensees to conduct inspections of VHP nozzles prior to December 31, 2001).

The RA advised that while both the Reactor Projects Branch 4 Chief and the Senior Resident Inspector believed that they understood the causes of the boric acid leakage and corrosion at Davis-Besse, in hindsight, their assessment of these issues was wrong. The RA continued that because the boric acid issues at Davis-Besse were not perceived as safety significant by Region III managers, the Region did not direct inspection activities towards these matters during 12 RFO. He noted that the boric acid issues and Davis-Besse entering into a Limiting Condition for Operation were not discussed during the PPR meetings.

The RA told OIG that after the 1990 NRC review of PWR licensee boric acid corrosion prevention programs to ensure compliance with GL 88-05, the NRC decided not to pro-actively inspect licensee implementation of their programs. Consequently, the Region did not conduct any inspections to follow up on licensee's implementation of GL 88-05. The RA also stated that the Region never invoked inspection procedure IP 62001 to address boric acid issues at Davis-Besse. The RA told OIG that the Region did not pro-actively conduct inspections to verify licensee compliance with GL 97-01. The RA stated that had his staff presented the boric acid issues to senior Region managers in a more compelling manner or expressed concern about these issues during the PPR meetings, the Region would have directed inspection resources towards these issues.

OIG Interviews NRC Headquarters Officials

The former Director, Division of Licensing Project Management, NRR, told OIG that until recently NRC had not integrated Generic Letters with the licensing, inspection, and enforcement programs. He told OIG that NRC failed to dedicate the resources or to adequately coordinate to ensure that the inspection efforts were integrated with licensing issues. He added that the NRR staff did not adequately communicate some of the generic issues to the Regions. He said he believed that NRC missed opportunities to ensure appropriate licensee compliance with Generic Letters. He noted that because the NRC worked under an expectation that licensees would follow through on what they committed to concerning the open items, NRC did not conduct inspections to address those remaining items. The Director explained that often the NRC did not verify if licensees were properly fulfilling their commitments. With respect to GL 88-05, he noted that following the issuance of GL 88-05 and the related actions by the NRC, open items remained for licensees to take corrective actions. The Director acknowledged that NRR did not provide the regions additional direction or guidance for follow up on those open items.

The Director told OIG that there was an Inspection Procedure (IP62001) that provided guidance for NRC examination of boric acid leakage and corrosion. He commented that if someone in Region III had raised a concern about indicators of boric acid leakage at Davis-Besse, it would have been very easy for Region management to implement IP62001. He believed that Region III had a lot of information which argued that IP62001 should have been implemented at Davis-Besse. He said it was his expectation that someone in the Region III would have articulated concerns about the boric acid issues at Davis-Besse and recommended that IP62001 be implemented.

The Director also related to OIG that during the time prior to 12 RFO, Davis-Besse was exhibiting indicators such as entering the 6-hour Limiting Condition for Operation and experiencing operability concerns because of containment radiation monitor filter fouling. He said that when a myriad of data points regarding boric acid issues were observed at Davis-Besse, additional questioning and challenging of the conditions at the site could have determined the cause of the problems. He opined that these issues should have been raised in the Region III PPR meetings. He said that all of the information regarding plant equipment and operation was readily available to resident inspectors in the plant's control room.

During a previous OIG interview, a former NRC Associate Director, Project Licensing and Technical Assessment, NRR, who was involved in the November 2001 decision to allow Davis-Besse to operate until February 16, 2002, stated that had he been informed of the rust-colored boron identified as coming from the RPV head or about the plant's containment radiation monitor filters frequently clogging with iron oxide and having to be changed everyday, he would have questioned FENOC about the source of the rust-colored boron. The Associate Director said that the information obtained from these additional questions would have been considered in the NRC decision to authorize Davis-Besse to operate past the December 31, 2001, deadline established in NRC Bulletin 2001-01.

FINDINGS

1. OIG found that NRC Headquarters did not integrate the issues raised in Generic Letters 88-05 and 97-01 into NRC's inspection program. Therefore, there was no requirement from NRC Headquarters for the regions to inspect licensee programs established in response to the Generic Letters. This resulted in Region III conducting no inspections to ensure the implementation of these programs at Davis-Besse. Additionally, the failure of NRC Headquarters to emphasize to the regions the issues discussed in Generic Letters 88-05 and 97-01 hindered Region III's ability to recognize the significance of the boric acid leakage and corrosion identified at Davis-Besse during 12 RFO.

2. OIG determined that there was ineffective communication among Region III managers concerning boric acid leakage and corrosion at Davis-Besse. OIG found that between the April 1999 mid-cycle outage and 12 RFO, Davis-Besse Resident Inspectors reported numerous instances of boric acid leakage and its corrosive effects on reactor components to their Branch Chief. However, these issues were not raised and discussed during Region III daily management meetings. Consequently, the recurring reports of boric acid leakage and corrosion at Davis-Besse were not provided to the senior Region III managers and NRC Headquarters representatives participating in the daily management meetings.

3. OIG determined that Region III managers, while planning inspection activities for 12 RFO, reviewed NRC inspection reports which documented recurring boric acid leakage and its effects on reactor components at Davis-Besse. Region III also received numerous accounts of boric acid leakage and corrosion from the Davis-Besse Resident Inspectors. However, Region III managers did not direct any inspection activities during 12 RFO to verify that FENOC completed its action plan, documented in Region III Inspection Report 50-346/99010, to resolve its boric acid leakage and corrosion problems. Additionally, Region III did not direct any inspection resources to follow-up on the numerous reports it had reviewed of boric acid leakage and corrosion at Davis-Besse during 12 RFO.

4. OIG determined that the Senior Resident Inspector, Resident Inspector, and possibly the ISI Inspector reviewed Davis-Besse CR 2000-0782 during 12 RFO. These inspectors did not recognize the significance of the boric acid corrosion described in CR 2000-0782. Consequently, the Region III inspectors did not inquire into the Condition Report and did not verify that by the end of 12 RFO, FENOC had cleaned the reactor vessel head and had identified the source of the boric acid leakage.

5. Region III inspectors at Davis-Besse did not relay the information depicted in CR 2000-0782 to Region III managers. Consequently, the information contained in CR 2000-0782 was not provided to NRC Headquarters staff and was not considered in NRC's November 2001 decision to allow Davis-Besse to operate past December 31, 2001.

ATTACHMENT

Seven color photographs attached to CR 2000-0782 depicting red-rusty boric acid deposits and iron oxide on the Davis-Besse vessel flange identified during 12 RFO.