UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF THE INSPECTOR GENERAL

December 30, 2002

MEMORANDUM TO: Chairman Meserve

FROM: Hubert T. Bell
Inspector General

SUBJECT: NRC'S REGULATION OF DAVIS-BESSE REGARDING DAMAGE TO THE REACTOR VESSEL HEAD (CASE NO. 02-03S)

Attached is an Office of the Inspector General (OIG), U.S. Nuclear Regulatory Commission (NRC), Event Inquiry into concerns that the NRC allowed the Davis-Besse Nuclear Power Station to operate despite indications of cracking to the reactor vessel head. This Event Inquiry reviewed how the NRC reached its decision regarding a shutdown order for Davis-Besse which the staff prepared in draft but never issued in connection with potential circumferential cracking of reactor vessel head penetration nozzles.

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 this Event Inquiry.

Attachment: As stated

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

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OFFICE OF
INSPECTOR GENERAL

U.S. NUCLEAR
REGULATORY COMMISSION

EVENT INQUIRY

SPECIAL AGENT

OFFICE OF THE
INSPECTOR GENERAL

NRC'S REGULATION OF DAVIS-BESSE REGARDING DAMAGE TO THE REACTOR VESSEL HEAD

Case No. 02-03S December 30, 2002

OFFICE OF THE INSPECTOR GENERAL
EVENT INQUIRY

NRC'S REGULATION OF DAVIS-BESSE REGARDING DAMAGE TO THE REACTOR VESSEL HEAD

Case No. 02-03S

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BASIS AND SCOPE

This Office of the Inspector General (OIG) event inquiry was based on concerns from the Union of Concerned Scientists (UCS) regarding a perceived lack of U.S. Nuclear Regulatory Commission (NRC) oversight of the Davis-Besse Nuclear Power Station (Davis-Besse). UCS alleged that NRC allowed Davis-Besse to operate despite indications of significant cracking to the reactor vessel head. UCS alleged that NRC's failure to adequately regulate the plant nearly resulted in a loss-of-coolant accident.

In this inquiry, OIG reviewed how NRC reached its decision regarding a shutdown order which NRC prepared in draft but never issued in connection with potential circumferential cracking of reactor vessel head penetration nozzles at Davis-Besse. Specifically, this report (1) provides background information concerning reactor vessel head cracking at NRC-regulated nuclear power plants, including Davis-Besse; (2) describes NRC actions related to Davis-Besse and its response to NRC Bulletin 2001-01; and (3) explores NRC's decision not to issue a shutdown order to Davis-Besse and to permit the plant to operate 6 weeks beyond a December 31, 2001, deadline proposed in NRC Bulletin 2001-01.

OIG notes that this event inquiry did not review NRC or licensee actions or inactions that possibly gave rise to the current condition of the Davis-Besse reactor vessel head, nor did it review the adequacy of information provided by FirstEnergy Nuclear Operating Company, the NRC license holder for Davis-Besse, to NRC relevant to this matter, because these matters were the subject of separate inspection and investigative activities conducted by NRC.

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GLOSSARY OF TECHNICAL TERMS

Axial Crack – A crack that propagates along the length of an object.

Boric Acid – A chemical added to the reactor coolant system to moderate the fission process in some reactor designs.

Circumferential Crack – A crack that propagates around an object's width or circumference.

Control Rod – A rod, plate, or tube containing a material such as hafnium, boron, etc., used to control the power of a nuclear reactor. By absorbing neutrons, a control rod prevents the neutrons from causing further fission.

Control Rod Drive Mechanism (CRDM) Nozzle — A type of reactor vessel head penetration nozzle that supports and guides the control rods which control the power of a nuclear reactor and, therefore, are critical to a licensee's ability to stop the fission process and shut down the reactor.

Coolant – A substance circulated through a nuclear reactor to remove or transfer heat. The most commonly used coolant in the United States is water.

J-groove Weld – The structural retaining weld of the CRDM nozzle located at the interior surface of the reactor vessel head.

Loss-of-Coolant Accident – A reactor accident that results in a loss of the primary coolant from the core at a rate in excess of the capability of the reactor makeup system due to one or more breaks in the reactor coolant pressure boundary. Such an event or sequence of events could result in the melting of part of the fuel in the reactor core.

Pressure Vessel – In addition to vessel internal structures, a thick, strong-walled steel container housing the core of most types of power reactors. It usually contains the fuel moderator, neutron reflector, thermal shield, and control rods.

Pressurized Water Reactor – A light water reactor in which the water used as a moderator is kept under pressure, preventing it from boiling at normal temperatures.

Reactor Coolant Pressure Boundary – In addition to the reactor pressure vessel, those components, pipes, and fittings that contain the primary reactor coolant (e.g., water).

Reactor Coolant System – In pressurized water reactors, the system used to remove energy from the reactor core and transfer that energy via steam generators to the steam turbine.

Reactor Vessel Head – The removable top section of a reactor pressure vessel. It is bolted in place during power operation and removed during refueling to permit access of fuel handling equipment to the core.

Technical Specifications – Part of an NRC license that establishes requirements for items such as safety limits, limiting safety system settings, limiting control settings, limiting conditions for operation, surveillance requirements, design features, and administrative controls.

Vessel Head Penetration (VHP) Nozzle – A steel sleeve welded into the reactor vessel head through which the control rod drive mechanisms pass. The VHP nozzle also maintains reactor coolant pressure.

BACKGROUND

Role of the Vessel Head and Vessel Head Penetration Nozzles

The risk of a nuclear power plant accident with a significant amount of radioactivity released offsite to the public is very small. This risk is small, in part, due to diverse and redundant barriers and numerous safety systems in the plant. To prevent the release of radioactive material to the environment, nuclear power plants are constructed with several barriers between the radioactive material and the environment surrounding the plant. The first barrier is the fuel cladding, sealed metal tubes in which ceramic pellets of low enriched uranium fuel are encased. The second barrier is the heavy steel reactor pressure vessel (RPV) and the primary coolant system piping, which acts as the "reactor coolant pressure boundary." 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 from the reactor system in the unlikely event of a serious accident.

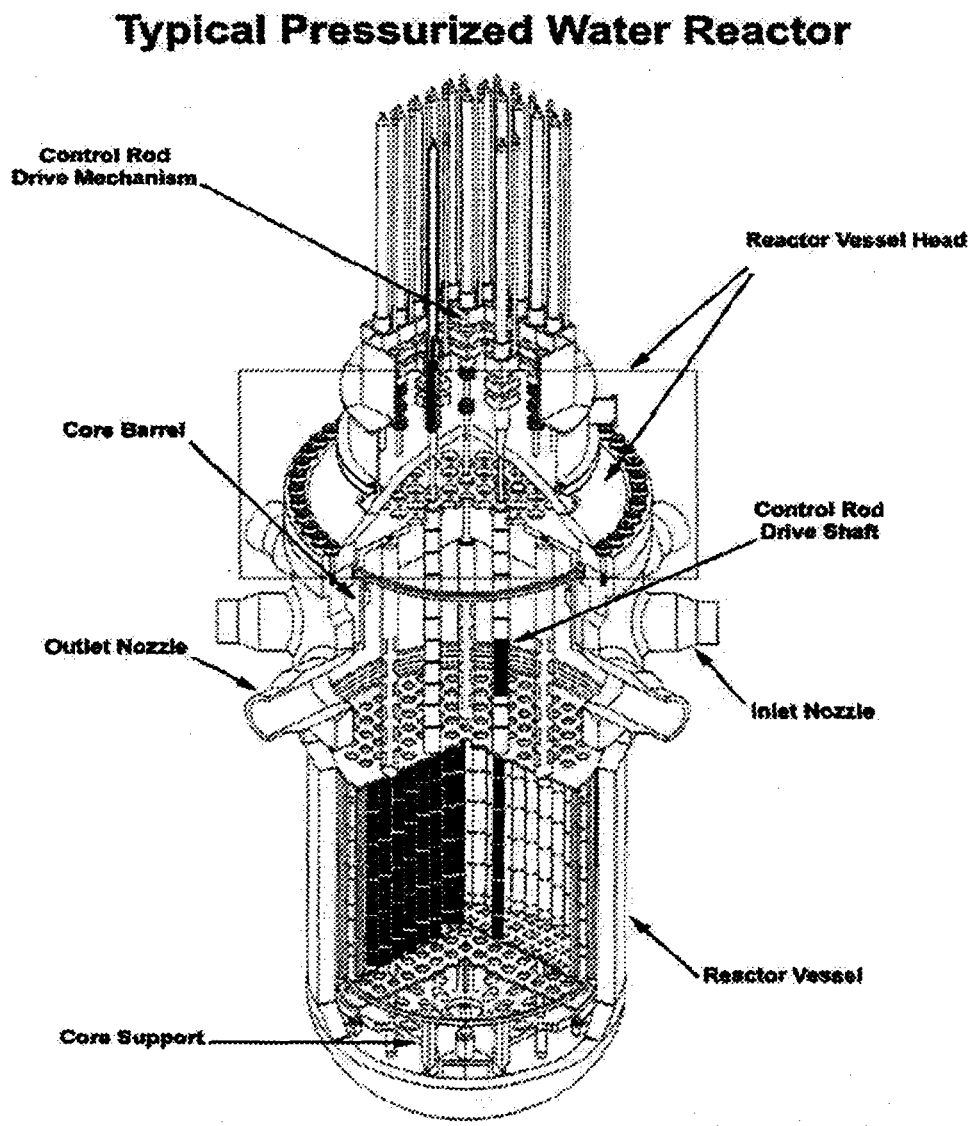

Figure 2. Typical Pressurized Water Reactor (PWR)

The reactor vessel head covers the reactor vessel in a nuclear reactor (see Figure 1). Integrity of the vessel head, its components, and the vessel itself are critical to maintain the second barrier of the defense-in-depth principle. The vessel head resembles a round cap that is bolted to the vessel and is approximately 15 feet in diameter. The reactor vessel head is constructed of 6-inch thick carbon steel with a 1/4- to 3/8-inch thick stainless steel inner cladding. The protective layer of cladding is necessary because the water inside the reactor vessel contains dissolved boric acid (used to assist in reactor control), and boric acid corrodes carbon steel.

The reactor vessel head typically contains 65 to 70 holes into which vertical tubes called vessel head penetration (VHP) nozzles (see Figure 2) are placed. These nozzles are permanently implanted into the reactor head and are welded tight to prevent boric acid from coming into contact with the reactor vessel exterior. The reactor pressure vessel head is an integral part of the reactor coolant pressure boundary and, as noted above, its integrity is important to the safe operation of the plant. Likewise, most VHP nozzles support and guide the control rods which control the power of a nuclear reactor and, therefore, are critical to a licensee's ability to stop the fission process and shut down the reactor. These nozzles are called control rod drive mechanism (CRDM) nozzles.

VHP Nozzle Cracking Discovered at Four Power Plants

Between November 2000 and April 2001, plant operators at four pressurized water reactors (PWRs) discovered cracking of their plants' VHP nozzles. In two cases — at Oconee Nuclear Station Unit 1 in November 2000 and Arkansas Nuclear One Unit 1 in February 2001 — the cracking was axial and determined by NRC to be of limited safety concern. This was because leakage related to such cracking would ordinarily be identified and repaired long before a serious safety consequence, such as a sudden loss-of-coolant accident (LOCA), could occur. A LOCA involves the loss of the coolant needed within the reactor pressure vessel to keep the nuclear fuel in the reactor core from overheating. However, circumferential cracks identified in two CRDM nozzles at Oconee Nuclear Station Unit 3 (ONS3) in February 2001 and at Oconee Nuclear Station Unit 2 (ONS2) in April 2001 were viewed by NRC as more serious. Of great concern was axial cracking above the J-groove weld on one CRDM nozzle at ONS3 that had become circumferential. This was considered a very significant safety concern by both NRC and the nuclear industry because a circumferential crack above the J-groove weld, if it went completely around a CRDM nozzle and through the nozzle wall, could lead to ejection of the control rod drive from the vessel head and could result in a LOCA.

NRC Response to Potential Safety Implications

The incidents of cracked and leaking VHP nozzles at Oconee's three units and at Arkansas Nuclear One Unit 1 raised concerns about the structural integrity of VHP nozzles throughout the PWR industry. This was because many PWR VHP nozzles had undergone similar design and fabrication processes. NRC issued Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," on August 3, 2001, to all licensees operating pressurized water nuclear power plants. That bulletin described instances of cracked and leaking VHP nozzles, including CRDM nozzles.

NRC Bulletin 2001-01 asked all NRC licensees of PWRs to provide specific information concerning the structural integrity of their plants' VHP nozzles. Additionally, using criteria published in NRC Bulletin 2001-01, all PWR licensees were required to self-identify their plant-specific ranking of susceptibility to VHP-nozzle cracking. The bulletin provided a ranking model to assess each plant's susceptibility to primary water stress corrosion cracking (PWSCC) which was determined to be the root cause of CRDM nozzle cracking at ONS2 and ONS3.

Based on a plant's rank, Bulletin 2001-01 presented, but did not require, specific inspection activities that NRC staff deemed logical for each level.

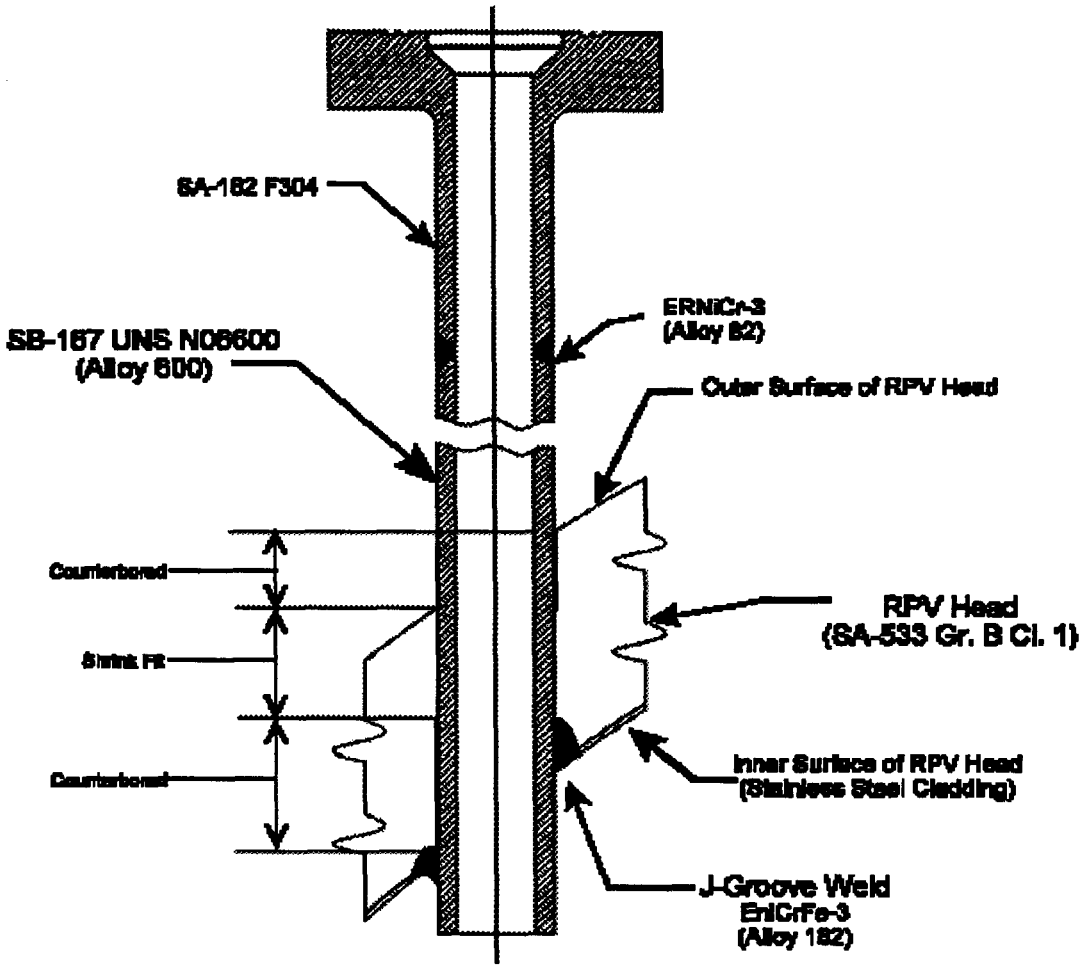

Figure 3. Schematic of Typical CRDM Nozzle Penetration

Bulletin 2001-01 proposed that the population of PWR plants be divided into four groups (or "Bins") based on their potential for having or developing VHP cracking:

Bin 1: Plants which had demonstrated the existence of PWSCC in their VHP nozzles (through the detection of boric acid deposits) and for which cracking could be expected to recur and affect additional VHPs;

Bin 2: Plants which could be considered as having a high susceptibility to PWSCC based upon a susceptibility ranking of less than 5 effective full power years (EFPY) from the ONS3 condition;

Bin 3: Plants which could be considered as having a moderate susceptibility to PWSCC based upon a susceptibility ranking of more than 5 EFPY but less than 30 EFPY from the ONS3 condition; and

Bin 4: The balance of plants which could be considered as having low susceptibility based upon a susceptibility ranking of more than 30 EFPY from the ONS3 condition.

The recommended inspection activities for plants in each of the four bins depended on each plant's susceptibility to cracking. For example, the August 3, 2001, bulletin recommended qualified volumetric examination of 100 percent of the VHP nozzles for Bin 1 plants and, at a minimum, qualified visual examination of 100 percent of the VHP nozzles for Bin 2 plants. The bulletin indicated that inspections by December 31, 2001, would be an appropriate way to handle plants that had either experienced cracking or leaking or were considered highly susceptible to these conditions (Bins 1 and 2). The goal of these inspections was to confirm the structural integrity of the VHP nozzles so as to avoid a possible CRDM nozzle ejection resulting in a LOCA.

Each PWR licensee was required to provide its plans for inspecting its RPV head penetrations and/or the outside surface of the RPV head to determine whether the nozzles were leaking. Licensees of plants with a high-susceptibility ranking for developing cracks were required to provide NRC with a description of their plans for future inspections and their basis for concluding that those inspections would assure that regulatory requirements related to reactor coolant leakage would be met. Furthermore, if a licensee with a high-susceptibility ranking lacked plans to include inspections for VHP nozzle cracking before December 31, 2001, that licensee was to provide NRC with its basis for concluding that the regulatory requirements would continue to be met until the inspections were performed.

When preparing NRC Bulletin 2001-01, the NRC staff was aware of the financial and scheduling difficulties that some plants would face in conducting the recommended inspections, which, for Bin 1 and Bin 2 plants, could be performed only when the plant was shut down. Anticipated difficulties included a revenue loss for plants that had not planned an outage during that time frame and would need to arrange for this unanticipated outage. Furthermore, most licensees did not have the equipment or staff onsite to perform the necessary inspections and would, consequently, need to vie with other plants to schedule the necessary personnel and equipment. As a result, the staff allowed Bin 1 and Bin 2 plants until December 31, 2001, to accomplish the suggested inspection activities. Staff told OIG that the rationale for the December 31, 2001, deadline was not rooted in scientific analysis, but the date was viewed as practical in that it would allow a 5-month window for plants to either perform the inspections during already-scheduled outages or to plan for and conduct an unscheduled outage.

DETAILS

I. NRC ACTIONS RELATED TO DAVIS-BESSE FOLLOWING ISSUANCE OF NRC BULLETIN 2001-01

Licensees Respond to NRC Bulletin 2001-01

From August to November 2001, NRC received responses to NRC Bulletin 2001-01 from licensees of the 69 operating PWR plants. Of the 69 plants, 5 were characterized as Bin 1, 7 as Bin 2, and the remainder as either Bin 3 or Bin 4. OIG learned that during this period the staff was engaged in discussions with the licensees for the 12 plants identified by NRC as having identified cracking or as being highly susceptible to cracking (Bin 1 and Bin 2). These discussions focused on which inspection would be performed and at what point in time.

According to NRC staff, simultaneous with the agency's technical review of licensee responses to the Bulletin, the staff began to consider how they would respond to any Bin 1 or Bin 2 plants that decided not to shut down and sought to operate for a period of time beyond 2001 without inspecting for VHP nozzle cracks. The staff decided the NRC response would be to exercise its regulatory authority to require a licensee to cease power operations. To that end, the staff began preparing draft shutdown orders[1] in October 2001 for two plants, D.C. Cook Unit 2 and Davis-Besse Nuclear Power Station (Davis-Besse), because the plants had indicated an unwillingness to conduct inspections before December 31, 2001.

OIG learned that Office of Nuclear Reactor Regulation (NRR) staff and management pursued a "dual track" with regard to the high-susceptibility plants. On one side, NRR staff continued to engage the licensees regarding VHP nozzle cracking issues and the staff was open to reviewing any new and relevant information that would justify operation beyond December 31, 2001. This dialog, OIG was told, focused on ensuring that licensee management was aware of NRC's concerns about the potential safety significance of VHP nozzle cracking. Alternatively, NRR was positioned to issue an order to any licensee that did not commit to shutting down its facility and performing the recommended inspections by December 31, 2001.

By November 1, 2001, 10 of the 12 Bin 1 and Bin 2 plants had either already performed satisfactory inspections of the VHP nozzles or made the decision to shut down to perform inspections prior to the December 31, 2001, deadline. By mid-November, NRC had received inspection results from six of these plants. Of the six plants, four reported that they had identified small circumferential cracks. In addition, one Bin 3 plant had also reported discovering one circumferential crack during a planned refueling outage.

In reviewing these findings, NRC determined that none of the cracks identified by the licensees were of an immediate safety significance. NRC staff informed OIG that during this period they continued to analyze and evaluate postulated crack growth rates, as well as the potential consequences if a circumferential crack led to a CRDM ejection and LOCA.

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[1] Title 10, Code of Federal Regulation, Part 2.202 authorizes the NRC Commission to institute an order to modify, suspend, or revoke a nuclear power plant's license if the Commission finds that the public health, safety, or interest so requires. Signature authority for such orders, which may result in the shutdown of a power plant, is delegated to the director of NRC's Office of Nuclear Reactor Regulation.

With respect to the two remaining Bin 1 and Bin 2 plants — D C. Cook Unit 2 and Davis-Besse — NRC continued to pursue a dual track approach. While NRR staff continued discussions with each licensee, the staff also began to prepare shutdown orders for these plants. By mid-November 2001, NRC had authorized D.C. Cook an extension to operate until its planned refueling outage commencing January 19, 2002. In granting the 19-day extension, NRC staff credited the licensee for time the plant was shut down earlier in the year due to other events. This left Davis-Besse as the only plant that did not commit to perform the requested inspection activities before the year's end.

NRC Prepares Shutdown Order for Davis-Besse

FirstEnergy Nuclear Operating Company (FENOC), the license holder for Davis-Besse, provided its initial response to NRC Bulletin 2001-01 in a letter dated September 4, 2001. Because of plant age and other similarities to ONS3, FENOC ranked Davis-Besse as a "high-susceptibility" plant for developing cracks. Nevertheless, FENOC informed the staff in this letter that it did not intend to conduct qualified visual inspections of the RPV head until its next (13th) refueling outage (RFO), then scheduled for March 30, 2002. This initial response was later supplemented with additional information during meetings and in correspondence between FENOC and NRC in October 2001. In each of these communications, FENOC continued to assert that based on previous inspections it conducted, analyses it performed, its ability to identify cracks, and industry evaluations and findings, there was reasonable assurance that the Davis-Besse plant would continue to operate safely until its next scheduled outage.

The licensee's justification to defer inspections recommended by the bulletin relied, in large part, on the condition of the reactor vessel head penetrations during the refueling outages of 1996, 1998, and 2000. The licensee submitted photographs of the reactor vessel head taken during these outages. However, due to the poor quality of the photographs, the NRC staff concluded that the licensee's efforts would not justify an exception to the bulletin's requirements.

FENOC management told OIG that it advised NRC staff of the adverse financial and other consequences of a shutdown occurring prior to 13RFO. Specifically, FENOC management explained to senior NRR officials the financial costs associated with an unscheduled shutdown for VHP inspections, particularly when it would still need to perform a scheduled refueling outage a few months later. FENOC informed NRC that a shutdown for VHP nozzle inspections during the fall 2001 might have an adverse impact on winter electric supply for Northwestern Ohio. In addition, FENOC explained to NRC its difficulty in scheduling the specialized personnel and equipment necessary to perform the inspections. FENOC officials also briefed NRC on the increased radiation exposure inspectors would receive performing VHP nozzle inspections not associated with a refueling outage.

Through mid-November 2001, FENOC representatives continued to advocate during meetings and telephone discussions with NRR staff that Davis-Besse could defer inspections recommended by the bulletin until 13RFO and operate safely. Nevertheless, FENOC was unable to convince NRR staff that Davis-Besse was unique from six similar plants that had identified VHP nozzle cracking. In a letter to FENOC dated November 19, 2001, the NRR Project Manager for Davis-Besse again made NRC's position clear, stating:

> [T]he Davis-Besse facility is considered to have a high susceptibility to primary water stress corrosion cracking (PWSCC) at reactor pressure vessel head penetration (VHP) nozzles . . . . With respect to the seven operating Babcock

> and Wilcox (B&W) facilities, the other six facilities (Davis-Besse excluded) have performed inspections as recommended in the bulletin and all six facilities have identified cracking in VHP nozzles and/or the associated J-groove welds. More significantly, three of these B&W facilities have identified circumferential cracking in the VHP nozzles. Based on this evidence, the staff believes there is a more than reasonable likelihood that the Davis-Besse facility currently has cracking in one or more VHP nozzles and/or the associated J-groove welds, the extent of which is not known.

On November 16, 2001, the NRR Director forwarded a draft shutdown order for Davis-Besse to the NRC Executive Director for Operations (EDO). The cover memorandum, signed by the NRR Director, asserted to the EDO that:

> [A]dequate protection of the public health and safety cannot be assured without successful completion of the recommended inspections [and it] is unacceptable for a facility to continue operation beyond December 31, 2001, without performing the recommended inspections.

The draft order, prepared for the NRR Director's signature, described the agency's technical basis for the proposed shutdown and contained empirical and analytical data and a discussion of risk implications associated with VHP nozzle cracking and leakage. The order required Davis-Besse to (1) cease power operations by December 31, 2001, and bring the unit to cold shutdown or (2) demonstrate to NRC that there was "reasonable assurance" that the VHP nozzles were free of significant defects. This order had been developed by NRR technical staff, and reviewed and concurred in by NRR senior management and the NRR Director. In addition, NRC's Office of the General Counsel (OGC), the legal arm of the agency, reviewed and identified no legal objection with the regulatory action. The draft order outlined the conclusions reached by the NRR Director, stating, in part:

> Based on the information provided by the licensee and the extent of vessel head penetration cracking and leakage found at multiple facilities, I find that the licensee has not provided an adequate basis to operate beyond December 31, 2001, without performing inspections to verify the integrity of the reactor coolant pressure boundary at Davis-Besse Nuclear Power Station, Unit No. 1. Performance of the recommended inspections prior to operation beyond December 31, 2001, is timely and necessary given Davis-Besse's high-susceptibility ranking and the extent of cracking and leakage found at other similarly-designed facilities. Consequently, I find that a potentially hazardous condition exists and warrants the issuance of an Order that modifies the operating license for Davis-Besse Nuclear Power Station, Unit No. 1, to require that (1) the facility be shut down by December 31, 2001, and proceed to the cold shutdown or lower mode, and (2) the licensee perform inspections to demonstrate to the NRC that there is reasonable assurance that the vessel head penetration nozzles are free of defects prior to subsequent plant operation.

On November 21, 2001, the EDO sent the draft shutdown order to the NRC Commission with a new cover memorandum that he signed. The EDO's cover memorandum advised the Commission of NRC's intent to issue the order no sooner than 5 business days after the

Commission received it.[2] The staff also advised the Commission that it would continue to engage the licensee in dialog regarding the matter.

FENOC Offers Compensatory Measures

OIG learned that on or about November 27, 2001, the NRR Director instructed a senior NRR manager to contact FENOC and advise the licensee that a draft shutdown order for Davis-Besse had been forwarded to the Commission. OIG was told that, consequently, the NRR senior manager contacted the president of FENOC and informed him that a shutdown order had been forwarded to the Commission and asked if there were any compensatory actions FENOC could take that would persuade NRC not to issue the shutdown order. By the afternoon of November 27, 2001, NRR staff received a list of steps FENOC was willing to take to avoid a shutdown of Davis-Besse.

On November 28, 2001, the NRC staff hosted a public meeting in Rockville, MD, with FENOC representatives to discuss the licensee's position regarding VHP nozzle inspections. During this session, the licensee provided its revised probabilistic safety assessment related to continued operations beyond December 31, 2001. At that time, FENOC also formally committed to take specific steps to avoid an NRC shutdown order and continue operations beyond December 31, 2001.

As compensatory measures, FENOC committed to the following: (1) shut down Davis-Besse by February 16, 2002, to begin the refueling outage 6 weeks earlier than the 13 RFO scheduled outage date of March 30, 2002; (2) perform 100-percent qualified visual inspection and non-destructive examination of VHP nozzles and, should cracks be detected, characterization of flaws through destructive examination; (3) reduce reactor coolant system hot leg temperature from 605°F to 598°F for the remainder of the operating cycle; (4) maximize availability of the plant's redundant critical safety systems by minimizing online maintenance and testing of these systems; and (5) provide increased human factors reliability through additional training and dedicated personnel. These compensatory measures were intended to reduce the likelihood of a LOCA as well as to improve Davis-Besse's ability to respond should such an event occur. In addition, Davis-Besse staff informed NRR management that the plant could not initiate 13RFO earlier than February 16, 2002, because it was unable to secure delivery of replacement fuel any sooner.

NRC Considers FENOC Compensatory Measures

OIG learned that following the November 28, 2001, public meeting and licensee presentation, an NRR associate director convened an internal staff meeting of approximately 12 to 16 NRC staff to discuss FENOC's proposal and commitments and obtain a consensus on how NRC should proceed. Those present for the meeting, which lasted several hours, included NRR technical experts in material engineering and probabilistic risk assessment as well as representatives from NRR management and the OGC. OIG was told that the NRR Director attended a portion of the meeting but left prior to the taking of consensus among attendees. NRC staff were unable to provide OIG with any documentation concerning discussions, analysis, or conclusions related to this meeting or with a list of attendees. However, staff who participated told OIG that during the meeting, participants debated the relative value of

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[2]OIG determined that due to holidays and weekends, the order would have been issued by staff no sooner than November 29, 2001.

FENOC's commitments intended to reduce a postulated CRDM nozzle failure. With respect to FENOC's proposal, the staff said they considered the effect of variables such as RPV head operating temperature and time on crack growth rates and studies concerning the crack size required to cause CRDM nozzle ejection. Participants also said they considered the steps offered by the licensee which were designed to mitigate the consequences of a possible event (i.e., LOCA).

NRR staff present at the November 28, 2001, staff meeting told OIG they participated in two separate votes concerning Davis-Besse's request for continued operation. First, the NRR associate director who convened the meeting asked staff to consider whether to accept FENOC's proposal to continue operating until February 16, 2002, at which time it would initiate 13RFO and conduct qualified visual inspections pursuant to NRC Bulletin 2001-01. During this initial vote, the staff voted to either accept FENOC's offer or go forward with the shutdown order. Staff did not reach a unanimous decision during this vote; three staff members voted to proceed with the shutdown order. Subsequently, the NRR associate director called for a second vote. This vote focused solely on whether NRR staff thought that Davis-Besse would experience a CRDM nozzle ejection or other safety significant event if allowed to continue operating until February 16, 2002. On this matter, NRR staff reached unanimous agreement that a CRDM nozzle ejection before February 16, 2002, was unlikely and that there was no significant safety concern that would preclude continued operation until that date.

On November 29, the results of the November 28, 2001, staff meeting were provided to the NRR Director. OIG learned that following receipt of this information, the NRR Director met with the three staff members who initially voted against continued operation to learn whether they were comfortable with the outcome of the second vote. OIG was told by the three staff members and by the NRR Director that the staff members told the NRR Director that they did not feel strongly enough about their concern to file a Differing Professional View (DPV) or Differing Professional Opinion (DPO).[3] Following these discussions, the NRR Director concluded that there was sufficient information available to justify operation of the Davis-Besse facility for 6 weeks past the deadline established in Bulletin 2001-01. He subsequently informed the Commission that the staff and licensee had reached a mutually acceptable resolution of the matter. The draft order requiring Davis-Besse to cease operations was never issued.

On November 30, 2001, the NRR staff briefed the Commissioners' technical assistants on NRR's decision not to issue the shutdown order. NRR staff described to the technical assistants the risk assessment performed by NRR, the compensatory measures submitted by FENOC, and how NRR's decision to allow Davis-Besse to operate until February 16, 2002, comported with the five safety principles outlined in NRC's risk-informed decisionmaking

[3]NRC's DPV/DPO processes are intended to afford opportunities for staff to formally disagree with agency decisions.

guidelines.[4] NRR staff noted that although four out of five safety principles were not explicitly met,[5] the staff concluded that Davis-Besse could operate safely until February 16, 2002.

Significant Reactor Vessel Head Degradation Discovered at Davis-Besse

On February 16, 2002, Davis-Besse began a refueling outage that included inspections of the VHP nozzles. In conducting these inspections, Davis-Besse identified that 5 of its 69 CRDM nozzles had either axial or circumferential cracks. Specifically, the licensee identified the 5 CRDM nozzles as having a total of 24 cracks ranging in length from approximately ½ to 4 inches. Nine of the cracks were "through wall"[6] axial cracks sufficient to allow leakage. Only 1 of the 24 cracks was circumferential (1.18 inches) and it was not "through-wall" in depth. According to NRR staff, the size and number of cracks and leaks identified at Davis-Besse were less than NRR's conservative estimates.

During the repair process, the licensee conducted a visual examination and identified a large cavity in the RPV head on the side of one CRDM nozzle (see Figure 3). Followup testing indicated that the low alloy steel RPV head material adjacent to the nozzle had disintegrated and that the affected (or "wastage") 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 found to be approximately 3/8 inch which was the stainless steel cladding on the inside surface of the RPV head. This was the only material preventing a breach of the reactor coolant pressure boundary and leak of radioactive coolant into the containment building.

NRC staff told OIG that the degradation found at Davis-Besse that was identified as a result of inspections performed pursuant to NRC Bulletin 2001-01 was unexpected, and it was not the purpose of the bulletin to identify this type of problem. (As noted earlier, OIG did not review NRC or licensee actions or inactions that possibly gave rise to the degradation of the Davis-Besse reactor vessel head.) NRC staff told OIG that the bulletin was intended to facilitate the identification of potential circumferential cracking that could lead to ejection of a rod and possibly result in a LOCA. As one NRC engineer stated, vessel head corrosion "was not on the radar screen," and not the focus of NRC Bulletin 2001-01.

One Year After Davis-Besse Decision, NRC Documents Its Safety Rationale

One year after the NRR staff accepted FENOC's compensatory measures and permitted Davis-Besse to continue operating 6 weeks past December 31, 2001, before performing inspections pursuant to NRC Bulletin 2001-01, NRC provided FENOC with a documented rationale for that decision. This rationale, which concluded that "the likelihood of a LOCA at Davis-Besse due to

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[4]These principles are described in NRC Regulatory Guide 1.174, An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis. In materials used to brief the technical assistants, the five safety principles were summarized as (1) current NRC regulations are met, (2) NRC's defense-in-depth philosophy is maintained, (3) sufficient safety margins are maintained, (4) minimal increase in risk of core damage, and (5) risk measurement is monitored using performance measurement strategies.

[5]The single safety principle that NRR staff predicted would definitively be met by allowing Davis-Besse to continue to operate until February 16, 2002, was the fourth principle listed in footnote 4, minimal increase in risk of core damage.

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

CRDM nozzle ejection during the period of operation from December 31, 2001, to February 16, 2002, was acceptably small," was transmitted in an eight-page enclosure to a December 2, 2002, letter from an NRR senior manager to FENOC's Chief Operating Officer. In the letter, the NRR manager characterized NRC's delay in documenting its rationale as an "oversight." The letter acknowledged that a commitment to develop such documentation had been made 1 year earlier in a December 4, 2001, letter from NRC to FENOC conveying NRC's acceptance of FENOC's proposal to operate Davis-Besse until February 16, 2002. However, according to the December 2002 letter, "staff failed to complete the documentation of its safety rationale once the December 4, 2001, letter had been issued."

II. NRC DECISION NOT TO ISSUE PROPOSED DAVIS-BESSE SHUTDOWN ORDER

NRC Weighs Financial Implications of Regulatory Action

Since the early 1990s, the U.S. electric industry has moved away from traditional rate-based regulation towards increased competition in a deregulated marketplace. Prior to deregulation, a

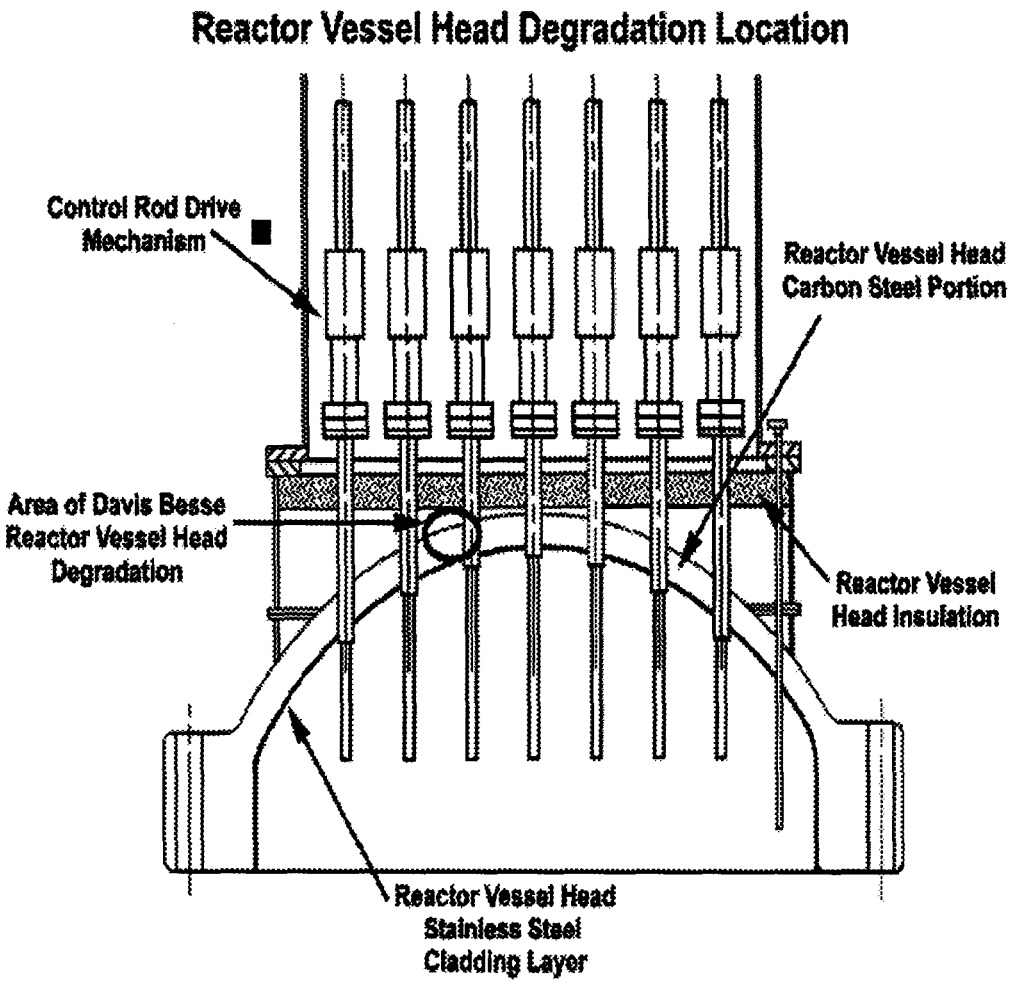

Figure 4. Reactor Vessel Head Degradation Location at Davis-Besse

power producer could pass on most of its costs to consumers, including costs associated with a forced shutdown by a Federal regulator. Under today's deregulation, more costs are borne by the corporate shareholders rather than the consumers, and utilities seek to keep these costs low. During this same time period, NRC established as one of its performance goals the reduction of unnecessary regulatory burden. The NRC has defined unnecessary regulatory burden on NRC licensees as requirements that go beyond what is necessary and sufficient to provide reasonable assurance that the public health and safety will be protected.

The NRR Director told OIG that in accordance with NRC's performance goal to reduce unnecessary regulatory burden, it is appropriate for the staff to consider licensee costs in its decisionmaking process. He stated:

> If we have flexibility and we can reduce the regulatory burden by making a different decision and we still maintain safety, then that's fine — we should take that business case into consideration. And that's no different than any decision we make. We use the four performance goals, we weigh them, but maintain[ing] safety is always paramount.

NRR staff acknowledged to OIG that they considered financial impact for all affected plants when they prepared Bulletin 2001-01. Staff said they selected December 31, 2001, as the deadline for Bin 1 and 2 plants to conduct the suggested inspection activities pursuant to Bulletin 2001-01 partly because they believed the date would allow sufficient time for plants to plan for and accomplish the inspection activities without undue financial burden.

Staff also said that in responding to FENOC's request to extend the December 31, 2001, deadline, they recognized that the licensee sought to minimize the financial impact an earlier shutdown would have on Davis-Besse. To that end, NRC pursued a dialog with FENOC that ultimately resulted in a compromise. One NRC engineer told OIG that he thought there were only two sets of equipment in the country to perform the kind of examinations that were required and that it did not make sense to order a shutdown on December 31, 2001, only to have a licensee sit for 6 weeks before that equipment became available. In an E-mail message between NRR managers, one senior NRR manager commented:

> [W]e can justify today to shut these plants down however we are exercising discretion noting it would clearly be punitive to immediately shut a plant down and they sit there for a month waiting to obtain the correct inspection equipment etc. . . . .

It is undisputed by NRC and FENOC officials that a shutdown order would adversely affect the licensee financially. A senior NRC official explained that the need to issue a shutdown order would indicate a clear disconnect between the agency and licensee, where the agency concludes that a plant should be shut down, and industry does not feel a shutdown is necessary. He stated that such a result would indicate that the parties were either misaligned in their technical assessments or held differing values related to public health and safety.

An NRR manager stated that from the perspective of external stakeholders, the need for a shutdown order is not a positive indicator for the nuclear industry and would destabilize confidence in the nuclear industry's ability to make the right decisions. Another NRR engineer explained to OIG that a nuclear plant operator would suffer a "black eye" if issued a shutdown order even if the licensee was positioned to fight the matter. He said just litigating the matter would jeopardize the licensee's relationship with the NRC, result in bad press locally, and could

even affect the licensee's financial rating. With respect to Davis-Besse, one NRR senior official noted to OIG that the staff considered the large cost FENOC would incur if ordered to shut down, particularly if no cracking was found upon inspection.

The NRR Director acknowledged to OIG that after NRC Bulletin 2001-01 was issued, each PWR licensee made a business decision on how to proceed. As noted earlier, the bulletin asked licensees considered highly susceptible to developing cracks to either (1) conduct inspections by December 31, 2001, to confirm the structural integrity of the VHP nozzles so as to avoid a possible CRDM nozzle ejection and LOCA or (2) or provide NRC with its basis for concluding that the regulatory requirements would continue to be met until the inspections were performed at a later date. The NRR Director explained that these licensees had options in responding to the bulletin. Some plants had outages scheduled prior to December 31, 2001, which made compliance with the bulletin less difficult. However, other licensees that did not have outages scheduled in that time frame had to make a business decision to either shut down prematurely to conduct inspections or develop a technical basis to justify continued operations and engage NRC on that basis.

With respect to Davis-Besse specifically, OIG reviewed a November 21, 2001, internal NRC memorandum related to a discussion between the NRR Director and the FENOC President. The document conveyed that the NRR Director had spoken with the FENOC President and was aware of the licensee's financial concerns pertaining to an unscheduled shutdown. According to the memorandum, the FENOC President told the NRR Director that the impact of a shutdown prior to February 2002 would be significant, and that Davis-Besse would be better positioned to shut down in February because of the availability of replacement fuel. The FENOC President confirmed to OIG that this discussion took place.

NRC Staff Explains Significance of December 31 Deadline

NRC Bulletin 2001-01 indicated that plants which had either experienced VHP nozzle cracking or leaking or were deemed highly susceptible to these problems ought to be inspected by December 31, 2001, a date which, OIG was told, had more practical than technical significance. OIG was told that staff picked that date as a benchmark because it was the end of the year. The staff was concerned that if each of the 12 plants that were in the high-susceptibility bins or had experienced cracking or leakage were to perform, or seek to perform, inspections simultaneously, there would not be enough qualified people and test equipment available to perform the inspections required. OIG learned that the December 31st date reflected NRC's desire to provide time for the licensees to schedule the use of those scarce resources.

One NRR senior manager explained, "we needed to know by the end of the year and we felt like that was a good basis without putting undue regulatory burden on licensees." He stated that although he felt somewhat uneasy about fixing an arbitrary date in the future for licensee responses, it was almost impossible to do otherwise. One NRR engineer told OIG, "there's no magical technical basis for it [the December 31, 2001 date]," and "any other date would [have been] just as relevant."

OIG learned that the staff's lack of a technical basis for selecting the December 31st date ultimately complicated its regulatory position. Because the staff lacked a firm technical basis for the December 31st date, NRC Commissioners' staff members questioned NRR's grounds for proposing that Davis-Besse be ordered to shut down if it failed to comply with that date. According to several of the Commissioners' technical assistants, the draft shutdown order provided for their review in late November 2001 failed to present a strong justification for

requiring the plant to cease operations on that particular date. They informed OIG that the staff was unable to provide a satisfactory argument as to why the licensee was presumably capable of operating Davis-Besse safely up to December 31, 2001, but could not do so the following day. As one technical assistant phrased it, NRC "didn't make a case for saying why January 5th was worse than December 31st."

OIG noted that the efforts by NRR staff to defend the validity of the December 31, 2001, deadline seemed misdirected in light of the NRR Director's rationale concerning the need for timely inspections. As the NRR Director stated in the draft shutdown order:

> This situation constitutes a special circumstance, the potential consequence of which is the loss of the reactor coolant pressure boundary, one of the "defense-in-depth" barriers, and the potential for the plant's core damage frequency to approach the conditional core damage probability of a loss-of-coolant accident, constituting an undue risk to public health and safety. Therefore, I lack reasonable assurance that adequate protection will be maintained without performance of timely inspections that are sufficient to detect this type of degradation.
>
> . . . I have determined that a potentially hazardous condition may exist, such that the integrity of the reactor coolant pressure boundary may not be maintained at the Davis-Besse Nuclear Power Station, Unit No. 1. Accordingly, pursuant to 10 CFR 2.202, I find it necessary to require the licensee to shutdown the facility by December 31, 2001, and to demonstrate, by inspection, that the vessel head penetration nozzles are free of defects.

Despite the NRR Director's stated "lack of reasonable assurance" of adequate protection of the public if Davis-Besse's continued operation without inspections, OIG found that the technical assistants' questioning of the date's validity led NRR staff to question their own rationale for selecting the deadline. This questioning was compounded by the fact that other licensee inspection results submitted to the NRC by mid-November 2001 had identified no cracks that were of an immediate safety significance. OIG observed that NRR's preoccupation with defending the validity of the December 31, 2001, date overshadowed the staff's prior determination as noted in the draft shutdown order and transmittal memorandum that the NRC lacked reasonable assurance of adequate protection of public health and safety if Davis-Besse operated without performing the inspections.

NRC Staff Will Not Order Shutdown Based Upon a Postulated Condition

There are a number of regulations, general design criteria (GDC), and technical specifications[7] that prohibit the existence of a leak in the reactor coolant pressure boundary. Just one leaking CRDM nozzle could justify NRC to order the plant to shut down. However, in trying to decide whether a shutdown order was appropriate for Davis-Besse, NRR staff faced a perceived dilemma concerning the level and type of proof needed to take this type of action. While FENOC and NRC assessments postulated that there were leaking or cracked nozzles at Davis-Besse, OIG was informed that neither party had physically confirmed the existence of a leaking or cracked nozzle.

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[7] See Title 10, Code of Federal Regulation, Part 50 and Technical Specifications, Section 3/4.4.6. for the Davis-Besse Nuclear Power Station.

OIG found that Federal regulations authorize NRC to initiate enforcement action whenever it lacks "reasonable assurance" that the licensee can operate safely. However, many NRC staff expressed to OIG their unwillingness to pursue enforcement action against a licensee without absolute proof of a regulatory violation. For example, one NRR engineer explained that there were seven B&W plants — six of these had already shut down and examined CRDM nozzles, and each had found cracks. Thus, he said, it was logical that Davis-Besse (the seventh plant) would have cracks. NRC and FENOC also discussed this topic at the public meeting held November 28, 2001, in Rockville, Maryland. During that session, FENOC's risk-informed evaluation estimated that Davis-Besse had between one and nine leaking CRDM nozzles, depending on the analysis used.

OIG learned that technical specifications for the Davis-Besse plant permit no pressure boundary leakage and, if such leakage is identified, the plant must completely shut down within 30 hours. Leakage from a CRDM nozzle would violate this technical specification. The NRR staff described its concern about the possibility of such a violation in the draft shutdown order for Davis-Besse:

> [I]t is extremely important from a safety standpoint to maintain the reactor coolant pressure boundary in a leaktight and structurally sound condition, with an extremely low probability of gross failure. [Three relevant GDC] are carried forward in the Technical Specification, Section 3/4.4.6, requirement that does not allow continued operation with any pressure boundary leakage, and the intent of the inservice inspection requirements of 10 CFR 50.55a(g)(4).
>
> Failure of the licensee for Davis-Besse Nuclear Power Station, Unit No. 1, to conduct inspections of the reactor vessel head penetration nozzles in a manner that is sufficient to detect the extent of degradation caused by a mechanism known to be degrading [at] other similar plants in that portion of the vessel and prior to a significant reduction in safety margin, is inconsistent with these GDC. The level of degradation that has been found in other similar plants, if left uncorrected, could result in a gross failure of the reactor coolant pressure boundary (loss-of-coolant accident).

According to the NRR Director, NRC did not know for a fact that there was a crack. Based both on inspections at the other plants and the analytic modeling NRC performed, the information available indicated that there were cracks (and likely leaks) at Davis-Besse. The NRR Director told OIG that from a legal point of view, there was an issue about constructing an order without knowing with certainty that there were cracks.

Nevertheless, a senior attorney from OGC told OIG that his office concurred with the lawfulness of the proposed shutdown order for Davis-Besse. He further noted:

> [T]he judgment about whether to go forward with an order in these circumstances would be both a technical and a policy judgment to be made by the staff offices. We provided legal advice and counsel on different approaches to dealing with it, including development of an order, [but] the decision on whether to go forward with that kind of action rests with [NRR staff].

Another senior NRR official explained that it is difficult to create an argument based on what you do not know, and that was predominantly what NRC was looking for with all PWRs. He explained that NRC, in essence, was asking the plants to tell them why they did not have this

problem. To formulate a shutdown order, NRC had to craft an argument that Davis-Besse did not have sufficient information to know that it did not have this problem (circumferential cracks).

A senior NRR official interviewed by OIG drew a link between the litigation process and the issuance of a shutdown order, implying that the agency considers the possibility of a legal challenge when deciding whether to take this type of regulatory action. This official explained to OIG that the litigation process is very burdensome on NRC and, as a result, the agency tries to do the very best job it can early on to position itself for a guaranteed win. The official acknowledged that NRC was reluctant to take regulatory action when issues are not black and white, but "gray," and he believed the Davis-Besse matter was truly in the gray area.

OIG learned that NRR's concern over the possibility of litigating the reasonableness of a shutdown order for Davis-Besse was unfounded. OIG was told by the President of FENOC that he spoke to the NRR Director shortly before the draft shutdown order was forwarded to the Commission on November 21, 2001. The FENOC President stated that during that conversation he told the NRR Director that a formal shutdown order for Davis-Besse was unnecessary and that the plant would voluntarily cease power operations before December 31, 2001, if NRR technical staff remained unconvinced that Davis-Besse could operate safely until late-March 2002. The FENOC President told OIG that all that would be required to initiate a shutdown was a telephone call from NRC informing him of the need to do so.

The NRR Director confirmed to OIG that Davis-Besse management had informed NRC that the plant would shut down voluntarily without an order if NRC determined that it was necessary.

NRR Director Stated He Lacked a Basis To Issue Davis-Besse Shutdown Order

Despite express language contained in the draft order to the contrary, the NRR Director told OIG that on November 21, 2001, when the draft order was forwarded to the Commission, he was not actually prepared to issue the order because he perceived that he lacked a regulatory basis to do so. He said NRR forwarded the draft order to the Commission merely to put "the Commission on notice" that an order may be necessary. Thus, he said, his decision not to issue a shutdown order for Davis-Besse could not be considered a change of position. He emphasized that the staff pursued a "dual path" with FENOC and continued dialog with the licensee even after the proposed order had been forwarded to the Commission. He explained that depending on additional information expected from FENOC and the staff's analysis of that data, NRR staff planned to determine whether it could allow the plant to continue to operate. According to the NRR Director, NRC staff agreed that the compensatory measures submitted by FENOC in late-November 2001 would allow Davis-Besse to continue to operate while assuring adequate protection of public health and safety.

OIG's review disclosed that while the NRR Director expressed to OIG that he lacked a regulatory basis to shut down Davis-Besse, the proposed shutdown order forwarded to the EDO and then to the Commission did not indicate that the regulatory basis outlined therein was flawed or unsupported. Furthermore, the NRR Director's transmittal memo to the EDO did not indicate this stance. Instead, the transmittal memo stated it was "unacceptable" for a facility to continue operating beyond December 31, 2001, without performing the recommended inspections in order to protect public health and safety. The cover memo further stated that it was the NRR Director's intent to issue the shutdown order 5 days after the EDO informed the Commission of this action.

OIG reviewed the concurrence chain for the draft order from NRR to the EDO and noted the document had been reviewed by NRR's Divisions of Engineering, Licensing and Project Management, and Systems Safety and Analysis; the Office of Enforcement; and OGC. Prior to forwarding the draft order to the NRC Commission on November 21, 2001, the EDO also reviewed and concurred with the draft order. Furthermore, during interviews conducted by OIG, no one other than the NRR Director articulated concerns to OIG about a lack of regulatory basis for the shutdown order.

Legal counsel to one NRC Commissioner told OIG that it was his impression that the technical positions contained in the proposed order were fully supported. He further noted that the Commissioners did not expect to receive notices of a proposed regulatory actions that the NRR staff believed it could not support.

NRC Rationale Not To Issue Order Not Documented

OIG's review disclosed that NRC technical staff worked diligently to analyze and understand the risk significance posed by VHP nozzle cracking. NRC documents demonstrate that the CRDM nozzle cracking issue had been followed by the staff since the early 1990s. Upon the identification of circumferential cracking of the CRDM nozzles in early 2001, NRC promptly issued Bulletin 2001-01 to alert PWR operators of this occurrence and requested that they provide specific data to NRC. Documents reviewed by OIG indicated that, not waiting for licensees to respond to the matter with their individual safety assessments, NRC began developing its own risk models. OIG identified more than a dozen staff members involved in some aspect with issues addressed in NRC Bulletin 2001-01.

OIG was told that NRC's decision to allow Davis-Besse to operate until February 16, 2002, was based on NRR's analysis of FENOC's proposed compensatory measures which were aimed at both reducing the likelihood of a LOCA and improving the licensee's ability to mitigate the effects of a LOCA if it occurred. However, OIG determined that NRC's decision to accept FENOC's justification to operate until February 16, 2002, was made without a well-documented analysis of available information. For example, on November 28, 2001, FENOC committed to move up its planned shutdown date approximately 45 days (from March 30 to February 16, 2002) and to lower reactor coolant system hot leg temperature from 605°F to 598°F for the remainder of the operating cycle. These two compensatory measures (time and temperature) most directly affected VHP nozzle crack growth rate, the issue at the very basis of NRC Bulletin 2001-01. Nevertheless, OIG found little documentation of NRC analysis of the relative benefit provided by the staff's acceptance of these measures on November 29, 2001. Instead, several NRR staff suggested that the safety benefits provided by reducing plant operation time and temperature were intuitive. Other NRR staff, including senior NRR managers, told OIG they questioned whether the compensatory measures related to time and temperature had any significant value at all. Additionally, the NRC staff had earlier conducted a probabilistic risk assessment of the likely condition of the plant's VHP nozzles. OIG learned that in late November 2001, there was NRR staff debate concerning applicable crack growth rates, the appropriate start date for estimating possible cracking, and the extent to which Davis-Besse should be given credit for past inspections of its vessel head.

In addition, another compensatory measure offered by FENOC on or about November 28, 2001, related to the positioning of a dedicated operator in the control room. According to NRC, FENOC stated that Davis-Besse staff would position a dedicated operator within the control room for the purpose of responding to the increased likelihood of an accident scenario. However, in the subsequent 2 weeks, communication between NRC and FENOC clearly

indicated that NRC's interpretation of a "dedicated operator" differed from FENOC's interpretation. While a mutual understanding was later achieved, this example indicates that any risk assessment NRR performed and used on November 28, 2001, to justify continued operation at Davis-Besse was not based on a clear understanding of FENOC's proposal. Furthermore, OIG found no evidence that a subsequent NRR risk analysis justifying Davis-Besse's continued operation was performed after NRC and FENOC came to a mutual understanding as to what the posting of a dedicated operator entailed.

OIG's inquiry did not disclose any documentation of an analysis performed in the Fall of 2001 by the NRR staff of the risk reduction likely to be achieved by implementation of the compensatory measures offered by FENOC prior to the staff accepting the measures and deciding to forgo a forced shutdown. While NRR's change of position on November 29, 2001, may have been based upon sound engineering judgment, it was not supported by a record documenting the NRR staff's analysis of FENOC's proposals to serve as the basis for the staff's decision. As an example, OIG learned that there was no meeting summary or record of what NRR staff attended the November 28, 2001, staff meeting that followed the public meeting, how staff voted, or the nature of their deliberations.

The December 2, 2002, letter by NRR to FENOC regarding the staff's rationale for permitting Davis-Besse's continued operation until February 16, 2001, confirms the lack of documentation relative to this decision in the Fall of 2001. According to the December 2, 2002, letter, the staff's failure to provide documentation sooner was an oversight. Stated purposes of the December 2, 2002, letter were to fulfill the NRC staff's commitment to document the safety rationale underlying the decision to permit Davis-Besse's continued operation, capture the process used by the NRC staff in the fall of 2001 for review of FENOC's response to NRC Bulletin 2001-01, and make the NRC staff's evaluation publicly available.

FINDINGS

1. During its review of the potentially hazardous condition at Davis-Besse, the NRC staff considered the financial impact to the licensee of an unscheduled plant shutdown. This is in keeping with one of NRC's performance goals — established to support agency strategic goals — which is the reduction of unnecessary regulatory burden on licensees. However, the goal of NRC Bulletin 2001-01 was, in the interest of public health and safety, to have plants that were identified as being highly susceptible to vessel head penetration nozzle cracking perform inspections by December 31, 2001, to confirm the structural integrity of the nozzles with the intent to avoid a possible control rod drive mechanism nozzle ejection and possible loss-of-coolant accident. The fact that FENOC sought and staff allowed Davis-Besse to operate past December 31, 2001, without performing these inspections was driven in large part by a desire to lessen the financial impact on FENOC that would result from an early shutdown. Consequently, while the decision by the staff to allow Davis-Besse to continue to operate was in keeping with the NRC performance goal to reduce unnecessary regulatory burden, it was contrary to the goal of NRC Bulletin 2001-01 to have at-risk plants conduct timely inspections to ensure NRC regulatory requirements related to reactor coolant leakage were met.

2. NRC Bulletin 2001-01, dated August 3, 2001, advised that inspections by December 31, 2001, would be an appropriate way to handle plants identified as having experienced or being highly susceptible to vessel head penetration nozzle cracking. This date was not rooted in scientific analysis but was viewed by the staff as practical in that it would allow a 5-month window for plants to either perform the inspections during already-scheduled outages or to plan for and conduct an unscheduled outage. However, when questioned about the importance of that particular date, NRC staff were called to justify why December 31, 2001, was any more safety significant than any other date, e.g., January 1, 2002. As a result, NRR staff found themselves unsuccessfully trying to defend the December 31, 2001, date even though the NRR Director stated that adequate protection of the public health and safety could not be assured without performing the inspections at Davis-Besse.

3. NRC appears to have informally established an unreasonably high burden of requiring absolute proof of a safety problem, versus lack of reasonable assurance of maintaining public health and safety, before it will act to shut down a power plant. The staff articulated this standard to OIG as a rationale for allowing Davis-Besse to operate until February 16, 2002, even in light of information that strongly indicated Davis-Besse was not in compliance with NRC regulations and plant technical specifications and may have operated with reduced safety margins.

4. On November 21, 2001, the NRR Director forwarded a draft shutdown order for Davis-Besse through the EDO to the NRC Commission for its information. However, contrary to the strong justification presented in the order, the NRR Director told OIG he never intended to actually issue the order because he lacked a regulatory basis. OIG learned that the order was concurred in by all cognizant NRC staff to include the EDO and the Office of General Counsel, and OIG learned of no concerns by the staff that the NRC lacked a basis to issue the order.

5. NRC staff developed a well-documented technical basis for preparing an order to shut down Davis-Besse, and on November 21, 2001, the EDO informed the NRC Commission of the intent of the NRR Director to shut down the plant on or before December 31, 2001. However, contrary to the strong justification presented in the order, the NRR Director did not force a shutdown. Instead, on November 29, 2001, the NRR Director concluded that FENOC could safely operate Davis-Besse until February 16, 2002, provided the licensee implemented several compensatory measures it had developed. OIG found that, in reaching this decision in November 2001, NRR lacked a full understanding of those compensatory measures, and the NRR staff did not document its analytical bases and conclusions that supported its decision.

LIST OF ACRONYMS

13RFO	13th Refueling Outage
ANO1	Arkansas Nuclear One Unit 1
B&W	Babcock and Wilcox
CRDM	Control Rod Drive Mechanism
EDO	Executive Director for Operations (NRC)
EFPY	Effective Full Power Years
FENOC	FirstEnergy Nuclear Operating Company
GDC	General Design Criterion/Criteria
LOCA	Loss-of-Coolant Accident
NRC	U.S. Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation (NRC)
OGC	Office of the General Counsel (NRC)
OI	Office of Investigations (NRC)
OIG	Office of the Inspector General (NRC)
ONS1	Oconee Nuclear Station Unit 1
ONS2	Oconee Nuclear Station Unit 2
ONS3	Oconee Nuclear Station Unit 3
PWR	Pressurized Water Reactor
PWSCC	Primary Water Stress Corrosion Cracking
RFO	Refueling Outage
RPV	Reactor Pressure Vessel
UCS	Union of Concerned Scientists
VHP	Vessel Head Penetration

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