Davis-Besse Reactor Vessel Head Damage
NRC UPDATE

October 2003

This is the fourteenth periodic update on the NRC response to the reactor vessel head damage at the Davis-Besse Nuclear Power Station. The updates will be available at public meetings of the NRC Davis-Besse Oversight Panel which is coordinating the agency's activities related to the damage. Each update will include background information to assist the reader in understanding issues associated with the corrosion damage.

NRC Inspection Continues for Reactor Cooling System Test

The NRC is completing a special inspection which monitored the seven-day test of Davis-Besse's reactor cooling system, which was conducted in late September.

The test began on September 22. A problem with one of the plant systems necessitated a pressure reduction on September 25. After pressure was returned to the normal operating level, the test was continued until September 30, providing a full seven days at normal operating pressure.

The reactor was not started up for the test. Heat generated by the cooling system pumps raised the pressure in the reactor and associated piping to approximately 2155 pounds per square inch -- the normal operating pressure -- and approximately 530 degrees Fahrenheit, which is near the normal operating temperature. The test was conducted to assure that the reactor cooling system, including the new reactor vessel head, is leaktight.

The test was also to assess FirstEnergy's position that there is no leakage from the bottom of the reactor vessel. There are 52 tubes which pass through the bottom wall of the reactor vessel to carry reactor monitoring instrumentation. These penetrations through the bottom of the vessel were cleaned and visually inspected using a video camera system prior to the test. The tubes are being reinspected with the video camera system to detect any evidence of leakage.

In addition, the NRC resident inspectors assigned to the plant, assisted by inspectors from the Region III office, monitored the utility's performance during the test. Two operational

Ongoing and Planned NRC Inspections

The NRC has a series of inspections underway and planned before any decision on whether or not the Davis-Besse plant may resume operations:

- **Report Pending** - Corrective Action Team Inspection - This inspection looked at the effectiveness of the corrective action program at Davis-Besse -- how the utility finds, evaluates, and fixes problems. A public meeting to discuss the findings of this inspection will be scheduled.
- **Report Pending -** Safety System Design Reviews - The utility's Systems Health verification program and earlier NRC inspections had found potential design questions that needed to be resolved. This inspection looked at the effectiveness of the design reviews. Public meeting on findings to be held October 8.
- **Ongoing -** Management and Human Performance, Phase III (Safety Culture) - This inspection focuses on FENOC's actions to improve management effectiveness and human performance and its processes to survey and assess the safety culture among the staff at Davis-Besse -- how the management and workers will identify and deal with safety concerns.
- **Ongoing -** Reactor Cooling System Test (Normal Operating Pressure) - This inspection will monitor the plant's test of the reactor vessel and associated piping to assure there are no leaks in the system as well as reviewing the performance of the plant staff.

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problems occurred. During preparations for the test, about 1,000 gallons of water drained from a core flood tank into another holding tank because plant operators failed to adequately monitor pressure in the reactor cooling system.

After the seven-day test period was completed, another operational incident occurred. Normal procedures required that one group of control rods be withdrawn from the reactor core while the reactor cooling system test was conducted. Plant operators failed to properly control pressure conditions in the reactor cooling system, and a pressure variation led to the automatic insertion of that group of control rods. Since the reactor was already shut down at the time, this incident had no safety consequences.

The NRC inspection team is reviewing the two incidents as part of its assessment of the performance of the plant operating staff.

The NRC inspection team will issue a report about 30 days after the completion of the reactor pressure test inspection. The report will be available on the NRC's Davis-Besse web site under News and Correspondence.

NRC Inspections - continued:

- **Planned** - Backlog Review - This inspection will review work which FirstEnergy plans to complete after possible restart of the plant to determine if the utility has properly characterized and evaluated the work items which will be deferred.
- **Planned -** Completeness and Accuracy Review - This inspection will evaluate the findings of a FirstEnergy review of documents previously submitted to the NRC to assure that the information submitted was complete and accurate.
- **Planned -** Restart Readiness Assessment Team - As the utility nears the point where it will seek NRC authorization for restart, this team inspection will thoroughly review the readiness of the plant and the plant staff to resume plant operations safely and in compliance with NRC requirements.

Modifications planned for high pressure pumps

Following the completion of the seven-day reactor cooling system test and associated reviews, FirstEnergy will remove the two high pressure injection pumps and ship them offsite for modification. An earlier engineering review by FirstEnergy found that the pumps could malfunction under certain accident conditions. In a pipe break or other loss of coolant accident, the high pressure injection pumps would pump water into the reactor cooling system while pressure remained high. Other emergency cooling systems would start once pressure in the reactor cooling system was lowered.

FirstEnergy is completing the testing of the planned modifications which are intended to prevent damage to the pumps if debris would be drawn into the pumps. The NRC staff has been monitoring FirstEnergy's testing activities.

The utility will meet with the NRC staff at 9 a.m. October 21 in the NRC Headquarters office (Commissioner's Conference Room O-1G16) in Rockville, Maryland, to discuss the technical aspects of the pump modification. Additional information on the meeting will be available on the NRC's web site.

NRC's Safety Culture Inspection Continues

An NRC inspection team is continuing its review of FirstEnergy's efforts to evaluate and improve the safety culture at the Davis-Besse plant. This review includes the utility's program to foster a "safety conscious work environment" in which workers feel free to raise safety issues without fear of retaliation.

The remaining inspection activities are (1) review of the process for the plant's internal assessment of safety culture; (2) observation of the activities of the plant's Safety Conscious Work Environment Review Team; and (3) review of FirstEnergy's plan for long-term improvement actions and assessment of plant staff safety culture.

FirstEnergy met with the NRC staff at the Region III Office in Lisle, Illinois, on October 1 to present its ongoing assessment of plant safety culture and its plans for long-term improvement actions and assessment of the plant staff's safety culture. The information discussed in the meeting will be incorporated in the NRC's safety culture inspection.

Mail Call

The NRC continues to receive letters and e-mails expressing interest and concern about Davis-Besse -- now totaling several thousand.

The agency will respond to all individual letters and e-mails sent in by interested members of the public.

Davis-Besse Restart Checklist

The Oversight Panel has created a "restart checklist" categorizing 31 actions in seven major areas which FirstEnergy needs to complete before the NRC can consider making a decision on whether Davis-Besse may restart. The NRC oversight panel has determined that the utility has adequately completed 18 of those actions.

NRC inspections are directed at evaluating the checklist items as well as reviewing the ongoing work at Davis-Besse.

The completed items are shown in italics and have a check mark in front of the item. For the completed items, the list also includes the inspection report which documents the NRC's review of the item.

1. **Adequacy of Root Cause Determinations**
- ✔ *1.a Penetration Cracking and Reactor Pressure Vessel Corrosion* (Report No. 50-346/03-04)
- ✔ *1.b Organizational, Programmatic and Human Performance Issues* (Report No. 50-346/02-18)

2. **Adequacy of Safety Significant Structures, Systems, and Components**
- 2.a Reactor Pressure Vessel Head Replacement
- ✔ *2.b Containment Vessel Restoration Following Reactor Pressure Vessel Head Replacement* (Report No. 50-346/03-08)
- 2.c Structures, Systems, and Components Inside Containment
- ✔ *2.c.1 Emergency Core Cooling System and Containment Spray System Sump* (Report No. 50-346/03-17)
- 2.d Extent-of-Condition of Boric Acid in Systems Outside Containment
- 2.e High Pressure Injection Pump Internal Clearance/Debris Resolution

3. **Adequacy of Safety Significant Programs**
- 3.a Corrective Action Program
- ✔ *3.b Operating Experience Program* (Report No. 50-346/03-09)
- 3.c Quality Audits and Self-Assessments of Programs
- ✔ *3.d Boric Acid Corrosion Management Program* (Report No. 50-346/03-17)
- ✔ *3.e Reactor Coolant System Unidentified Leakage Monitoring Program* (Report No. 50-346/03-09)
- ✔ *3.f In-Service Inspection Program* (Report No. 50-346/03-09)

Next Davis-Besse NRC Oversight Panel Meetings
2 p.m. and 7 p.m., Tuesday, Nov. 4, Oak Harbor High School

✔ *3.g Modification Control Program* (Report No. 50-346/03-09)
✔ *3.h Radiation Protection Program* (Report No. 50-346/03-17 - to be issued)
3.i Process for Ensuring Completeness and Accuracy of Required Records and Submittals to the NRC

4. **Adequacy of Organizational Effectiveness and Human Performance**
✔ *4.a Adequacy of Corrective Action Plan* (Report No. 50-346/02-18)
4.b Effectiveness of Corrective Actions

5. **Readiness for Restart**
5.a Review of Licensee's Restart Action Plan
5.b Systems Readiness for Restart
5.c Operations Readiness for Restart
5.d Test Program Development and Implementation

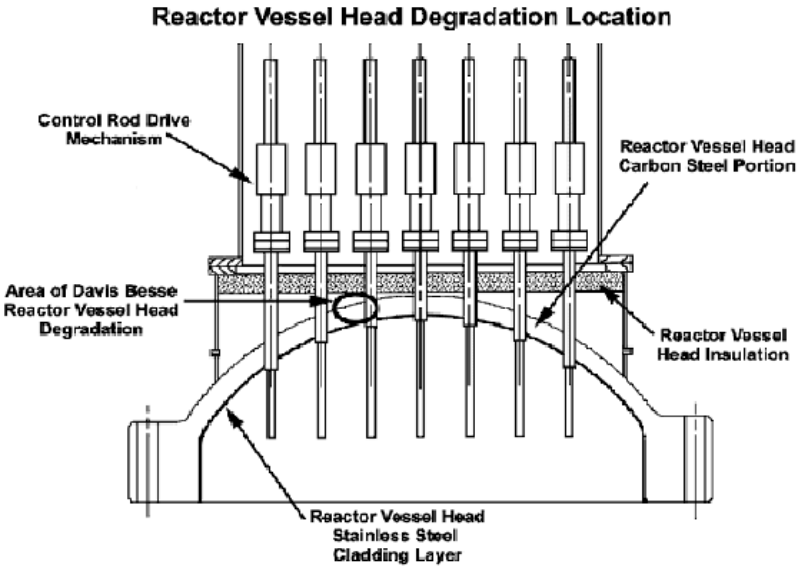
6. **Licensing Issue Resolution** (Not discussed in inspection reports)
✔ *6.a Verification that Relief Requests A8 and A12 regarding the Shell to Flange Weld (previously submitted by letter dated September 19, 2000) is not Impacted by the Midland RPV Head*
✔ *6.b American Society of Mechanical Engineers (ASME) Code Relief Request for Failure to Maintain Original Radiographic Tests of the Midland Head to Flange Weld (Planned Relief Request A26)*
✔ *6.c ASME Code Relief Request for Inability to Radiographically Test 100% of the Midland Reactor Pressure Vessel Head to Flange Weld (Planned Relief Request A27)*
✔ *6.d Resubmit Relief Request A2 (previously submitted by letter dated September 19, 2000) for ASME Code for Inability to Perform 100% volumetric and surface examination of Head to Flange Weld*
✔ *6.e Reconciliation Letter that Demonstrates How the New Reactor Pressure Vessel Head Correlates With the ASME Code and QA Index for Section III and Section XI - Commitments*
✔ *6.f Verification Letter of Technical Specification Pressure/Temperature Curves for New Vessel Head - Commitment*
✔ 6.g *Request to relocate High Pressure Injection and Low Pressure Injection Subsystems Flow Balance Testing from Technical Specifications 4.5.2.h to Updated Safety Analysis Report Technical Requirements Manual*

7. **Confirmatory Action Letter Resolution**
7.a Verification that Confirmatory Action Letter Items are Resolved, Including a Public Meeting to Discuss Readiness for Restart

Background Summary: What Happened at Davis-Besse

In March 2002 plant workers discovered a cavity in the head or top of the reactor vessel while they were repairing control rod tubes which pass through the head. The tubes, which pass through the reactor vessel head, are called control rod drive mechanism nozzles. Cracks were detected in 5 of the 69 nozzles.

In three of those nozzles, the cracks were all the way through the nozzle, allowing leakage of reactor cooling water, which contains boric acid.



Corrosion, caused by the boric acid, damaged the vessel head next to Nozzle No. 3, creating an irregular cavity about 4 inches by 5 inches and approximately 6 inches deep. The cavity penetrated the carbon steel portion of the vessel head, leaving only the stainless steel lining. The liner thickness varies somewhat with a minimum

design thickness of 1/8 inch. Subsequent examination by Framatome, FirstEnergy's contractor, found evidence of a series of cracks in the liner, none of which was entirely through the liner wall.

After circumferential cracks - around the nozzle wall - were found in the control rod drive nozzles at Unit 3 of the Oconee Nuclear Power Station in 2001, the NRC required all pressurized water reactor (PWR) operators to report to the NRC on structural integrity of the nozzles and their plans to inspect the nozzles. Plants with similar operating history to Oconee Unit 3, including Davis-Besse, were to inspect their reactor vessel head penetrations by December 31, 2001, or to provide a basis for concluding that there were no cracked and leaking nozzles.

FirstEnergy Nuclear Operating Company requested an extension of the inspection deadline until its refueling outage beginning March 30, 2002, and provided the technical basis for its request. The NRC did not allow the plant to operate until March 30, but agreed to permit operation until February 16, provided that compensatory measures were taken to minimize possible crack growth during the time of operation. The NRC was unaware that nozzle leakage or corrosion had occurred at Davis-Besse when it agreed to the February 16 date.

Barriers Built into Nuclear Plants to Protect Public Health and Safety

The design of every nuclear power plant includes a system of three barriers which separate the highly radioactive reactor fuel from the public and the environment. The Davis-Besse reactor head damage represented a significant reduction in the safety margin of one of these barriers, the reactor coolant system. The reactor coolant system, however, remained intact, as well as the other two barriers, the fuel and the containment.

1. Fuel Pellets and Rods

The first barrier is the fuel itself. The fuel consists of strong, temperature-resistant ceramic pellets made of uranium-oxide. The pellets are about the size of a fingertip. They retain almost all of the highly radioactive products of the fission process within their structure.

The pellets are stacked in a rod made of a zirconium alloy. At Davis-Besse, each fuel rod is about 13 feet long. The rods are assembled into bundles, with each assembly containing 208 rods. The reactor core contains 177 fuel assemblies. Any fission products which escape from the pellets are captured inside the cladding of the rod, which is designed to be leak-tight. Small pin hole leaks do occasionally occur, however, and the operating license requires leakage monitoring and contains limits on the maximum allowable leakage of radioactive materials from the fuel rods.

2. Reactor Coolant System

The second barrier is the reactor coolant system pressure boundary. The reactor core is contained inside the reactor pressure vessel, which is a large steel container. Thick steel pipes supply cooling water to the reactor and carry away the heated water after it passes through the reactor core. The pressure vessel, the connected piping, and other connected components make up the reactor coolant system pressure boundary. At Davis-Besse, the reactor coolant system contains about 60,000 gallons of cooling water, circulated by four large pumps at a rate of about 360,000 gallons per minute.

This system is designed to be leak-tight at operating conditions which include a water temperature of 605° F and a water pressure of 2,150 pounds per square inch. The operating license contains limits on the maximum allowable amount of leakage from the system, and it specifies requirements for monitoring any leakage. If a leak is identified as being through any solid wall of the system (reactor vessel, cooling pipes or other components) continued operation of the plant is prohibited, no matter how small the leak rate.

3. Containment Building

The third barrier is the containment building. This is a large cylindrical building which contains the entire reactor coolant system. None of the piping that contains the high-temperature and high-pressure reactor coolant water extends outside the containment building. The containment is a 1 ½ inch thick steel cylinder, rounded at the top and bottom, which is designed to be leak-tight. This steel structure is surrounded by a reinforced concrete shield building, which is the round building visible from the outside of the plant. Its walls are 2 to 3 feet thick.

NRC's Response to Vessel Head Damage

The NRC responded to the vessel head degradation with a series of actions, some specific to Davis-Besse and others aimed at other PWR plants. The agency directed all PWR licensees to report on the condition of their reactor heads and later specified more stringent examination for inspecting the reactor heads. The NRC also established a Lessons Learned Task Force to review the agency's activities associated with the Davis-Besse reactor head issue.

NRC Davis-Besse Oversight Panel

An NRC Davis-Besse Oversight Panel was created in April 2002 to make sure that all corrective actions, required to ensure that Davis-Besse can operate safely, are taken before the plant is permitted to restart and that Davis-Besse maintains high safety and security standards if it resumes operations. Should the plant restart, the Oversight Panel will evaluate if Davis-Besse's performance warrants reduction of the NRC's heightened oversight and, if so, recommend to NRC management that the plant return to a regular inspection schedule. The panel was established under the agency's Manual Chapter 0350.

The panel brings together NRC management personnel and staff from the Region III office in Lisle, Illinois, the NRC Headquarters office in Rockville, Maryland and the NRC Resident Inspector Office at the Davis-Besse site. The eight-member panel's chair and co-chair are John Grobe, a senior manager from Region III, and William Ruland, a senior manager from NRC headquarters.

The agency will also supplement the resident inspection staff with an additional resident inspector who be at Davis Besse in September, bringing the total staff there to three.

Public Participation in the Process

The NRC's experience is that members of the public, including public officials and citizens, often raise questions or provide insights that are important to consider. If you have questions or want to provide information or a point of view, please contact us. For feedback on this newsletter, contact Viktoria Mitlyng 630/829-9662 or Jan Strasma 630/829-9663 (toll free 800/522-3025 - ext -9662 or -9663). E-mail: opa3@nrc.gov. Extensive information about the Davis-Besse reactor vessel head damage and the ensuing activities is available on the NRC web site: http://www.nrc.gov - select "Davis-Besse" under the list of key topics.