Davis-Besse Reactor Vessel Head Damage
NRC UPDATE

January 2003

This is the fifth 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 Activities:

1. The NRC staff will conduct a public meeting January 30 with FirstEnergy officials in the NRC Region III office in Lisle, Illinois, to discuss the status of the company's evaluation of safety culture issues among the plant management and staff and its programs to address those issues. The meeting time and additional details will be added to the public meeting listing on the NRC's web site when arrangements are finalized. Teleconferencing will be available for persons unable to attend.

2. NRC staff will observe the licensee's preparations and reloading of reactor fuel.

3. NRC staff will inspect the first phase of the modification to the sump screen planned by the licensee to increase the area of the sump strainers in the reactor containment to ensure that the strainers do not get clogged by debris which might collect at the bottom of the containment. The sump is a collection point for water that would be recirculated for reactor cooling in the event of a loss-of-coolant accident. This sump modification, which was not required by the NRC, has been initiated by FirstEnergy to create additional surface area of the sump strainers, which will substantially improve the plant's design safety margin.

4. NRC staff will observe the Integrated Leak Rate Tests designed to verify that the reactor containment, which was cut open to move the new and old reactor vessel heads, meets NRC requirements for "leak-tightness."

5. FirstEnergy will conduct a special seven-day pressure test of the reactor cooling system at normal operating temperature and pressure to determine if the system is leak tight. This test will be performed after

Ongoing NRC Inspections:

1. The Management and Human Performance Inspection completed its evaluation of FirstEnergy's root cause analysis associated with management, organizational effectiveness and human performance factors that are believed to have led to the degradation of the reactor head. The inspection will now focus on the adequacy of licensee's proposed corrective actions to create a more safety-focused environment and the efficacy of these actions.

2. The Program Effectiveness Inspection is reviewing the plant's progress in creating more effective programs. The review of the corrective actions and boric acid corrosion control programs has been completed. NRC inspectors are currently reviewing the plant's in-service inspection and the operating experience programs, including the adequacy of improvements and their implementation.

3. The Systems Health Inspection continues to assess the licensee's review of specific safety significant plant systems, such as the emergency reactor cooling systems and standby power systems. The goal of this inspection is to verify that the plant's safety significant systems can perform their safety functions as designed.

4. The Two NRC resident inspectors continue their inspections of day-to-day activities as well as supporting the specific inspections underway.

fuel has been loaded in the reactor, but before FirstEnergy seeks authorization from the NRC staff to restart the plant. (The reactor will not be started up for the test; heat added through the operation of the reactor cooling pumps will be sufficient to reach normal operating temperature and pressure.) The NRC staff will perform several specific inspections leading up to the test and during the test.

NRC Issues Reports on Two Special Inspections

The Nuclear Regulatory Commission staff has issued reports for two special inspections related to work on steam generators at the Davis-Besse Nuclear Power Plant in February of last year that led to elevated worker radiation exposures and offsite radioactive contamination. The exposures and contamination were not related to the corrosion damage to the reactor vessel head.

On February 20 several contract workers were exposed to unexpected radiation levels while performing work on the steam generators and were contaminated both internally and externally with radioactive material. The workers underwent decontamination procedures before they were allowed to leave the plant site. Evaluation by the utility and the NRC found that none of the workers received radiation exposures beyond NRC limits.

Four of the contract workers were found to have minor radioactive contamination on their clothing when they reported for work at nuclear power plants in South Carolina and Texas. Utility radiation specialists surveyed the temporary housing used by the workers and other associated places and found tiny radioactive particles at several locations in Ohio, Virginia, and South Carolina.

The inspection of the worker radiation exposures resulted in two findings with a preliminary evaluation of "white," indicating low to moderate safety significance:

- The utility failed to conduct adequate evaluations of the radiological work conditions prior to the steam generator work.

- The utility failed to make suitable measurements of radioactive material in the work area and to adequately monitor the intake of radioactive material by the workers.

The inspection which focused on the offsite radioactive contamination resulted in one "green" finding, meaning that it was of very low safety significance:

- Inadequate radiation surveys of the workers resulted in the uncontrolled release from the plant of low levels of radioactive material on their clothing. The low level of radioactivity involved was found to present little potential health risk to the workers or the general public.

The reports note that the utility has adopted corrective actions in its radiation protection program to preclude similar problems in the future. The utility's radiation protection program, including its corrective actions, will be covered by NRC inspections prior to a decision by the agency on restart of the Davis-Besse facility.

NRC Inspector General Issues Report, Commission Responds

The NRC's Inspector General issued a report December 30, 2002, on the findings of its inquiry into the agency's Regulation of Davis-Besse Regarding Damage to the Reactor Vessel Head. On January 6, 2003, NRC Chairman Richard Meserve responded to the report with a memorandum to the Inspector General. Both documents are available on the NRC's web site: http://www.nrc.gov. For the Inspector General's report, select the 'Inspector General' link at the bottom left of the page, and then click on the 'OIG Reports' link. For the Chairman's reponse, select 'Davis-Besse' from the 'key topics' menu and the select 'News and Correspondence.'

Background: 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.

Earlier indications of the problem: Through-Wall Cracking of Nozzles in France and at the Oconee Nuclear Power Station in South Carolina

In the early 1990's control rod drive mechanism nozzle cracking was discovered at a nuclear plant in France. These cracks penetrated the nozzle wall along the length of the nozzle (referred to as 'axial' cracking). In 1997 the NRC issued Generic Letter 97-01 to gather information on the inspection activities for possible cracking in the control rod drive mechanism nozzles in plants in the United States. Subsequently, through-wall circumferential cracks -- around the nozzle wall -- were discovered in two control rod drive mechanism nozzles at the Oconee Nuclear Power Station, Unit 3, in 2001. While axial cracking had been found at several other plants and repaired, circumferential cracking had not been seen before. Circumferential cracking is more significant because it could lead to complete separation of the nozzle and a resulting loss-of-coolant accident.

NRC's "Lessons Learned"

The Nuclear Regulatory Commission is meeting January 14 with the agency's staff to discuss the Lessons Learned Task Force Report, which focused on the agency's handling of issues related to the reactor vessel head damage, and with the Senior Management Review Team, which has developed plans for appropriate agency action on the task force recommendations.

The review team's recommendations and any resulting commission actions will be available on the NRC web site. The meeting transcript and related documents will be on the web site at:

http://www.nrc.gov/reading-rm/doc-collections/commission/

After the Oconee discovery, the NRC issued Bulletin 2001-01, requiring all pressurized water reactor (PWR) operators to report to the NRC on structural integrity of the nozzles, including the extent of any nozzle cracking and leakage and their plans to ensure that future inspections would guarantee structural integrity of the reactor vessel boundary. The NRC's Bulletin instructed nuclear power plants with similar operating history to Oconee Unit 3, including Davis-Besse, 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.

Boric Acid Corrosion Control Procedure

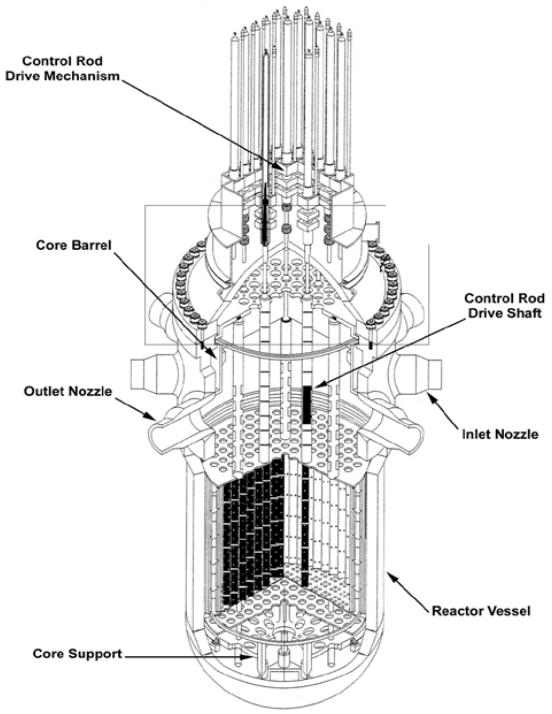
The water that circulates through a pressurized water reactor to cool the nuclear fuel contains a low concentration of boric acid. This borated water can potentially leak through flanges, pump and valve seals, and other parts of the reactor cooling system and cause corrosion.

The NRC has taken steps to make sure that PWR operators are aware of and pay attention to the corrosion boric acid can cause in certain environments:

- In 1986-89, the NRC issued a series of documents, called "generic communications," informing PWR licensees that boric acid can corrode and damage steel reactor components.

- The NRC's Generic Letter 88-05 requested PWR operators to implement a program to ensure that boric accid corrosion does not lead to degradation of the reactor cooling system components. All nuclear power plants with PWRs, including Davis-Besse, reported to NRC that the Boric Acid Control Procedures had been established and would be implemented.

Typical Pressurized Water Reactor



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 little finger-tip. 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.

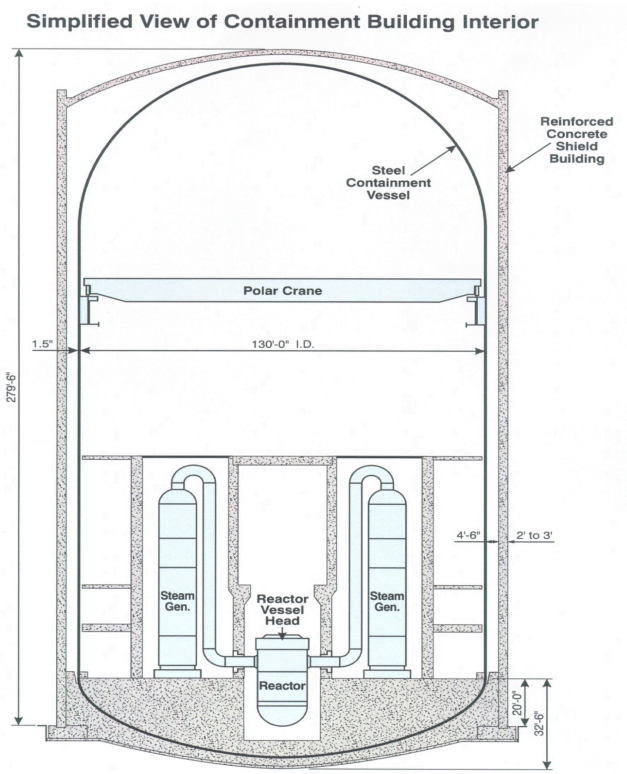
2. Reactor Coolant System

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 1/2 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 began a review of its regulatory activities as well.

Davis-Besse

On March 12, 2002, the NRC initiated an Augmented Inspection Team to examine conditions that led to the head degradation and on March 13, 2002, the NRC issued a Confirmatory Action Letter to Davis-Besse documenting a number of actions the plant needed to implement for the unit to be allowed to restart. On April 29, 2002, the NRC established an Oversight Panel under the Agency's Manual Chapter 0350, to coordinate and oversee NRC activities necessary to address repairs and performance deficiencies at the plant in order to guarantee that it can operate safely. The plant will not restart until the NRC is satisfied that plant operators have met all necessary safety requirements.

Generic

On March 18, 2002, the NRC issued Bulletin 2002-01, instructing PWR licensees to report on the condition of their head, past incidents of boric acid leakage and the basis for concluding that their boric acid inspection programs were effective. All plants sent their responses and indicated that no evidence of extensive corrosion of reactor vessel heads was found at these plants. On August 9, 2002, the NRC issued Bulletin 2002-02 advising PWR operators that more stringent inspection techniques may be necessary to detect head penetration nozzle cracks. Visual examination of reactor vessel heads and nozzles may need to be supplemented with other inspection techniques, such as the use of ultrasound, electric currents and liquid dyes. In October, the agency also requested PWR licensees to provide additional information on their boric acid inspection program with greater detail than initially covered in the responses to Bulletin 2002-01.

NRC Davis-Besse Oversight Panel

An NRC Davis-Besse Oversight Panel was created 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 Dean, a senior manager from NRC headquarters.

As part of determining if plant corrective actions are adequate to support restart, the Oversight Panel will evaluate FirstEnergy's return to service plan, which is divided into seven areas of performance that the utility calls "building blocks." A series of NRC inspections are being performed to verify the company is taking proper actions in each of the seven areas. These reviews will include the work by the FirstEnergy staff and, in addition, the NRC staff will perform independent inspections in each of the "building block" areas.

Issues to be resolved in order for Davis-Besse to restart

The NRC Oversight Panel will only consider recommending that Davis-Besse resume operations when the plant has demonstrated its readiness to operate safely. Key elements will include:

- Davis-Besse management and personnel properly understand the technical, organizational, programmatic and human performance problems that led to the extensive degradation of the plant's reactor vessel head.
- Davis-Besse enhances programs for operating the plant safely, detecting and correcting problems, controlling boric acid corrosion, and is fostering a more safety-conscious environment among plant managers and workers.
- Davis-Besse improves the performance standards of its managers and workers, including their "ownership" of the quality of work products and the safety focus of decision-making.
- The replacement of the vessel head is technically sound and all reactor components are inspected, repaired as necessary, and demonstrated to be ready for safe operation.
- Plant safety systems inside and outside containment are inspected, repaired as necessary, and have been confirmed to be ready to resume safe operation of the plant.
- Plant operators demonstrate appropriate safety focus and readiness to restart the plant.
- Any organizational or human performance issues resulting from the ongoing investigation conducted by the NRC's Office of Investigations are addressed.
- All licensing issues that have arisen as a result of the reactor head replacement have been resolved.
- Resolution of radiation protection issues associated with the radiation exposure to workers during steam generator work and the particle contamination found in offsite locations.
- Modification of the strainer system for the containment sump, which would be the source of cooling water for recirculation in the event of a loss-of-coolant accident.

What Happens If the Plant is Allowed to Restart

If the facility is permitted to restart, the NRC Oversight Panel will continue to monitor plant activities and operations until panel members are confident that the root cause(s) of the problem have not recurred. Should FirstEnergy achieve that performance level, the NRC Oversight Panel would recommend to NRC management that responsibility for the plant oversight be transferred back to the Region III line organization for monitoring under the Reactor Oversight Process. The panel would then cease to exist. Should FirstEnergy not demonstrate sustained improved performance, the panel will recommend appropriate regulatory actions.

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.