

Overview of Reactor Vessel Head Degradation

SEE [HTTP://WWW.NRC.GOV/REACTORS/OPERATING/OPS-EXPERIENCE/VESSEL-HEAD-DEGRADATION.HTML](http://www.nrc.gov/reactors/operating/ops-experience/vessel-head-degradation.html) FOR ACCESS TO COMPLETE INFORMATION ABOUT THE DAVIS-BESSE REACTOR INCIDENT

- [Generic Activities on Alloy 600 Cracking](#)

On February 16, 2002, the Davis-Besse Nuclear Power Station in Oak Harbor, Ohio, began a refueling outage that included inspecting the nozzles entering the head of the reactor pressure vessel (RPV), the specially designed container that houses the reactor core and the control rods that regulate the power output of the reactor. Of these vessel head penetration (VHP) nozzles, the licensee's inspections focused on the nozzles associated with the mechanism that drives the control rods, known as the control rod drive mechanism (CRDM). Both the inspections and their focus were consistent with the licensee's commitments in response to [NRC Bulletin 2001-01](#), "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," which the agency issued on August 3, 2001.

In conducting its inspections, the licensee found that three CRDM nozzles had indications of axial cracking, which had resulted in leakage of the reactor's pressure boundary. Specifically, the licensee found these indications in CRDM nozzles 1, 2, and 3, which are located near the center of the RPV head. The licensee reported these findings to the NRC on February 27, 2002, and provided supplemental information on March 5 and March 9, 2002. The licensee also decided to repair the three leaking nozzles, as well as two other nozzles that had indications of leakage but had not resulted in pressure boundary leakage.

The repair of these nozzles included roll expanding the CRDM nozzle material into the material of the surrounding RPV head and then machining along the axis of the CRDM nozzle to a point above the indications in the nozzle material. On March 6, 2002, the licensee prematurely terminated the machining process on CRDM nozzle 3 and removed the machining apparatus from the nozzle. During the removal, the nozzle was mechanically agitated and subsequently displaced (or tipped) in the downhill direction (away from the top of the RPV head) until its flange contacted the flange of the adjacent CRDM nozzle.

To identify the cause of the displacement, the licensee investigated the condition of the RPV head surrounding CRDM nozzle 3. This investigation included removing the CRDM nozzle from the RPV head, removing boric acid deposits from the top of the RPV head, and ultrasonically measuring the thickness of the RPV head in the vicinity of CRDM nozzles 1, 2, and 3.

Upon completing the boric acid removal on March 7, 2002, the licensee conducted a visual examination of the area, which identified a large cavity in the RPV head on the downhill side of CRDM nozzle 3. Followup characterization by ultrasonic testing indicated wastage of the low alloy steel RPV head material adjacent to the nozzle. The wastage area was found to extend approximately 5 inches downhill on the RPV head from the penetration for CRDM nozzle 3 and was approximately 4 to 5 inches at its widest part. The minimum remaining thickness of the RPV head in the wastage area was found to be approximately 3/8 inch. This thickness was attributed to the thickness of the stainless steel cladding on the inside surface of the RPV head, which is nominally 3/8 inch thick.

The investigation of the causative conditions surrounding the degradation of the RPV head at Davis-Besse is continuing. Boric acid or other contaminants could be contributing factors. Other factors contributing to the degradation might include the environment of the RPV head during both operating

and shutdown conditions (e.g., wet/dry), the duration for which the RPV head is exposed to boric acid, and the source of the boric acid (e.g., leakage from the CRDM nozzle or from sources above the RPV head such as CRDM flanges).