UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

August 13, 2003

NRC INFORMATION NOTICE 2003-11: LEAKAGE FOUND ON BOTTOM-MOUNTED INSTRUMENTATION NOZZLES

Addressees

All holders of operating license or construction permits for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to indications of leakage in the form of boron deposits discovered on bottom-mounted instrumentation (BMI) nozzles at South Texas Project Unit 1 (STP Unit 1). It is expected that the recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On April 12, 2003, licensee personnel performed boric acid corrosion control (BACC) program walkdowns of STP Unit 1 during the unit's 1RE11 refueling outage as part of the licensee's program in response to Generic Letter (GL) 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants." Licensee personnel performed a 100-percent bare metal visual examination of the STP Unit 1 reactor pressure vessel (RPV) bottom head as part of the BACC program inspections. Similar inspections had been performed during prior STP Unit 1 and Unit 2 outages and no evidence of boron deposits had been identified. In April 2003, however, licensee personnel identified white deposits around STP Unit 1 BMI penetrations 1 and 46. Penetration 1 is centrally located 8.5 inches from dead bottom center of the STP Unit 1 bottom head. Penetration 46 is located on the "hillside" of the RPV bottom head, near the periphery of the RPV, approximately 60 inches (by planar projection) from dead bottom center of the STP Unit 1 bottom head. The licensee quantified the amount of observed deposits as 150 milligrams around penetration 1 and 3 milligrams around penetration 46.

Licensee personnel obtained samples of the deposits from STP Unit 1 BMI penetrations 1 and 46 for chemical and isotopic analysis. The licensee's chemical analysis confirmed the presence of lithium and boron in the samples, which is consistent with leakage of reactor coolant system (RCS) water. To establish an approximate average age of the deposits, the licensee performed a cesium isotopic analysis. The licensee found that the samples were, on

average, about 4 years old. Based on the chemical and isotopic analyses of the samples, the licensee concluded that reactor coolant pressure boundary leakage was the most likely source of the deposits.

Subsequently, the licensee initiated a nondestructive evaluation (NDE) program to inspect the STP Unit 1 penetrations for evidence of cracking or other degradation. The capability of the major elements of the NDE inspection was demonstrated through blind and nonblind testing of the inspection equipment, personnel, and procedures. The major elements of the licensee's NDE program to detect cracking or other degradation were ultrasonic testing (UT) of all 58 STP Unit 1 BMI nozzles from the nozzle inside diameter (ID) using axial, circumferential, and zero degree probes to inspect the nozzle wall material; enhanced visual testing (EVT-1) of the J-groove weld surfaces of all 58 STP Unit 1 BMI penetrations for evidence of cracking; eddy current testing (ECT) using a bobbin coil probe to examine four nozzles, including penetrations 1 and 46, for evidence of cracking at the ID of the nozzles; ECT using an array probe mounted on a pole to examine eight of the STP Unit 1 BMI penetration J-groove weld surfaces for evidence of surface-breaking cracks; and phased-array UT from the outside surface of the RPV bottom head to inspect the low-alloy steel RPV head in the vicinity of penetrations 1 and 46 for evidence of corrosion.

The licensee reported three axially-oriented, crack-like indications in the penetration 1 nozzle wall and two axially-oriented, crack-like, indications in the penetration 46 nozzle wall. One of the indications in penetration 1 was characterized as an axial crack with a length of about 1.38 inches, breaking surface on the OD of the nozzle above and below the J-groove weld, as well as on the ID of the nozzle. The other two indications in penetration 1 were characterized as being small, embedded cracks near the interface between the nozzle wall and the root pass of the J-groove weld. One of the indications in penetration 46 was characterized as an axial crack with a length of about 0.98 inch, breaking the surface on the OD of the nozzle above and below the J-groove weld. The other indication in penetration 46 was characterized as an embedded crack having an axial length of 0.95 inch. The UT inspections conducted by the licensee were not demonstrated to be effective for the purpose of examining the subsurface volume of the J-groove weld. No cracklike indications were identified in any of the other 56 STP Unit 1 BMI nozzle penetrations.

The UT inspection identified other features of the BMI penetrations which the licensee considered relevant. UT reflectors were observed and characterized as "discontinuities" at the interface of the nozzle and the J-groove weld in all of the STP Unit 1 BMI penetrations. The licensee concluded that these discontinuities were possibly evidence of weld lack of fusion, porosity, or other welding defects from original fabrication. These discontinuities were particularly evident in 7 penetrations, including penetrations 1 and 46. The licensee also concluded that discontinuities in penetrations 1 and 46 were located at the same general azimuthal locations as the cracklike indications.

The licensee concluded that no cracking of the 58 BMI penetration J-groove welds was evident based on the EVT-1 and ECT examinations of the J-groove weld surfaces. In addition, based on the phased-array UT examination of the penetration 1 and 46 low-alloy steel base materials the licensee concluded that there was no indication of wastage of the low-alloy steel due to exposure to borated RCS water (the source of the deposits identified at penetrations 1 and 46). Subsequent visual examination of the nozzle bores during the repair of penetrations 1 and 46 also supported the conclusion that there was no evidence of low-alloy steel wastage.

On July 11, 2003, the licensee submitted a preliminary root cause analysis. The conclusion of the analysis was that the most likely root cause explanation for the degradation observed in STP Unit 1 BMI penetrations 1 and 46 was "manufacturing (welding) flaws resulting in excessive stress in the nozzle/weld material leading to crack initiation with low cycle fatigue/primary water stress corrosion cracking then supporting crack propagation." To further investigate the potential root causes of the STP Unit 1 BMI penetration cracking, the licensee cut material samples from STP Unit 1 BMI penetrations 1 and 46 for destructive evaluation. These samples were taken by cutting material from the nozzle-to-J-groove weld interface with a specially designed electrical discharge machining tool. Information gained from the analysis of these material samples is expected to provide additional insights into the initiation and/or propagation of the flaws in STP Unit 1 BMI penetrations. The licensee plans to submit its final root cause report to the NRC in October 2003.

Discussion

The NRC has closely monitored the inspections conducted at STP Unit 1 and the licensee's evaluation of the root cause for the observed cracking. At this time, insufficient information exists to make a determination as to the root cause of the STP Unit 1 cracking. The evaluation of the material samples taken from STP Unit 1 BMI penetrations 1 and 46 is expected to provide additional information to differentiate between potential causes of crack initiation and propagation, including fabrication defects, PWSCC, fatigue, or some combination of these.

Based on the information currently available, the degradation that occurred at STP, Unit 1 may be relevant to other PWR facilities. The NRC staff is in the process of evaluating what information regarding PWR RPV lower head penetrations may be needed for licensees to demonstrate that reactor coolant pressure boundary integrity is maintained at each facility. The NRC staff will develop other generic communications, as necessary, to address this issue.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

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LIST OF RECENTLY ISSUED
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Information Notice No.	Subject	Date of Issuance	Issued to
2003-10	Criticality Monitoring System Degradation at BWX Technologies, Inc., Nuclear Products Division, Lynchburg, VA	08/04/2003	All U.S. Nuclear Regulatory Commission (NRC) licensees authorized to possess a critical mass of special nuclear material.
2002-26, Sup 1	Additional Failure of Steam Dryer after a Recent Power Uprate	07/21/2003	All holders of operating license or construction permits for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.
2003-09	Source Positioning Errors and System Malfunctions During Administration of Intravascular Brachtherapy	07/16/2003	All medical licensees.
2003-08	Potential Flooding Through Unsealed Concrete Floor Cracks	06/25/2003	All holders of operating licenses or construction permits for nuclear power reactors.
2003-07	Water in the Vent Header/vent Line Spherical Junctions	06/24/2003	All holders of operating licenses for boiling water reactors (BWRs) with a Mark I containment.
2003-06	Failure of Safety-related Linestarter Relays at San Onofre Nuclear Generating Station	06/19/2003	All holders of operating licenses or construction permits for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.

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OL = Operating License
CP = Construction Permit