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

May 1, 1990

NRC INFORMATION NOTICE NO. 90-30: ULTRASONIC INSPECTION TECHNIQUES FOR DISSIMILAR METAL WELDS

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose:

This information notice is intended to alert addressees to potential problems associated with the ultrasonic examination of dissimilar metal welds in operating nuclear plants. It is expected that 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

NRC inspections of inservice inspection activities at licensed facilities have revealed that dissimilar metal welds containing Inconel 600 series base materials, alloy 82 and 182 weld butter, and/or filler material are being examined with shear wave mode ultrasonic testing (UT) transducers. As a result of the intergranular stress corrosion cracking (IGSCC) problems identified in piping at boiling water reactor (BWR) plants, the NRC staff, BWR owners, independent research institutes and vendors of UT equipment have discovered that exclusive use of shear wave transducers will not reliably detect cracks in dissimilar metal welds of this type. General Electric has notified BWR owners about this problem by the issuance of a Nuclear Services Information Letter dated June 23, 1989 (SIL No. 455, Revision 1 and Supplement 1). SIL No. 455 and Supplement 1 contained specific recommendations regarding the ultrasonic testing procedures for BWR owners to use as part of their inservice inspection program in performing ultrasonic examinations of dissimilar metal welds. These recommendations stated the following:

> "The use of 45-degree and 60-degree refracted longitudinal waves for crack detection and sizing in the alloy 182 material and the low alloy material is essential. This should be performed at a gain level such that the small signals received from the inside surface, which is sometimes referred to as an ID roll, are at approximately 10 percent of full screen height. Scanning should be performed with the sound beams directed both

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axially and circumferentially. A 45-degree shear wave also should be used in examining the low alloy material after suspect indications are detected with the refracted longitudinal wave search units. These techniques should be qualified and calibrated on a realistic mock-up of the weld configuration which contains suitable reflectors in the areas of concern."

The following list contains examples observed during NRC inspections, demonstrating the limitations of shear wave transducers. Had such transducers been used exclusively, significant axial and circumferential cracking would have gone undetected in Inconel 182 alloy weld butter, filler material and Inconel 600 base material.

1. Axial Cracking

At the Brunswick Steam Electric Plant before 1986, the licensee performed manual examinations on both 28-inch recirculation nozzle-to-safe-end welds. Calibrations were performed on a basic Section XI calibration block using 45-degree shear-wave search units. At this point, no indications associated with IGSCC were recorded.

During the March 1986 outage, examinations were performed using 45-degree and 60-degree, 1Mhz, refracted longitudinal (RL) wave search units. One indication oriented in the axial direction was recorded in the Inconel butter material in each nozzle. These indications were confirmed with both 45-degree RL and 60-degree RL search units and estimated to be approximately 15 percent of the wall thickness. However, neither of these indications could be detected with subsequent 45-degree or 60-degree shear wave examination.

2. Axial and Circumferential Crack

At Brunswick before 1988, the licensee used shear wave search units to examine core spray safe-end-to-nozzle welds. No indications associated with IGSCC were recorded.

During the 1988 outage, the licensee used 45-degree and 60-degree refracted longitudinal wave search units for examination. One axial planar indication, estimated to be 30 percent of wall thickness on one of the safe-ends, and one circumferential, planar indication estimated to be 60-percent of the wall thickness on the other were recorded. These indications were seen with both 45-degree and 60-degree refracted longitudinal wave search units. Neither of these indications were seen with the 45-degree shear wave search unit.

3. Inconel Base Material Crack

During the 1988 outage at Brunswick, the licensee used both 45-degree and 60-degree shear wave search units to examine all the welds in the safe-end thermal sleeve attachments of the 12-inch recirculation system. Calibrations were performed on a safe-end nozzle mock-up block with notches located in the thermal sleeve area. No evidence of cracking was detected with the shear wave examination, even with a scanning gain level of 14 to 29 dB over the calibration sensitivity.

During an examination of a safe-end-to-nozzle weld repair overlay using 45-degree and 60-degree refracted longitudinal wave search units, the licensee detected a crack extending from the safe-end thermal sleeve attachment weld. The licensee then performed 45-degree and 31-degree refracted longitudinal wave calibrations on the same mock-up block notches that were previously used for the shear wave examinations, and re-examined all of the thermal sleeve welds. With these examinations, the licensee detected cracking throughout the heat affected zone and adjacent safe-end material of the safe-end thermal sleeve. All 10 of the safe-end thermal sleeve welds showed evidence of extensive intermittent cracking, for 360 degrees, which was associated with IGSCC.

4. Pressurized Water Reactor (PWR) Facilities

NRC inspections at the Oconee Nuclear Station in November and December of 1989 revealed that all dissimilar metal welds were examined with shear wave transducers. This finding indicates that licensees for PWR facilities may be using inadequate UT inspection techniques as well.

Discussion:

Because no formal instructions exist concerning the choice of transducers for PWR applications, licensees may wish to evaluate the types of materials involved in the dissimilar metal welds at their plants and the ultrasonic techniques and equipment used to examine these materials. The American Society of Mechanical Engineers (ASME) Code does not delineate whether shear wave or refracted longitudinal wave transducers should be used when performing inservice inspections of dissimilar metal welds. However, the intent of the ASME Code examination is to thoroughly examine the weld and the adjacent base material in the heat-affected zone. Without the proper transducers these examinations may not detect rejectable indications in the reactor coolant pressure boundary. Furthermore, enhanced inspection effectiveness can improve confidence in the soundness of welds for plant life extension efforts.

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 NRR project manager.

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Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
90-29	Cracking of Cladding and Its Heat-Affected Zone in the Base Metal of a Reactor Vessel Head	4/30/90	All holders of OLs or CPs for nuclear power reactors.
90-28	Potential Error in High Steamline Flow Setpoint	4/30/90	All holders of OLs or CPs for BWRs.
90-27	Clarification of the Recent Revisions to the Regulatory Requirements for Packaging of Uranium Hexafluoride (UF_6) for Transportation	4/30/90	All uranium fuel fabrication and conversion facilities.
89-70, Supp. 1	Possible Indications of Misrepresented Vendor Products	4/26/90	All holders of OLs or CPs for nuclear power reactors.
90-26	Inadequate Flow of Essential Service Water to Room Coolers and Heat Exchangers for Engineered Safety-Feature Systems	4/24/90	All holders of OLs or CPs for nuclear power reactors.
90-25	Loss of Vital AC Power with Subsequent Reactor Coolant System Heat-Up	4/16/90	All holders of OLs or CPs for nuclear power reactors.
90-24	Transportation of Model Spec 2-T Radiographic Exposure Device	4/10/90	All NRC licensees authorized to use, transport, or operate radiographic exposure devices and source changers.
90-23	Improper Installation of Patel Conduit Seals	4/4/90	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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