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

April 30, 1990

NRC INFORMATION NOTICE NO. 90-29: CRACKING OF CLADDING AND ITS HEAT-AFFECTED ZONE IN THE BASE METAL OF A REACTOR VESSEL HEAD

Addressees:

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

Purpose:

This information notice is intended to alert addressees to a potential problem related to cracking of cladding and its heat-affected zone in the base metal of a reactor vessel head. 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:

During the 1990 refueling at Quad Cities Unit 2, the licensee observed cracks in the cladding and its heat-affected zone in the base metal of the reactor vessel head. The cracks were initially observed visually as rust stains on the cladding. Subsequent liquid penetrant and ultrasonic testing (UT) revealed 34 surface and 15 subsurface flaws. The longest surface flaw was 30 inches and circumferentially oriented in the direction of welding. The longest subsurface flaw was approximately 20 inches and circumferentially oriented. All flaws were circumferentially oriented except for one surface flaw that was transversely oriented in the direction of welding.

The licensee excavated 9 flaws and removed 5 boat samples. The excavations and boat samples indicated that the deepest penetration into the base metal was 0.225 inch beyond the base metal-clad interface, but was contained within the heat-affected zone of the cladding.

Discussion:

The licensee observed cracks and linear indications both on the surface and beneath the surface of the cladding on the reactor vessel head of Quad Cities Unit 2. The cracking is located mainly in a region of the head where the cladding originally applied by submerged arc welding intersects the shielded

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metal arc back-clad. (Back-clad is applied to components where sections of the component are welded together and each section had previously been clad.) Metallographic analysis indicates that the surface flaws were propagating through the cladding as inter-dendritic stress corrosion cracks. Some cracks continued into the base metal heat-affected zone. The factors contributing to the initiation of the surface cracks were high residual stresses in the cladding, low ferrite content of the cladding, and the oxidizing environment (large amounts of oxygen and peroxide mixing with condensed steam) on the inside surface of the reactor vessel head. The cracks were located in the back-clad region adjacent to the head-to-flange weld. The cladding in this region had been subjected to a considerable amount of grinding during fabrication. The licensee believes that the grinding during fabrication was a significant contributor to the high residual stress in the cladding.

The cause of the cracks that were found beneath the surface is believed to be fabrication related. The nuclear steam supply system vendor, the licensee, and the staff are still evaluating the available information to establish the root cause of the cracking problem and its generic implications. General Electric issued RICSIL No. 050, dated April 23, 1990 to BWR owners on this subject.

The surface cracks can be detected by penetrant testing of the back-clad region and the subsurface cracks can be detected with enhanced UT procedures that are performed by experienced nondestructive examination personnel. The presence of extensive machining or grinding marks or rust stains on the cladding surface could indicate a potential area of cracking.

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.

Charles E. Rossi

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

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(301) 492-0931

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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
90-28	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.
90-22	Unanticipated Equipment Actuations Following Restoration of Power to Rosemount Transmitter Trip Units	3/23/90	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

metal arc back-clad. (Back-clad is applied to components where sections of the component are welded together and each section had previously been clad.) Metallographic analysis indicates that the surface flaws were propagating through the cladding as inter-dendritic stress corrosion cracks. Some cracks continued into the base metal heat-affected zone. The factors contributing to the initiation of the surface cracks were high residual stresses in the cladding, low ferrite content of the cladding, and the oxidizing environment (large amounts of oxygen and peroxide mixing with condensed steam) on the inside surface of the reactor vessel head. The cracks were located in the back-clad region adjacent to the head-to-flange weld. The cladding in this region had been subjected to a considerable amount of grinding during fabrication. The licensee believes that the grinding during fabrication was a significant contributor to the high residual stress in the cladding.

The cause of the cracks that were found beneath the surface is believed to be fabrication related. The nuclear steam supply system vendor, the licensee, and the staff are still evaluating the available information to establish the root cause of the cracking problem and its generic implications. General Electric issued RICSIL No. 050, dated April 23, 1990 to BWR owners on this subject.

The surface cracks can be detected by penetrant testing of the back-clad region and the subsurface cracks can be detected with enhanced UT procedures that are performed by experienced nondestructive examination personnel. The presence of extensive machining or grinding marks or rust stains on the cladding surface could indicate a potential area of cracking.

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Document Name: INFO NOTICE - ELLIOT, WEN
*SEE PREVIOUS CONCURRENCES

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The cause of the cracks that were found beneath the surface is believed to be fabrication related. The nuclear steam supply system vendor, the licensee, and the staff are still evaluating the available information to establish the root cause of the cracking problem and its generic implications.

The surface cracks can be detected by penetrant testing of the back clad region and the subsurface cracks can be detected with enhanced UT procedures that are performed by experienced nondestructive examination personnel. The presence of extensive machining and/or grinding marks or rust stains on the cladding surface could indicate a potential area of cracking.

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PCW	BJE	WHK			CERossi
OGCB:DOEA:NRR	EMCB:DET:NRR	EMCB:DET:NRR		RPB:ADM	04/ /90
PCWen	BElliot	WHKoo		TechEd	C/OGCB:DOEA:NRR
04/24/90	04/24/90	04/24/90	JMain	04/24/90	CHBerlinger
					04/24/90

C/EMCB:DET:NRR
OGC 4/24/90