Commonwealth Edison
1400 Opus Place
Downers Grove, Illinois 60515

April 19, 1993

Dr. Thomas E. Murley, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attn: Document Control Desk

Subject: Quad Cities Nuclear Power Station Unit 2
Request for NRC Approval of a Non-Code Repair
for a Recirculation System Pipe Flaw
NRC Docket No. 50-265

References: (a) Teleconference between CECo (J. Schrage, et. al.) and NRC (C. Patel, et. al.) on April 15, 1993

(b) Teleconference between CECo (J. Schrage) and NRC (C. Patel) on April 16, 1993

Dear Dr. Murley:

During the current refueling outage for Quad Cities Station Unit 2 (Q2R12), Commonwealth Edison Company (CECo) identified a flaw in a two-inch line on the Recirculation System. This flaw and the proposed repair method were discussed with the NRC Staff in the referenced teleconferences. The proposed repair is not an ASME Code Section XI approved repair. However, implementation of a code approved repair would require draining the reactor vessel during the current refuel outage, resulting in a potential and unnecessary extension of the outage. In addition, draining the vessel would increase radiation levels in primary containment, resulting in higher personnel exposures to implement the code repair.

Based on the potential impact to critical path outage activities, and the increased personnel exposure necessary to implement the code approved repair, CECo requests NRC approval to implement a temporary non-code repair for one cycle of operation. CECo will implement a permanent code repair for the flaw during the following Quad Cities Station Unit 2 refuel outage (Q2R13), unless NRC approval is obtained for greater than one cycle of continued operation with the non-code repair.

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Dr. Thomas E. Murley

April 19, 1993

A description of the flaw, the proposed non-code repair method, and a safety assessment for the proposed repair are provided in the Attachment to this letter. CECo respectfully requests review and approval of the proposed non-code repair by April 22, 1993. This schedule request is based upon the current schedule of outage activities (commencement of fuel load is scheduled for April 26, 1993).

If there are any questions concerning this matter, please contact John L. Schrage at (708) 663-7283.

Sincerely,

John L. Schrage
Nuclear Licensing Administrator

Attachment

cc: A. Bert Davis, Regional Administrator-RIII
C.P. Patel, Project Manager-NRR
T.E. Taylor, Senior Resident Inspector-Quad Cities
R.A. Hermann-NRR
Office of Nuclear Facility Safety-IDNS

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ATTACHMENT

QUAD CITIES STATION RECIRCULATION SYSTEM PIPE FLAW PROPOSED REPAIR METHOD

1.0 Weldment and Flaw Description

Weld 02-F2B is a fillet weld joining line 2-0209B-2" (2" NPS schedule 80 [0.218" thick]) to valve body MO 2-0202-6B (22" NPS) in a socket-type weldment (See Figure 1). Line 2-0209B-2" provides bypass circulation around valve MO 2-0202-6B. This line and valve are made from ASTM A-312, Type 304 and A-351, Grade CF8M stainless steels, respectively.

During the Quad Cities Unit 2 1993 outage (Q2R12), health physics surveys performed near this weld detected high levels of beta radiation usually associated with primary piping system leakage. Further investigation lead to a liquid penetrant examination of this weld and the discovery of a 3/32" to 5/32" long through-wall flaw as shown in Figure 2. This flaw is difficult to observe visually, but is slowly weeping under hydrostatic conditions.

2.0 Degradation Mechanism

This flaw was believed to have been caused by one of the following degradation mechanisms:

1. High Cycle Vibration Fatigue,
2. Intergranular Stress Corrosion Cracking (IGSCC) and Crevice Assisted Corrosion Cracking, or
3. Weld Defect

2.1 High Cycle Vibration Fatigue

Because of the socket-type nature of weld 02-F2B and the presence of a motor-operated valve in line 2-0209B-2" near weld 02-F2B, it appeared possible that this flaw was caused by high-cycle vibration fatigue. For this configuration, this type of degradation mechanism would propagate a defect starting at the toe of the fillet on the outside of the pipe through the pipe wall to the inside pipe surface under a bi-directional applied load. This type of defect would be expected to have a longer circumferential length on the outside surface than the inside surface of the pipe, and would be much more easily identified during volumetric examination than an IGSCC indication.

Ultrasonic examination (UT) of the pipe under the fillet weld did not detect any flaws in the planes perpendicular to the pipe axis. Therefore, CECo has determined that high cycle vibration fatigue was not a contributor to the initiation and propagation of the flaw.

2.2 IGSCC and Crevice Assisted Corrosion Cracking

Even though weld 02-F2B is not a full penetration butt-weld with a heat affected zone (HAZ) adjacent to the weld extending from the inside to the outside surface of the pipe, through-wall IGSCC is still possible within this weldment. CECo performed a study addressing the affects and effectiveness of weld overlay

repairs on weldments without waterbacking. This study concluded that outside surface welding could sensitize pipe wall thicknesses below 0.5" completely through-wall. Line 2-0209B-2" is only 0.218" in thickness, therefore, based upon the study, it appeared possible that the pipe wall was sensitized, permitting IGSCC to propagate as under applied load conditions (unidirectional or bi-directional applied load).

As shown in Figure 2, a crevice also exists in weld 02-F2B. It was believed that this crevice could be the initiation site for a defect starting at the heal of the fillet weld and propagating by means of IGSCC through the HAZ under the fillet weld due to the residual stress condition.

Ultrasonic examination of the pipe under the fillet weld was able to identify the inaccessible end of the 2" line inside of the socket-like fitting at various azimuth locations around the pipe circumference, but could not identify any cracks or crack branching in the pipe wall under the fillet weld. Based upon these results, IGSCC and/or crevice assisted corrosion cracking do not appear to be a likely contributor to the flaw initiation and propagation.

2.3 Weld Defect with Service Induced Stresses

Based upon the UT results which did not detect any reflectors in the pipe wall under the fillet weld, the flaw appears to propagate in the direction parallel to the pipe surface/pipe axis, along the fillet weld to the pipe fusion zone.

Weld defects propagated by service induced stresses were confirmed by destructive examination in two flawed socket joints at another CECo station (a 2" bowl drain line and a 3/4" after-seat drain line, both AISI Type 304 stainless steel and socket welds).

Given the UT results, and the previous experiences with cracked socket joints, CECo believes that the most likely cause of the flaw initiation is a weld defect, propagated by service induced stresses.

3.0 Governing Codes and Regulations

Generic Letter 88-01 "applies to all BWR piping made of austenitic stainless steel that is four inches or larger in nominal diameter and contains reactor coolant at a temperature above 200 degrees F during power operation regardless of code classification". Therefore, because line 2-0209B-2" is made from 2" NPS piping, the requirements of NUREG-0313 do not automatically apply to weld 02-F2B. However, based upon "guidance" offered in Generic Letter 90-05, a licensee is required to request the USNRC to grant relief for non-code repairs on a case-by-case basis for Class 1 and 2 piping.

All "structural" weld overlays (as opposed to corrosion-resistant cladding overlays) are currently "non-code repairs", therefore, USNRC approval is required. Therefore, Commonwealth Edison Company requests NRC review and approval of a proposed engineered weld overlay for the pipe flaw described in sections 1.0 and 2.0. This weld overlay is proposed for one cycle of operation, and will be replaced with an ASME Section XI code repair during the subsequent refuel outage (Q2R13), unless NRC approval is obtained for continued operation greater than one cycle. The following section describes the weld overlay design and a safety assessment for the weld overlay.

4.0 Weld Overlay and Safety Assessment

The weld overlay design meets the requirements of Generic Letter 88-01, NUREG-0313, and ASME Section XI (See Figure 3). A 360 degree long, 100% through-wall flaw and an ASME Section XI applied load safety factor of 2.77 were assumed in the overlay design.

If the first structural layer has a ferrite content of at least 7.5FN, it shall be included in the structural thickness of the final overlay.

This type of weld overlay will "choke" the underlying pipe that it is applied to, creating a compressive stress along the pipe-to-weld overlay interface. The compressive stress will eliminate the growth of a flaw, weld defect, or stress corrosion crack along the pipe-to-weld overlay path.

As demonstrated both in independent laboratory experiments and CECo's own in-plant experience, the high measured ferrite content and the low carbon content inherent in the ER308L or ER309L filler metals that will be used to fabricate the weld overlay will also ensure that stress corrosion cracking, if any is effectively mitigated. In NUREG CR-4667, "Environmentally Assisted Cracking in Light Water Reactors: Semi-annual Report - April-September 1986", dated September 1987, Argonne National Laboratory demonstrated that IGSCC which propagated through the furnace-sensitized 304 base material portion of a compact test specimen could not propagate through a ER308L weld overlay. The resistance of weld overlay material is further illustrated by a boat sample extracted from weld 02J-S3 at Quad Cities Unit 2 by CECo in 1990: a through-wall IGSCC defect was completely arrested at the pipe-to-weld overlay interface in an actual in-plant weldment subjected to a fuel cycle of operation.

In addition, the heat input controls utilized during weld overlay application are designed to minimize base metal sensitization. The maximum heat input (28 Kj/in.) and maximum allowable outside pipe surface temperature permitted between the application of weld overlay beads (212 degree F) utilized by CECo during weld overlay implementation are almost identical to the welding parameters (25 Kj/in. and 210 degree F) offered by EPRI/General Electric in EPRI document NP-2033-LD "BWR Large-Diameter Pipe Repair/Replacement Study", dated September 1981. These parameters ensure a lack of base metal sensitization during the application of inside pipe surface corrosion-resistant cladding (CRC) in thin-walled pipe.

The proposed weld overlay design also incorporates a more gradual (minimum 2:1 rather than a standard 1:1) and taper to soften the stiffness of the weld overlay-to-pipe transition as compared to the more abrupt stress riser transition associated with the original pipe-to-socket configuration. This gradual and taper will increase the number of applied load cycles required to initiate a new high cycle vibration fatigue defect if this degradation mechanism actually exists at this weldment location.

To ensure that flaws are not propagating axially along the pipe-to-weld overlay interface, future UT bonding examinations should be performed.

5.0 Weld Overlay Fabrication and Examination/Inspection

Because of the physical configuration and interferences associated with weld 02-F2B, the fabrication, examination/inspection, and future inservice inspection requirements of the weld overlay to be applied to this weld cannot completely comply with the same Generic Letter 88-01, NUREG-0313, ASME Section XI, and CECo weld overlay technical requirements applied to other safety-related weld overlays applied at Quad Cities Units 1 and 2.

Accordingly, the following exceptions/clarifications to the GECo weld overlay technical requirements shall apply:

5.1 Overlay Welding Requirement

5.1.2 Manual GTAW may be used to apply all/parts of the repair.

5.1.2 Manual welding shall be applied in the same manner as machine welding relative to bead placement, maximum allowable pipe surface temperature control, maximum allowable heat input (28 Kj/in.), etc. In addition, welders should also attempt to maintain heat input control.

5.2 Overlay Layout

5.2.1 Because of the configuration of line 2-0209B-2", weld overlay axial shrinkage affects are of no concern relative to increases in piping system sustained stress. Therefore, "witness marks" are not required in the weld overlay layout.

5.2.2 The affect of weld overlay axial shrinkage on an adjacent pipe support guide is a concern. At the completion of the weld overlay application, the position of the support guide relative to line 2-0209B-2" should be reviewed and any required adjustments in the guide should be implemented.

5.2.3 If in fact the existing through-wall flaw was caused by high-cycle vibration fatigue, the weld overlay design shown in Figure 3 incorporates a minimum 2:1 rather than the standard 1:1 and taper to "soften" the stiffness of this end of the overlay. Therefore, the placement of weld overlay boundary marks should reflect this longer taper.

5.3 In-Process Nondestructive Examination/Measurement Requirements and Acceptance Criteria

5.3.1 A "snow white" liquid penetrant examination (PT) of the original pipe surface may be delayed until the application of a "sacrificial" first overlay layer to repair the existing through-wall flaw. This sacrificial layer shall not be included in the design thickness of the weld overlay.

5.3.2 If the existing through-wall flaw is repaired using an excavation and seal/fill welding and this repair and the surrounding original pipe surface is shown to be "snow white", then the first overlay layer can be included in the design thickness of the weld overlay if it passes a normal ferrite content check.

5.3.3 As explained above, axial shrinkage measurements are not required.

5.3.4 Because post-weld overlay volumetric UT of this weld overlay is considered unreliable, a layer-by-layer PT examination shall be required during the application of this weld overlay. The PT examination of all layers except the final layer shall have the same acceptance criteria as the pre-overlay PT examination requirements.

5.4 Welding Instructions and Techniques

5.4.1 All welding shall be performed with waterbacking. As discussed above, surface welding without waterbacking may sensitize the pipe completely through-wall establishing a new HAZ at the tapered end of the weld overlay.

5.4.2 A bead-by-bead welding log is not required.

5.5 Final Nondestructive Examination/Measurement Requirements and Acceptance Criteria

5.5.1 The final surface of the weld overlay shall be suitable for visual, PT, and UT bonding examination and UT thickness measurement. The weld overlay may be surface conditioned as directed by CECo to allow future volumetric UT examination.

5.5.2 Axial shrinkage measurement is not required.

5.5.3 Volumetric UT is not required no prohibited.

6.0 Future Inservice Inspection

As discussed above, weld 02-F2B does not fall within the scope of Generic Letter 88-01, therefore, CECo is not required to comply with the inspection categories/frequencies of NUREG-0313. However, because CECo has already included small diameter weldments in the future inservice inspection program at Quad Cities Station, weld 02-F2B will be inspected at the same frequency as required for NUREG-0313 IGSCC Category "E" welds (all welds every 2 refueling cycles). Inservice inspections shall be surface and UT bonding examinations only.

FIGURE 1

Weld O2-F2B

Pipe/Valve Configuration and Flaw Location

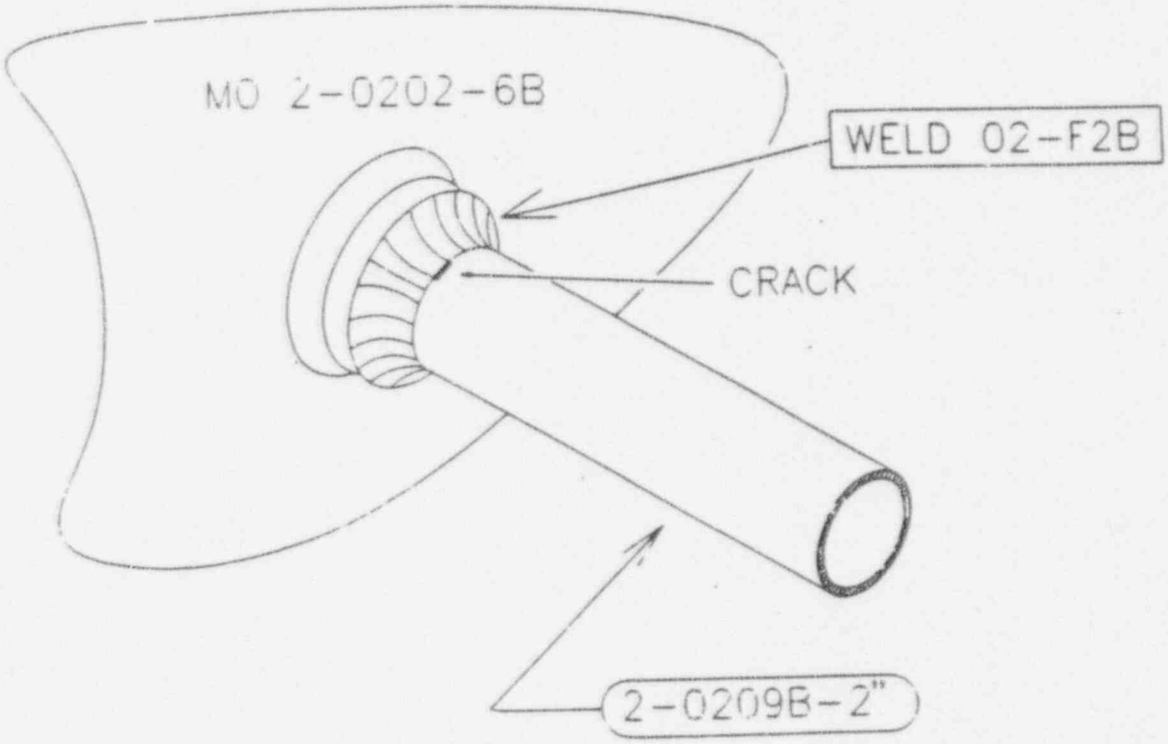


FIGURE 2

Weld O2-F2B

Crevice and Flaw Configuration

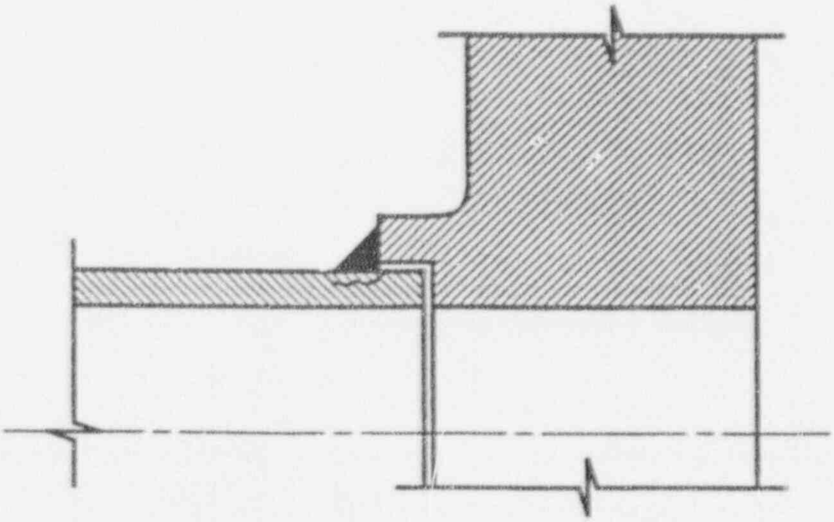
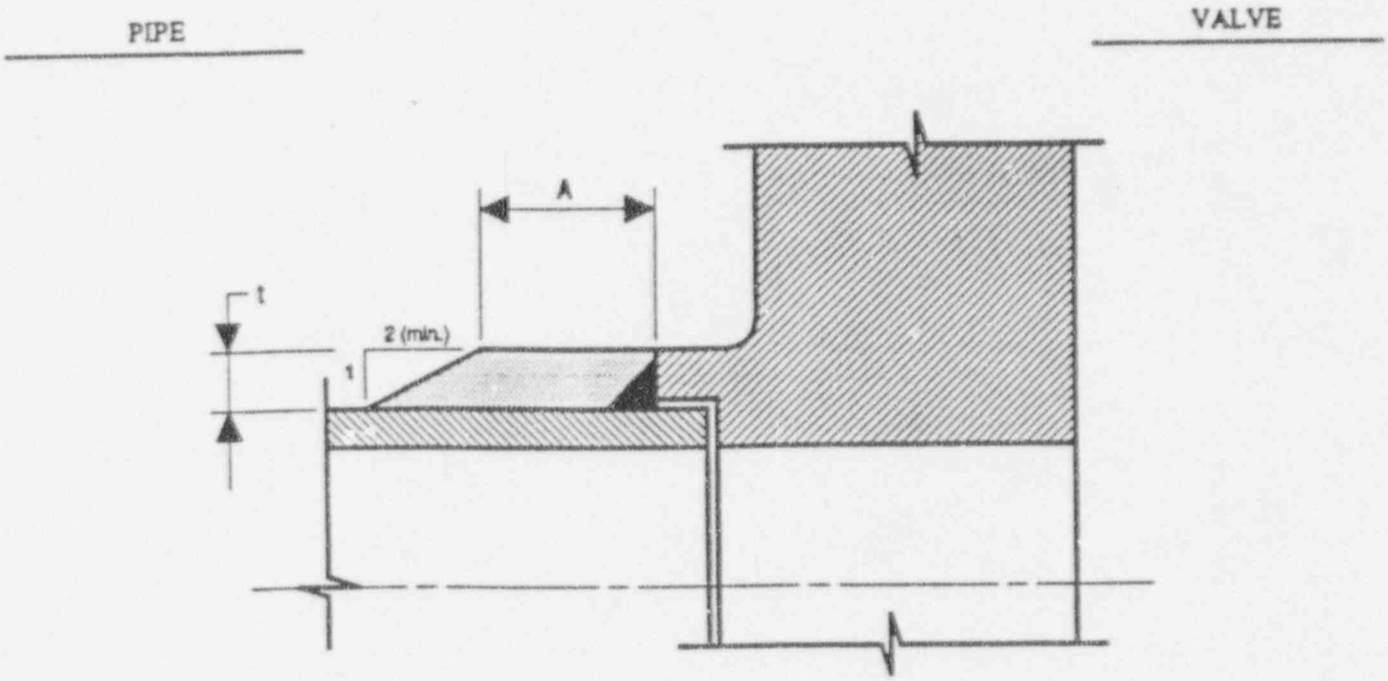


FIGURE 3

Weld O2-F2B

Proposed Repair Design

Engineered Weld Overlay



U.S. PATENT NO. 4,624,402

WELD OVERLAY REPAIR DESIGN

NOTES:

(1) THIS REPAIR SHALL COMPLY WITH THE TECHNICAL REQUIREMENTS CONTAINED IN DOCUMENT NO. COE-107-500, REVISION 0, AS MODIFIED BY LETTER NO. CHF-93-013.

(2) OVERLAY THICKNESS SHALL PROVIDE A SMOOTH TRANSITION WITH EXISTING FITTING. OVERLAY THICKNESS DIMENSION "t" DOES NOT INCLUDE FIRST LAYER THICKNESS IF USED TO SEAL EXISTING THRU-WALL DEFECT.

(3) AT THE STATION'S DIRECTION, OVERLAY LENGTH DIMENSION "A" MAY BE INCREASED TO 2.25" TO PERMIT FUTURE VOLUMETRIC ULTRASONIC INSPECTION.

WELD NUMBER	FLAW CHARACTERIZATION	DESIGN DIMENSIONS		COMMENTS
		t	A	
02-F2B	3/32" TO 5/32" LONG THRU-WALL DEFECT	0.22"(2) (min.)	1.0" (min.)(3)	"FULL-STRUCTURAL" WOR DESIGN