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March 2, 1987

Mr. Harold Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington D.C. 20555

Subject: Dresden Station Unit 2
Inservice Inspection Information

Reference: 1) J.R. Wojnarowski to H.R. Denton dated August 27, 1986.
2) J.A. Zwolinski to D.L. Farrar dated December 3, 1986.
3) J.R. Wojnarowski to H.R. Denton dated January 16, 1987

Dear Mr. Denton:

This is the final report of the Dresden Unit 2 84-11 augmented piping inspection. This report provides a description of flaws found and of analytical and repair action taken during the fall 1986 refueling outage.

1. Augmented Inspection Results, Dresden Unit 2, Fall 1986 outage.

   This attachment is a summary of the augumented stainless steel ultrasonic examination performed during the fall 1986 refueling outage. Compliance to the NRC accepted sampling plan submitted by Commonwealth Edison has been demonstrated.

2. Dresden Unit 2 Stainless Steel Flaw List.

   This attachment lists the flawed welds, when they were identified and their disposition.

3. Discussion and Observations Regarding Flawed Welds in a Hydrogen Mitigated Environment.

   This attachment discusses the UT examination results and actions for weldments which have been reported as flawed from previous and present outages.

4. Effectiveness of Hydrogen for Mitigation of IGSCC.

   This attachment discusses the effectiveness of hydrogen addition over the past two (2) cycles at Dresden Unit 2.

5. Discussion and Observations Regarding Ultrasonic Examinations of Weld Overlay Repaired Stainless Steel Welds.

   This attachment discusses the ultrasonic examination results from the UT exams of 6 weld overlay repairs performed this outage. (5 upgrades and 1 new)

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6. "Evaluation and Disposition of Flaws at Dresden Nuclear Power Plant Unit 2, (1986/87 Outage)", Prepared by: Nutech Engineers, San Jose, California.

   This report summarizes analysis performed by Nutech Engineers to evaluate flaw indications, including criteria employed in the analysis.

Please direct any additional questions regarding this issue to this office.

Yours very truly,

Irene M. Johnson

for J.R. Wojnarowski
Nuclear Licensing
Administrator

att.
cc: Resident Inspector-Dresden
M. Grotenhuis-NRR
M. C. Parker-IDNS

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Augmented Inspection Results
Dresden Unit 2, Fall 1986 Outage

Augmented inspection of IGSCC susceptible piping was conducted during the Dresden Unit 2 fall 1986 refueling outage. The inspection following the inspection plan submitted to the NRC on August 27, 1986 and approved by the NRC letter dated December 3, 1986. Examinations were performed by General Electric with evaluation of indications made by special level II ultrasonic (UT) examiners qualified by EPRI after September 10, 1985. Data packages were reviewed by CECo UT personnel and final acceptance or evaluations of indications were made by CECo level III personnel.

New IGSCC indications were detected in the first sample of welds resulting in a sample expansion. A total of 112 IGSCC susceptible stainless steel welds were examined during the fall 1986 outage compared to 57 welds called for in the inspection plan. Table 1 provides a summary of examinations performed during the outage. Table 2 is reproduced from the previously submitted Augumented Inspection Plan.

The total of six (6) weld overlays examined includes one (1) required by the 84-11 Plan, one (1) requested by the NRC (Reference 3), three (3) examined in the anticipation of NUREG. 0313 Rev. 2 requirements and one (1) new overlay. Five (5) overlays originally applied during prior outages were upgraded to a minimum of full structural design thickness. The new overlay was applied to meet full structural design criteria. Each of the overlays was surface finished to permit application of EPRI techniques for overlay UT examinations. The overlay weld metal and the upper 25 percent of the original piping material were examined with no flaws being found in these zones. All inspected weld overlays met the full structural design criteria.

Three (3) welds previously reported as containing IGSCC flaw indications were examined this outage. One (1) of the welds showed no significant changes in flaw characterzation, one (1) weld is no longer believed to be cracked and one (1) showed an apparent change which is discussed in Attachment 3. Another weld, PDIA-D14, was previously reported as having a geometric reflector and the examination this outage showed no change in the UT signals.

Two 12 inch recirculation safe ends were inspected this outage using CECo developed procedures proven to be effective on a mock up of the thermal sleeve attachment weld. This provided confidence in the UT Examinations. No indications of cracking were detected in the region of the thermal sleeve attachment welds. Details of this program will be contained in a future report to the NRC.

TABLE 1
DRESDEN UNIT 2
AUGMENTED INSPECTION SUMMARY

System	Size	Total Welds	Weld Overlays Examined	Hydrogen Addition Mitigated Flawed Welds Examined	Total Number[B] of Welds Examined
Recirculation					
Risers	12"	50	4	2	24
Outlets	28"	33		1	13
Headers	22"	18			11
LPCI/SDC	16"	42			17
SPC	14"	4			2
RWCU	8"	12[A]	2		12
ISO Condenser	14"	16			10
ISO Condenser	12"	13			10
Recirc/CRD/HV	4"	26			8
JPI		10			5
		224			112

Note A. Two (2) welds on the reactor water cleanup line were added to the list of IGSCC susceptible stainless steel welds and were inspected this outage.

Note B. Includes weld overlays examined and hydrogen addition mitigated flawed welds examined.

TABLE 2

Dresden Unit 2 84-11 Augmented Inspection Plan

1	2	3	4	5	6	7	8	9	10	11
SYSTEM	SIZE	TOTAL	1984 84-11 EXAM	NO QUALIFIED EXAMS	NO QUALIFIED EXAMS 1986/84-11 SAMPLE	WELD OVERLAYS	WELDS OVERLAY SAMPLE	CRACKED	EXAMINED WELDS 1986/84-11 SAMPLE	1986 84-11 TOTAL SAMPLE
Recirculation										
Risers	12"	50	12	29	6[b]	7	0	2	2	10
Outlets	28"	33	9	23	5[c]	0	0	1	2	8
Header	22"	18	6	12	4	0	0	0	2	6
LPCI/SDC	16"	42	11	31[a]	6	0	0	0	2	8
SDC	14"	4	2	2[a]	0	0	0	0	2	2
RWCU	8"	10	9	0	0	1	1	0	2	3
ISO Condenser	14"	16	4	12[a]	4	0	0	0	2	6
ISO Condenser	12"	13	6	7[a]	4	0	0	0	2	6
Recirc/CRD/HV	4"	26	10	16	4	0	0	0	2	6
JPI		10	10	0	0	0	0	0	2	2
		222			33		1	3	20	57

COLUMN

3 - TOTAL STAINLESS STEEL WELDS SUSCEPTIBLE TO IGSCC ON A PARTICULAR SYSTEM OR SIZE.
4 - TOTAL WELDS EXAMINED UNDER GENERIC LETTER 84-11 CRITERIA. EXAMINERS WERE QUALIFIED TO THE 83-02 QUALIFICATION.
5 - TOTAL WELDS NOT EXAMINED UNDER THE I E BULLETIN OR GENERIC LETTER.
6 - GENERIC LETTER 84-11 1986 SAMPLE OF WELDS THAT WERE NOT EXAMINED UNDER 83-02 QUALIFICATION.
7 - TOTAL WELD OVERLAYS ON A PARTICULAR SYSTEM AND SIZE.
8 - GENERIC LETTER 84-11 WELD OVERLAY SAMPLE. OVERLAID WELDS WITH CRACKS GREATER THAN 10% OF THEIR CIRCUMFERANCE WILL BE INSPECTED.
9 - TOTAL CRACKED WELDS WITH HYDROGEN ADDITION AS A MITIGATOR.
10 - GENERIC LETTER 84-11 1986 SAMPLE OF WELDS THAT WERE EXAMINED UNDER THE 83-02 QUALIFICATION.
11 - GENERIC LETTER 84-11 1986 TOTAL SAMPLE.

NOTE: [a] - 2 WELDS ON 16" LPCI, 2 WELDS ON 14" SDC, 1 WELD ON 14" AND 1 WELD ON 12" ISO CONDENSER, ARE INACCESSIBLE TO UT.
[b] - SAMPLE INCLUDES TWO 12" NOZZLE TO SAFE END WELDS.
[c] - SAMPLE INCLUDES ONE 28" NOZZLE TO SAFE END WELDS.

DRESDEN UNIT 2
STAINLESS STEEL FLAW DISPOSITION LIST

Weld Number	Flaw Initially Identified 1983	1984	1986	Action/Year	Remarks
12 Inch -					
PD19 D13	X			Weld Overlay/'83	
PD19 D14	X			Weld Overlay/'83	Built up and inspected 1986
PD4 D23	X			Weld Overlay/'83	Built up and inspected 1986
PD5 D20	X			Leave as is	
PD2 D5	X			Leave as is	
PD3 D2	X			Weld Overlay/'83	
PD9 D8	X			Weld Overlay/'83	Built up and inspected 1986
PD9 D11	X			Weld Overlay/'83	Built up and inspected 1986
PD2 D4	X			Weld Overlay/'83	
8 inch -					
8 K13		X		Weld Overlay/'84	Built up and inspected 1986
8 12			X	Weld Overlay/'86	Applied and inspected 1986
28 inch -					
PS 2/201-1	X			Leave as is	Evaluated as geometry in 1986

Discussion and Observations Regarding Flawed Welds in a Hydrogen Mitigated Environment

Background

Extensive ultrasonic (UT) examination programs of IGSCC susceptible stainless steel piping have been performed during both the 1983 and 1984 Dresden Unit 2 refueling outages. As a result of these examinations, IGSCC indications have been identified in a number of welds. Flawed pipe analyses have been performed by Nutech for each of these welds, with weld overlay repairs being utilized for some of these welds. Three (3) welds reported as flawed in 1983 were left as is and re-examined midcycle 1983, during the 1984 outage and during the current 1986 outage.

During the current 1986 refueling outage, UT examinations of approximately 50% of all class 1 and 2 IGSCC susceptible stainless steel piping were performed. This was the result of the apparent change in the UT indications of a previously flawed weld and the detection of a single IGSCC flaw in another weld. A summary of the UT results of the flawed welds is contained in Table 1.

Some general observations related to the examination reported in Table 1 include:

- Three (3) flawed welds examined four (4) times since 1983 - one (1) weld had no significant change, one (1) weld was reclassified as not cracked and one (1) showed an apparent change.
- One (1) weld evaluated as geometry in 1984 had no significant change in UT signals in 1986.
- One (1) flawed weld reported as no recordable indications in 1984 showed a significant flaw in 1986.

Specific Weld Discussion

Weld PD5-D20 (12" - Elbow to Pipe)

Indications of IGSCC were ultrasonically detected by Lambert, MacGill and Thomas (LMT) in February 1983. The flaws were reported as having a maximum depth of 17% throughwall. This weldment was monitored by ultrasonic examination techniques at each outage. Three subsequent examinations by LMT revealed no change in the depth or length of the indications. A fourth subsequent examination performed by General Electric (GE) resulted in a reported length increase from ¼ inch to 2 ½ inches and reported a new flaw indication located away from the previous flaws. All examinations were performed using Commonwealth Edison procedures.

This apparent length increase, coupled with the identification of an additional flaw indication, prompted CECo to contact EPRI, LMT, and GE for assistance in determining an explanation for this apparent change in the UT results.

After an independent review of the UT data generated over the last 4 years by each of the individuals involved, a meeting was held to discuss their conclusions. The general agreement was that the flaw indication that apparently grew longer was probably always approximately 2½ inches long and that the new flaw indication detected could have been missed by LMT in the earlier examinations.

In addressing the 2½ inch flaw indication, consideration was given to the length and depth measurements originally reported by LMT. If the flaw was only ¼ inch long, 17 percent through wall, and 90 percent of the distance amplitude correction (DAC) curve; it would be extremely difficult to detect. The feeling is that the flaw was longer, but could only be detected by the examiner for ¼ inch. During the 1986 examination, GE used a different revision of the procedure than did LMT. Additionally, different equipment was used. LMT used a Nortec 131 ultrasonic instrument with Harisonics ½ x ½ inch search units. GE used a Krautkramer USIP-11 ultrasonic instrument with Aerotech 3/8 in diameter search units. Both vendors used 45 degree refracted shear waves of 2.25 Mhz. The difference in instruments and search units could very easily result in different measurements for the flaw length and amplitude. The flaw indication amplitude as detected by GE was higher from approximately the 9 to 9½ inch markers but could be followed to the 7 inch marker with the signal amplitude much lower. This seems to be the best explanation for the increase in recorded length, i.e. that the signal dropped off in amplitude sharply and then continued at a low level (apparently undetected by LMT) for an additional two inches.

In addressing the new flaw it was stated that this flaw, reported by GE as 5/8" in length, could have been missed by LMT during the initial examination. In reviewing earlier LMT strip chart records, an indication was detected in the same vicinity, and had been characterized as geometry by the examiner at the time.

It is believed that these flaw indications were present in 1983 and not detected for the reasons above.

Weld PD2-D5 (12" Pipe to Elbow)

No significant changes have been observed this outage in the UT flaw signals from previous examinations.

Weld PS2/201-1 (28' Elbow to Pipe)

In 1983 an IGSCC flaw indication was detected by LMT. This weld was re-inspected mid cycle in 1983 and showed no change from the previous examination. During the 1984 refueling outage an LMT inspector re-examined this weld pre-decontamination and found no change in the UT signals. A post decon examination by a different LMT inspector detected the same indication and called it root geometry. In 1986 GE examined this weld and could not find any evidence of an IGSCC flaw indication but GE detected ID root geometry due to beam redirection in the same area. It is believed that this indication is an ID root geometric indication and not an IGSCC flaw.

Weld PDIA-D14 (28" - Elbow to Pipe)

This weld was inspected by LMT in 1984 and a circumferential flaw indication was found of .88 inches by 7% through wall. During that same outage Universal Testing re-examined this weld using I.D. creeping wave and shear wave. They also used a longitudinal wave transducer to map the ID surface configuration in the area of the indication found by LMT. Their conclusion was that the indication is caused by ID geometry in a window closure at the end of the welding operation and could not find any conclusive evidence of an IGSCC flaw indication.

General Electric re-examined this weld during the 1986 outage and detected the same indication as LMT found. In conversations with GE, the flaw indication was very shallow and difficult to detect. The indication was called by GE as an IGSCC flaw indication.

There was no significant change in the UT flaw signals from the previous exams.

Weld 8-12 (8" - Pipe to Valve)

Weld number 8-12 is a pipe to valve weld on the reactor water clean up line (RWCU). In 1984 the examination of all welds on the RWCU line revealed 16 welds with IGSCC flaws, 15 of which were replaced out-board of the isolation valve and one was weld overlayed in-board of the isolation valve. During the 1986 outage, UT exams detected an IGSCC flaw indication on the pipe side of the in-board pipe to valve weld.

This weld was examined in 1984 before the portion of the RWCU line out-board of the valve was replaced and no indications were detected. This flaw may have been very tight thus being a poor reflector and not detectable in 1984. Due to fit up and replacement welding on the other side of the valve, it is postulated the existing flaw had apparently opened up and become a better reflector for 1986 UT examinations.

Due to the size of this flaw the weld was overlayed with a full structural overlay and surface conditioned to permit the application of EPRI techniques for overlay UT inspection.

TABLE 1

DRESDEN UNIT 2
COMPARISON of ULTRASONIC EXAMINATION RESULTS FOR IGSCC FLAWS

Weld Number	Flaw Identified 1983 UT Exam Results LMT	1983 Midcycle UT Exam Results LMT	1984 UT Exam Results LMT	1986 UT Exam Results GE	Remarks
PD5-D20 12 inch Elbow to pipe	0.25" x 19% (elbow side) 0.25" x 17% (elbow side)	0.25" x 17% (elbow side) 0.25" x 15% (elbow side)	0.25" x 16% (elbow side) 0.25" x 16% (elbow side) Note 1	0.25" x 12% (elbow side) 2.5" x 15% (elbow side) 0.625 x 20% (pipe side)	Apparent change see discussion in this attachment
PD2-D5 12 inch Elbow to pipe	0.5" x 19% (elbow side) 0.25" x 14%	0.5" x 18% (elbow side) 0.25" x 16% (elbow side)	0.5" x 17% (elbow side) 0.25" x 17% (elbow side) Note 1.	0.2" x 15% (elbow side) Spot x 11% (elbow side)	No significant change from previous exams.
PS2/201-1 28 inch Safe end to elbow	1" x 16% (elbow side)	1" x 17% (elbow side)	1" x 17% (elbow side) Note 1.	Root geometry due to beam redirection	Re-evaluated as an I.D. Root Geometric indication by General Electric in 1986.
PDIA-D14 28 inch elbow to pipe	No Exam	No Exam	0.88" x 7% (Pipe Side)	1" x 8% (Pipe Side)	Evaluated by KWU as a geometric refector in 1984. No significant change from previous exam.
8-12 8 inch pipe to valve	No Exam	No Exam	No recordable indications	2" x 36% pipe side	Apparent new IGSCC see discussion in this attachment

Note 1. Pre and post examinations were performed - results were identical

Effectiveness of Hydrogen for Mitigation of IGSCC

Background

In 1983 a hydrogen addition system was installed by Commonwealth Edison in conjunction with the cooperation of EPRI and the DOE at Dresden Unit 2. This program was to determine if the addition of hydrogen is an effective mitigator for the IGSCC problem. Three (3) flawed welds were left in place and used to monitor flaw growth. These flaws have been examined five (5) consecutive times over a two (2) cycle period and no unexplained growth has occurred.

Discussion

The question of the effectiveness of hydrogen on IGSCC in stainless steel piping has been recently raised by some due to the apparent growth of one flaw and the detection of two apparently new flaw indications.

If the premise is taken that the new flaws were not present in 1984, they have then been initiated and grown to their current lengths and depths (2" x 30% and .625" x 20%) in an 18 month period. This is not consistent with typical IGSCC crack growth. In the case where apparent flaw growth has occurred, the flaw has grown in length and not in depth. This growth is not typical to any kind of IGSCC crack growth characteristics. Technical rationale, given the typically observed weld induced stress patterns for any crack growth, would lead one to believe that if any significant flaw growth in length occurs then growth in depth must also occur.

The effectiveness of hydrogen addition is demonstrated by the stability of the previously reported IGSCC indications from 1983 to 1986, from a reported flaw indication from 1984 to 1986, from the minimal repairs at Dresden Unit 2 during the last two (2) cycles and the stabilization of the furnace sensitized safe ends.

Conclusion

From the extensive review of the current and previous ultrasonic data reports, it is concluded that the observed IGSCC flaws were present in 1983 and the effectiveness of hydrogen continues to be demonstrated.

Discussion and Observations Regarding Ultrasonic Examination of Weld Overlay Repaired Stainless Steel Welds

Background

Six (6) weld overlay repaired welds were inspected during the 1986 refueling outage. Weld number 8-K13 (8" pipe to elbow) was required to be inspected by Generic Letter 84-11. Weld number PD9-D8 (12" pipe to elbow) had a designed (mini) weld overlay in place. The NRC requested Commonwealth Edison to inspect this overlay (reference #2) so the weld overlay was built up to full structural and inspected. Three (3) weld overlays-weld numbers PD19-D14 (12" pipe to elbow), PD4-D23 (12" pipe to elbow), and PD4-D23 (12" pipe to elbow)-were inspected in the anticipation of NUREG. 0313 Rev. 2 requirements. One (1) new overlay was installed to a full structural design on weld 8-12 (8" pipe to valve) and examined.

Results

Each of the 6 weld overlays were examined using a demonstrated Commonwealth Edison Procedure incorporating EPRI requirements for surface conditioning.

The UT results of all six (6) overlays examined showed no detectable flaws in the weld metal or in the upper 25% of the base material.

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