NRC FORM 366
(7-77)

LICENSEE EVENT REPORT

CONTROL BLOCK: (1) (PLEASE PRINT OR TYPE ALL REQUIRED INFORMATION)

0 1 | ALBRF2 (7) | 00-00000-00 (3) | 4 1 1 1 1 (4) | (5)

LICENSEE CODE (14) | LICENSE NUMBER (25) | LICENSE TYPE (30) | CAT (58)

CON'T

0 1 | REPORT SOURCE L (6) | 05000260 (7) | 12 30 82 (8) | 01 11 83 (9)

DOCKET NUMBER (68) | EVENT DATE (74) | REPORT DATE (80)

EVENT DESCRIPTION AND PROBABLE CONSEQUENCES (10)

0 2 During a refueling outage, while performing examinations required by IEB 82-03,

0 3 indications of cracking were found in recirculating piping on welds KR2-36

0 4 and KR12-14. The indications were found by ultrasonic inspection and confirmed

0 5 as cracks by X-ray examination. There was no effect on public health or

0 6 safety. There are no redundant system.

0 7

0 8 (80)

SYSTEM CODE (11) | CAUSE CODE (12) | CAUSE SUBCODE (13) | COMPONENT CODE (14) | COMP. SUBCODE (15) | VALVE SUBCODE (16)

0 9 CB | C | Z | PIPEXX | E | Z

(17) LER/RO REPORT NUMBER: EVENT YEAR 82 | SEQUENTIAL REPORT NO. 040 | OCCURRENCE CODE 01 | REPORT TYPE T | REVISION NO. 0

ACTION TAKEN X (18) | FUTURE ACTION X (19) | EFFECT ON PLANT Z (20) | SHUTDOWN METHOD Z (21) | HOURS 0000 (22) | ATTACHMENT SUBMITTED Y (23) | NPRD-4 FORM SUB. N (24) | PRIME COMP. SUPPLIER N (25) | COMPONENT MANUFACTURER K055 (26)

CAUSE DESCRIPTION AND CORRECTIVE ACTIONS (27)

1 0 Cracks appear to be fatigue-induced (see attached analysis and action plan).

1 1 An analysis will be performed on welds KR2-36 and KR2-14 to demonstrate that

1 2 the flaws will not propagate to an unacceptable level during the next cycle of

1 3 operation. A special test will be performed to monitor the movement and

1 4 vibration of the recirculation piping at these two welds. (80)

FACILITY STATUS H (28) | % POWER 100 (29) | OTHER STATUS (30) NA | METHOD OF DISCOVERY (31) | DISCOVERY DESCRIPTION (32)

1 5 H | 100 | NA | Inservice inspections

ACTIVITY RELEASED Z (33) | CONTENT OF RELEASE Z (34) | AMOUNT OF ACTIVITY (35) NA | LOCATION OF RELEASE (36) NA

1 6 Z | Z | NA | NA

PERSONNEL EXPOSURES: NUMBER 000 (37) | TYPE Z (38) | DESCRIPTION (39) NA

1 7 000 | Z | NA

PERSONNEL INJURIES: NUMBER 000 (40) | DESCRIPTION (41) NA

1 8 000 | NA

LOSS OF OR DAMAGE TO FACILITY: TYPE Z (42) | DESCRIPTION

1 9 Z |

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PUBLICITY: ISSUED Y (44) | DESCRIPTION (45) Responded to media inquiries.

2 0 Y | Responded to media inquiries. (80)

NRC USE ONLY

NAME OF PREPARER E. T. Holder PHONE (205) 729-0712

Tennessee Valley Authority
Browns Ferry Nuclear Plant

Form BF 17
BF 15.2
2/12/82

LER SUPPLEMENTAL INFORMATION

BFRO-50- 260 / 82040 Technical Specification Involved 3.6.G

Reported Under Technical Specification 6.7.2.a(3) * Date Due NRC 1/12/83

Event Narrative:

Unit 1 was operating at 99-percent power, unit 3 was operating at 99-percent power. On 12/30/82 with unit 2 in refueling outage, examinations were performed in accordance with IEB 82-03 on welds in the recirculation piping. Indications of cracking were found by ultrasonic inspection and confirmed as cracks by X-ray examination. Three indications were found in weld KR2-36 and one indication in weld KR2-14. These cracks appear to be fatigue-induced. An analysis has been performed to demonstrate that the flaws will not propagate to an unacceptable level during the next cycle of operation and special tests will be performed to monitor the movement and vibration of piping at and around the above welds for any in-service induced stresses. There was no effect on public health and safety of the public. There are no redundant systems. For further details see attached assessment and action plan.

* Previous Similar Events:

None

Retention: Period - Lifetime; Responsibility - Document Control Supervisor

*Revision: JRP

Browns Ferry Nuclear Plant Unit 2
Recirculation Manifold Indications
Assessment and Action Plan

Background

The recent discovery of throughwall intergrannular stress corrosion cracking (IGSCC) in the thick-wall recirculation piping at Nine Mile Point unit 1 has resulted in an increased concern to the BWR IGSCC issue, particularly for larger pipes. As a result, NRC issued IE Bulletin 82-03 which requires that inspections of increased sensitivity be performed by BWR licensees whose plants are currently in or scheduled to be in a refueling mode or extended outage through January 31, 1983. Browns Ferry Nuclear Plant unit 2 is currently near the end of an extended outage and the IE Bulletin 82-03 inspections are complete. The completed inspections, which were performed by LMT, Inc., on 40 class 1 welds did not reveal any unacceptable IGSCC indications.

As a result of indications that were found in a sweepolet at Hatch unit 2, NRC region II inspectors requested that TVA examine a sweepolet-to-manifold joint nearest the manifold end cap. TVA proceeded to perform a preliminary examination on sweepolet-to-manifold weld KR-2-36 in loop B (see attachment) and found unacceptable indications. LMT was then called back to Browns Ferry to examine the sweepolet-to-manifold weld KR-2-36 and three additional sweepolet-to-manifold welds. LMT found three unacceptable indications in weld KR-2-36 and one unacceptable indication in the loop A sweepolet-to-manifold weld joint nearest the end cap (KR-2-14). As a result of the unacceptable indication in KR-2-14, the four remaining sweepolet-to-manifold welds were examined. No additional unacceptable indications were found.

Description of the Indications

The unacceptable indications which were found in the loop B sweepolet-to-manifold joint nearest the end cap (KR-2-36) were determined to be in the heat-affected zone (HAZ) of the manifold, and their orientations looking down toward the sweepolet were approximately 1:30, 4:00, and 5:00 o'clock positions--assuming a 12:00 o'clock reference position in the direction toward the manifold end cap. The indication which was found in the loop A sweepolet-manifold joint nearest the end cap (KR-2-14) was also determined to be in the HAZ of the manifold, and its orientation looking down toward the sweepolet was approximately at the 1:30 o'clock position--assuming a 12:00 o'clock reference position in the direction toward the manifold end cap. All of the indications were interpreted by LMT to be cracks and were determined to be approximately 1-1/4 inches in length and 20-percent wall thickness in depth. A detailed report summarizing the ultrasonic inspections has been prepared by LMT and submitted to TVA.[1]

TVA proceeded to drain the recirculation lines so that radiography could be performed on the two welds in the four areas where the UT indications were found. The radiography was performed by Industrial laboratories, Inc. The technique involved double-wall shots taken with a 100 curie iridium source and M-type film. Source location was such that straight shots as well as various angle shots were made in the areas containing the indications. The sensitivity level was 2T.

The X-rays confirmed the evidence of cracklike indications in the 4:00 o'clock and 5:00 o'clock positions of sweepolet-to-manifold weld KR-2-36. The X-rays could not confirm the presence of cracklike indications in the 1:30 o'clock position of weld KR-2-36 nor in the 1:30 o'clock position of weld KR-2-14; however, these X-rays have been sent to Aptec Engineering for image enhancement.

Based on the ultrasonic examinations performed by LMT and the radiography performed by Industrial Laboratories, it is TVA's position that three small cracks exist in sweepolet-to-manifold weld KR-2-36 and one small crack exists in sweepolet-to-manifold weld KR-2-14. Because the original shop X-rays and the ASME Section XI preservice examinations did not reveal any similar indications in these areas, TVA believes that these cracks are service induced.

Assessment of Indications

TVA does not believe that the detected indications could be IGSCC indications because shop records show that both joints KR-2-36 and KR-2-14 were solution annealed after the final welding was complete and, therefore, are not sensitized. This has been verified by review of the original shop radiographs and the original heat treatment records. Also, metallography was performed by TVA adjacent to and in shop weld KR-2-36 (loop B) and in shop weld KR-2-14 (loop A). Both welds were examined in the area of the indications and had solution-annealed microstructures. The pipe adjacent to shop weld KR-2-36 was tested using in-place, electrolytic-oxalic acid etch (ASTM A262, practice A). No sensitization was found using this method. Additionally, delta ferrite readings taken by TVA in the shop welds showed less than 1 percent delta ferrite, whereas the field welds adjacent to the headers had 8 to 10 percent delta ferrite. This low level indicates that the delta ferrite present from welding was transformed to austenite by the solution heat treatments.

TVA believes that the indications were fatigue induced for the following reasons. There have been concerns in the past about audible noises in the general area of the unit 2 recirculation manifolds; and TVA, therefore, believes that there is a strong possibility that this noise was caused by vibrations in this piping system. If fatigue is the real cause, TVA believes that the two sweepolet-to-manifold joints with unacceptable indications would be the most likely locations to experience fatigue problems because the amplitude of vibration is expected to be greater near the free ends (capped ends) of the 22-inch recirculation manifold. This greater amplitude would then result in higher cyclic stress levels in the suspect sweepolet joints. Also, the locations and orientations of the indications in the manifold HAZ is where one would expect fatigue cracking caused by vibration-induced bending moments on the sweepolets because the stress levels in the area of the indications are higher. This has been documented by past research conducted by Battelle Memorial Institute relative to fatigue in sweepolet branch connections (see attached report).[2] TVA determined that the audible noise was due to a resonant frequency that was generated by the recirc pumps when they were operating at approximately 80-percent capacity. TVA has eliminated this noise problem by operating the pumps at different speeds during startup and operation. If fatigue cracks were initiated as a result of these vibrations, TVA believes that the driving force may have been eliminated.

Action Plan

Two basic options are available to disposition the cracks that were found during the subject inspection: (1) repair by welding or (2) perform a linear elastic fracture mechanics (LEFM) analysis to demonstrate that the flaws will not propogate to an unacceptable level during the next cycle of operation and monitor the two welds for any service-induced stresses. TVA ruled out performing a repair at this time for the following reasons. Because the flaws are assumed to be service induced, a throughwall repair would be involved. This would involve extremely high personnel exposure rates, as well as posing problems with back purging and moisture. In addition, the welding would sensitize the manifold in the excavated areas and a worse condition could develop as a result of a throughwall repair. The "backlay" repair technique, which has been used by other utilities, has not been demonstrated to be acceptable for sweepolet-to-header welds and in TVA's opinion is not an acceptable repair technique for fatigue-type cracking at this time.

Because of the many problems associated with any type of weld repair, it is TVA's decision to provide justification for continued operation in the "as is" condition. This justification will consist of (1) performing LEFM analysis to show that the indications will not grow to unacceptable sizes during the current fuel cycle, (2) installing instrumentation (accelerometers, etc.) near both suspect welds to assess the vibrations, (3) installing moisture-sensitive tape near the suspect joints to monitor for leakage at these joints, and (4) reinspecting the suspect welds at the next refueling outage and determining if any crack growth has occurred.

1. Linear Elastic Fracture Mechanics (LEFM)

   A LEFM analysis will be performed by General Electric Company (to be submitted later)[3] to predict the growth of the indications during the next fuel cycle. The analysis will predict growths of the indications for the next fuel cycle by using the anticipated system loading as taken from the design stress report. The predicted growth will be used to estimate the end of fuel cycle indication sizes. These final sizes will then be evaluated for acceptability using the criteria in the proposed Appendix X to ASME Section XI.

2. Vibration and Diagnostic Instrumentation

   Vibration analysis of the recirculation loop will rely heavily on the use of accelerometers. The number of penetrations and the extensive in-containment work for sensor installation will limit the total number of sensors installed; therefore, one-half of the recirculation loop (loop B) will be more thoroughly instrumented than the other loop (loop A). Accelerometers on loop B will allow an estimate of the vibration modes and amplitudes; and accelerometers on loop A will be at selected locations to ensure that vibrations are essentially a mirror image of loop B.

As stated previously, an apparent resonant vibration related to recirculation pump speeds has been detected under certain operating conditions; therefore, recirculation pump speed will be measured with proximity probes. The combination of pump speed data and vibration modes will enhance our knowledge of the resonance phenomenon and the possible effect on fatigue cracking.

If possible, strain gages will be installed on the two riser lines nearest each end cap. The strain gages will be located near the sweepolet-riser line welds and will be used to predict cyclic stresses in the areas of suspected fatigue cracking. TVA considers strain gages to be less important than the other sensors; therefore, they will be installed only if possible.

3. Moisture-Sensitive Tape

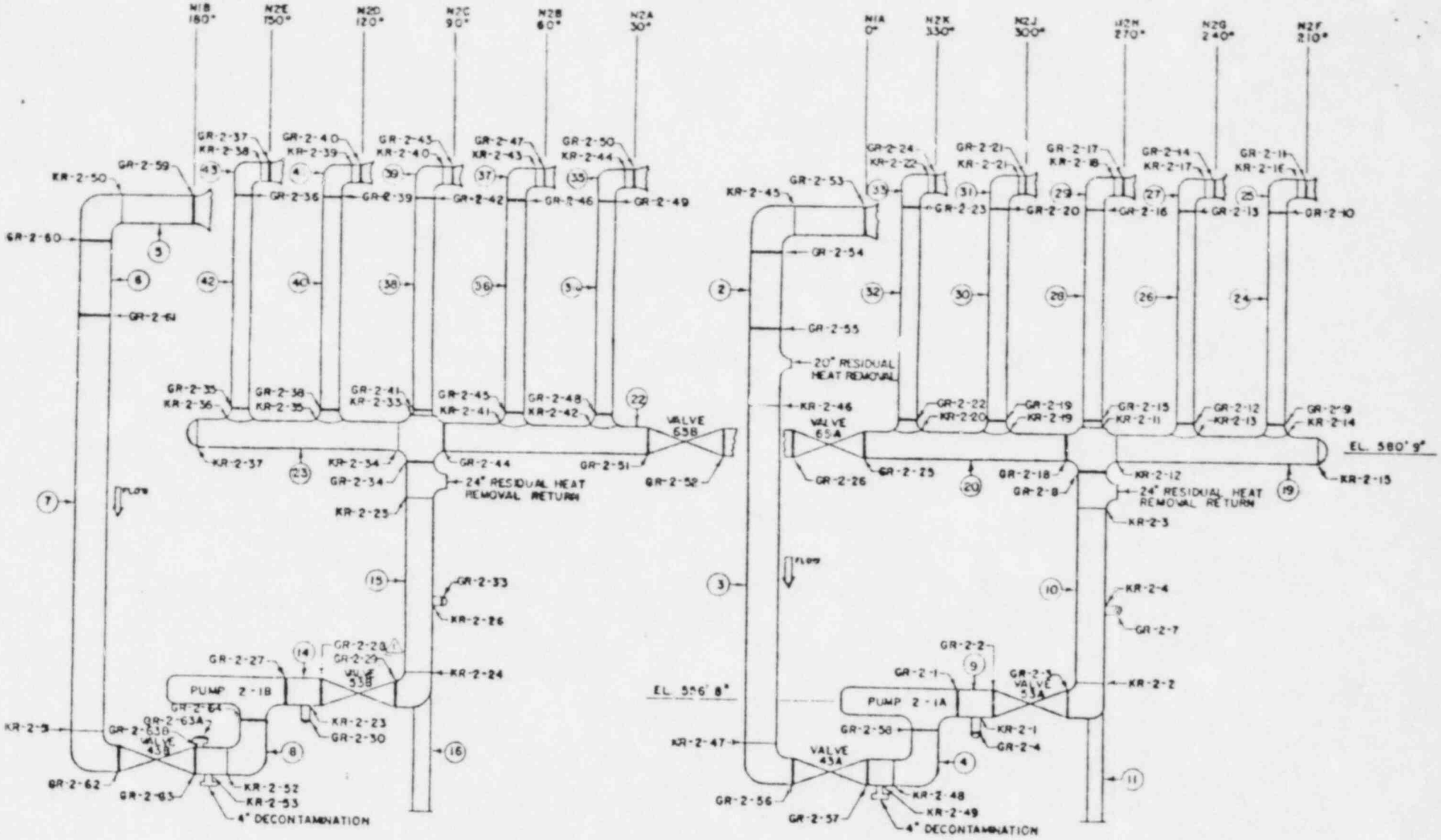
To monitor the recirculation system piping for possible leakage during the next fuel cycle, the installation of a leak detection system is under investigation. The primary detection system under consideration utilizes a moisture-sensitive tape. The moisture-sensitive tape sensors would be placed in several locations around the areas where the cracks have been identified. The detection system would provide indication outside primary containment. Techmark, Ltd., is being consulted for availability of detection systems. Preliminary conversations with Techmark indicate that four sensors and associated electronics should be available within three weeks after the date of the order.

4. Inspections at the Next Refueling Outage

The two sweepolet-to-manifold joints will be ultrasonically examined again at the next refueling outage using similar techniques to those used during this outage, and the results will be compared to the current examination results for assessment of any potential crack growth.

Conclusion

Based on the action plan which includes (1) justification by analysis, (2) installation of instrumentation to assist in assessing vibrational effects, and (3) installation of sensors near the two suspect welds to ensure early leak detection, TVA concludes that the detected cracks will not affect safe operation of the unit.



XR-N-N

K = KELLOGG SHOP WELD
G = GE FIELD WELD

RECIRCULATION UNIT NO. WELD NO.

○ INDICATES PIECE NUMBER

REF. DWGS.

TVA 47K1544-1
GE 153E734
KELLOGG BF 2-180

NO.	DATE	REVISIONS
1	6-8-74	CORRECT WELD NO.

TENNESSEE VALLEY AUTHORITY
DIVISION OF POWER PRODUCTION

BROWN'S FERRY NUCLEAR PLANT
UNIT 2
RECIRCULATION SYSTEM
WELD IDENTIFICATION