U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report Nos. 50-277/85-04
50-278/85-04

Docket Nos. 50-277
50-278

License No. DPR-44 Priority -- Category C
DPR-56

Licensee: Philadelphia Electric Company

2301 Market Street

Philadelphia, Pennsylvania 19101

Facility Name: Peach Bottom Atomic Power Station, Unit 2 and 3

Inspection At: Delta, Pennsylvania

Inspection Conducted: January 14-17, and February 13, 1985

Inspectors: J. P. Durr for 3/15/85
S. D. Reynolds, Jr. date
Lead Reactor Engineer, MP&S

E. H. Gray 3/11/85
E. H. Gray date
Lead Reactor Engineer, M&PS

Approved by: J. P. Durr 3/15/85
J. P. Durr, Chief, date
Materials and Processes Section,
EB, DRS

Inspection Summary: Inspection on January 14-17, and February 13, 1985 (Report Nos. 50-277/85-04 and 50-278/85-04)

Areas Inspected: Routine, unannounced inspection of the licensee's program for safe end repair and replacement. The inspection involved 29 hours on site by two region-based inspectors.

Results: No violations were identified.

DETAILS

1.0 Persons Contacted

Philadelphia Electric Company (PECO)

R. Fleischmann, Station Superintendnet
D. Smith, Assistant Station Superintendent
J. Otto, QA Engineer (E&R Division)
J. Pizzola, Engineering and Research QA
F. Hoelzle, Construction Engineer (Construction Department)
J. Stanlay, ISI Engineer (E&R Division)
*A. Bazzini, Lead Responsible Engineer N2 Safe End and Pipe Replacement, Mechanical Engineering
**R. Zong, Senior Metallurgical Engineer

General Electric Corp., A&ES Division (GE)

R. Lebre, NEBO Engineer
E. Ishizaka, NEBO Engineer
S. Keppler, Project Installation Manager
K. Noonan, Project Coordinator
D. DiFillipo, QC Manager
W. Anderson, QC Inspector, Level III PT & UT

Chicago Bridge and Iron (CB&I)

K. Schoenleber, Site Manager
C. Halfast, Project Manager
K. Czadnik, QA Manager

Nuclear Regulatory Commission (NRC)

*J. H. Williams, Resident Inspector

*Denotes those personnel who attended the exit interview on January 17, 1985
**Denotes those personnel who attended the exit interview on February 13, 1985

2.0 Background

The purpose of this inspection was to follow-up inspection 50-277/84-21 and 50-277/84-36 and determine current status and acceptability of the licensee's actions in reactor vessel safe end replacement which was required due to degradation by intergranular stress corrosion cracking (IGSCC).

3.0 Licensee Action on Previous Inspection Findings

(Closed) Unresolved Item (50-278/81-09-09) This item was from combined report 50-277/81-07 and 50-278/81-09 and related to the actions taken by the licensee following failure of the jet pump hold down beam. The inspector reviewed GE proprietary report NEDC-30250 (July 1983) on the holddown

beam metallurgical failure analysis and GE letter G-HE-3-18 (Davis to Cooney - PECO). The metallurgical report indicates the crack, initially reported to be approximately 150 mils, was approximately 1" long and 0.9" deep on the major tension side of the beam with a crack morphology shown to be intergranular and characteristic of IGSCC. It is reported that the replacement hold down beam heat treatment was modified to produce a lower as-heat treated age hardened structure and has lower installed loading stresses. Both of these changes should mimimize the chances for IGSCC. As of the time of the metallurgical report, this was the only GE BWR/4 designed plant holddown beam failure. All of the subject holddown beams have been replaced with lower stressed-lower yield strength beams. The inspector had no further questions. This item is considered r olved.

(Closed) IE Bulletin 80-07 (50-277/80-BU-07) During this outage the licensee replaced all of the jet pump holddown beams with material with lower age hardened yield strength and lower installed loading stresses. The requirements of the Bulletin are satisfied. This item is considered closed.

(Closed) Unresolved Item (50-278/83-14-02) The licensee had previously answered items b, h, and i of this unresolved item. The licensee provided answers to the other items as follows:

Item a. What is the method for calculating the overlay width and thickness for long axial cracks such as in weld 10-0-5?

Answer a. The two axial indications reported in weld 10-0-5 were sized at 0.75" in length. The overlay thickness calculation for these cracks is performed according to the Appendix A and IWB-4630 of Section XI. The width of the overlay is determined to:

1. Provide the required structural reinforcement to the crack locations, and

2. Provide sufficient overlay material beyond the crack and original weld crown to prevent growth around the end of the overlay.

For this weld, the overlay width at the base of the overlay is a minimum of 8". This width provides significant margin for a 0.75" long axial indication.

Item c. If the stress pattern produced by the weld overlay is similar to that produced in the IHSI process, there should be tensile stresses close to the pipe OD. What is the effect of this tensile stress on the IGSCC crack tip (which may have partially propagated by fatique)?

Answer c. It is possible that some tensile stresses could be produced close to the pipe OD during weld overlay, which is the reason the overlay design is conservatively sized to accommodate through-wall, 360 degree flaws. We would expect, however, the stresses to be similar to those occurring normally at the OD of pipe butt welds (varying magnitude and size), and not uniform tensile all around the OD as is typical for IHSI-treated welds. Nevertheless, the full structural overlay design does not require compressive stresses at the tip of the crack to maintain acceptable margin for the intended 18 month operational cycle.

Item d. What is the desired or calculated life of the overlay?

Answer d. For Unit #2 - 24 months operation
For Unit #3 - 18 months operation

Item e. What crack growth rate is used for calculation purposes?

Answer e. The crack growth rate used for disposition of all welds is that acceptable to SCXI Appendix A and IWB-4630. This is a conservative, upper-bound crack growth rate for the weld heat affected zone of Type 304 stainless steel.

Item f. What is the effect of pipe spool vendor (shop) OD weld metal build ups on the detectability and location of IGSCC cracks?

Answer f. An informational ultrasonic examination was performed on all of the #1 and #2 recirculation riser welds from the shop weld metal build up side of the weld. The majority of these welds also were examined by radiography (MINAC). The results of the ultrasonic examinations revealed no circumferential type reportable indications.

While the effects OD cladding on ultrasonic examinations are known, i.e., refraction and mode conversion at the interface of the clad/base material, it is felt that these effects were minimized due to the smooth surface condition and clad thickness; in most less than 0.2".

Item g. What is the metallurgical explanation for the long axial crack in weld 10-0-05 (which is not believed to have vendor OD weld build up)?

Answer g. It is recognized that the applied and residual stresses in the hoop direction, combined with the sensitized weld heat affected zone, can cause axial IGSCC. Until additional destructive examination is performed on axial cracking in the field, the full metallurgical nature of the cracking

and its apparent propagation beyond what would normally be considered weld heat affected zone cannot be determined. It is also possible that the UT sizing of these indictions, which must be done through the weld metal, may be overestimating their true length.

The most important consideration, however, for the axial flaw is the significant margin on length that can be demonstrated for the Type 304 stainless steel pipe weld. Calculations for this weld have shown that a through-wall axial crack could extend for a length of 5 inches before the limits of IWB 4630 of Section XI are reached. Even at this length, a factor of three safety margin is still maintained. Therefore, the axial indication 0.75" long is well within acceptable limits.

The inspector had no further questions on this item and considers it closed.

(Closed) Inspector Followup Item (50-277/84-21-01) The inspector raised a question concerning the effect of variations on the wire feed speed on the heat input and subsequent sensitization of the weld heat affected zone (HAZ). The licensee replied as follows:

PECO controls the quality of the weld by utilizing only welders qualified to the specific machine welding procedure used at Peach Bottom. Furthermore, this process with a typical joulian heat input and wire feed speed was used to weld a test plate which was then subject to the A262, Practice E, 10-hour sensitization test, which it passed.

The inspector has no further questions on this item. The IFI is closed.

4.0 Residual Heat Removal Head Spray Weld Joint Inspectability

The inspector questioned the licensee's ability to adequately inspect P8 to A8 buttered P1 weld joints in paragraph 5.0 of 50-277/84-36. This was not an unresolved item, but the licensee provided additional information during this inspection. The inspector concurred with the licensee's position that the side of the joint that is difficult to inspect is also the side of the joint where no IGSCC would be expected to occur. The licensee indicated the following:

An RT of the subject weld was performed for ASME Section III acceptance. As part of the ISI program, PECO intends to perform both a 0° and a 45° tangential scan on the weld, a 45° shear scan from the 316L side and a PT examination of the weld OD.

The inspector had no further questions on this item.

5.0 Safe End Replacement Status

Subsequent to inspection 50-277/84-36 the licensee modified their plans on the safe end repairs to require that all 10 safe ends and thermal sleeves be replaced rather than to attempt repairs of 8 of the 10 safe ends. The status of the replacement as of the exit interview time was as follows:

Safe End Identification	Status
30°	Nozzle weld (OD) in progress
60°	Joint welding complete. RT final in nozzle weld complete. Welding up purge hole plug welds
90°	Nozzle weld (OD) in progress
120°	Waiting for RT final on nozzle welds. All welding complete except for purge hole plug welds.
150°	Nozzle and thermal sleeve joints being fit up
210°	Nozzle weld (OD) complete and thermal sleeve weld complete. Waiting for VT,PT,RT and UT
240° 270° 300° 330°	Joints finished. Final weld packages not reviewed and approved by licensee at this time

No violations identified.

5.0 Observation of Welding

The inspector observed remote GTAW-ME welding operations being conducted by GE on safe ends. GE continues to use Arc Machines orbital GTAW-ME equipment and video fiber optics equipment. The welding is being controlled remotely by adjustments to the parameters determined by visual (TV) observation of the molten pool and solidified metal directly behind the molten pool through a fiber optics TV system. An optional "hands on" observer is being used to describe welding bead characteristics by reporting by phone to the welding operator. The observers are also qualified welding operators. The inspector witnessed welding being conducted by one of the new GE welding operators who had no previous experience on this type of equipment other than in training and qualification. (See paragraph 7.0)

The welding observed was being conducted in accordance with the applicable welding procedures and codes and standards requirements. The operators observed appeared to be adequately qualified for the remote welding operations.

No violations identified.

6.0 Review of Quality Documents

The inspector reviewed a special form utilized by GE A&ES for data compilation. (This is not a code required form. It is a Hartford Inspection Form "Manufacturers Report of Welded Repairs or Alterations"). The form indicates the forged safe end material to be SA-182, Grade 316, per ASME Section II, 1980 Summer 83. Review of the actual certified material test reports indicates the material procured is 0.02% Carbon (max.) 316 meeting the 316 regular carbon properties.

The inspector reviewed the following typical QA documentation forms for the 240° safe end:

a. Travelers for safe end removal SER-T-240.

b. SPCS documents (240-S-) align-1, and -1 thru -8 which document dimensional data for removal and replacement.

c. PT reports for the thermal sleeve weld preparation.

d. Traveler SEI-T-240 for the installation of the new safe end and thermal sleeve (includes records of welding parameters).

e. Filler metal requisition forms for 0.035" diameter ER 308L (from Johnston) Heat S468580. Only one heat used for all welding to date. (Previously reviewed).

f. Pipe UT calibration Data Sheet.

g. UT examination Data Form.

h. PT results (1) safe end to nozzle, (2) purge hole weld, (3) ID sleeve weld, final (4) safe end weld, final.

i. RT report on nozzle/safe end weld.

The inspector reviewed the following GE A&ES NCR's and responding GE NEBO FDDR's:

NCR: PB2-1, PBS-2, PB@-3, PB@-4, PBS-5, PBS-10, PBS-9
FDDR: HE2-0622, HE2-0625, HE2-0627, HE2-0636, HE2-0648

During the review of documents it was noted that the RT of the finished nozzle weld on the 90° safe end has a portion of the consumable insert (apparently cut-off during fitup) remaining between the thermal sleeve weld and the safe end ID. The licensee was informed of this problem. The removal method was not finalized. This item is unresolved pending removal of the object and verification by the NRC. (277/85-04-01).

No violations were identified.

7.0 Review of GE Welding Operator Qualifications

The welding operator qualifications for the first 10 welding operators were discussed in 50-277/84-26, paragraph 9.0. Two new welding operator qualifications were reviewed. These were stencil numbers J-7793 and E-7768. They were both qualified on one test assembly which was a 12" O.D. x 1.125" wall, P8 to P8 test assembly, welded in the 5G position. The welds were made employing TV optics viewing, using Arc Machines equipment and were radiographically inspected for acceptance. The joint employed a consumable insert. These welders had no prior GE experience with the GTAW-ME process.

Also reviewed was the qualification of a 6" OD x 0.450" wall, P1 to P1, A8 consumable insert joint welded in the 5G position using TV optics viewing and the Arc Machines equipment. This was for welding operator M-4420 who was previously qualified for GTAW-ME under the GE QA program at Pilgrim with Dimetrics equipment. This welder also qualified on the same test assembly for manual GTAW welding.

During review of these records the inspector noted a PECO QA finding report (OP290-17) concerning the applicability of the QW252.1 and QW 452.3 dimensional diameter and thickness ranges as essential variables for GTAW-ME welding operator qualification. It stated that these variables are considered to be "essential". The corrective action taken states that the original finding is incorrect and that SCIX in the introduction (Article III) and QW 305 clearly shows the intent to utilize the "process" as the only essential variable. The inspector concurs with the resolution to the finding and pointed out that even the proposed changes to QW-305 for machine welding operators do not consider thickness and diameter as an essential variable.

No violations were identified.

8.0 Radiographic Indication Anomolies

During review of vendor supplied pipe and pipe fitting radiographs it was noted that many films had transverse indications approximately 1/4" to 3/8" wide having the appearance of a solidification pattern which appeared to be in the root pass or root area. The indications were in the longitudinal seams of pipe supplied by Youngstown Welding and Engineering to Johnson Controls for GE NEBO. The indications were all dispositioned by Johnson Controls as "non-relevant transverse molecular alignment indications for YW&E Order C-1162". An example of these indications is found on 1.5" thick, 28" O.D., SA358 Grade 316, double welded pipe for GE drawing 112D3305G001 Tube #4.

The inspector discussed this anomoly with a metallurgical representative of NEBO and with the licensee. The licensee committed to obtain copies of the referenced Herron Testing Laboratories metallurgical report to Johnson Controls and to provide a metallurgical explanation for why these linear appearing indications are not SCIII rejectable and are not detrimental to the service performance of the pipe.

Region I also obtained a piece of pipe containing the radiographic indications for an independent evaluation.

This item is considered unresolved pending further NRC testing. (277/85-04-02)

9.0 Reactor Pressure Vessel Nozzle Flaws

The NRC became aware of a potential flaw in the 60° and 210° nozzle of the reactor vessel. The concern was that the appropriate ASME Code be used to disposition the indications, ASME III or XI. As a result, a meeting was held at the NRC Regional Office on February 7, 1985 to discuss specific radiographic problems related to the pipe replacement and N2 safe end replacement. The following personnel were in attendance:

Name	Title	Organization
S. Ebneter	Director, DRS	NRC, RI
J. Durr	Chief, M&PS	NRC, RI
R. Gallo	Chief, PS2A	NRC, RI
S. Reynolds, Jr.	Lead Reactor Engineer	NRC, RI
J. O'Rourke	Pipe Replacement Program Manager	PECo
R. Zong	Senior Met. Engineer	PECo
D. DiFilippo	QC Supervisor	GE, A&ES
W. Miller	NDE Specialist	GE, A&ES
E. Ishizaka	Principal Engineer	GE, NEBO

The following items were discussed:

- Re-review of the final GE radiograph of the 210° nozzle to safe end weld showed an indication (intermittent 5" long) which was rejectable in accordance with SCIII acceptance standards, but believed to be in the original buttering of the nozzle side; the defect was the subject of an NCR. The licensee conducted a parallax radiographic technique in accordance with the NDT Handbook method shown on page 20.49 and indicated the defect was in the buttering. Re-review of the supplementary root weld radiograph, which included the consumable insert plus two layer hot passes, indicated a defect adjacent to (outside of) the deposited metal. Re-review of the original joint radiographs showed a possible indication in the area of concern. Ultrasonic inspection by various techniques failed to detect the indication.

- The final weld radiograph of the 60° nozzle to safe end weld showed an indication believed to be associated with the last fill pass prior to reinforcement on the nozzle side. An attempt was made to remove this indication by excavation. This grinding operation failed to discover the defect and reduced the "butter" thickness on the nozzle side to a thickness less than permissible for repair by normal welding techniques, but was not through the buttering. The depth of the cavity is 0.385" deep. Subsequently, parallax radiography was attempted which located the defect in the butter.

  Re-radiography of the weld joint with the cavity now indicates the defect to be within acceptable length limits for SCIII or SCXI. Calculations conducted (for engineering purposes only) indicate that if it were determined that the indications were discovered during the service life of the nozzle it would be acceptable to SCXI. The joint with the grind out area meets engineering requirements if a 3 to 1 contour is produced on the sides of the grind out. The parallax radiography shows the defect to be 1.2" from the OD. Ultrasonic techniques show the defect to be 1.1" from the OD. The weld is "in process" and will be ground for proper contour to meet SCIII section size change rules and given a final PT. If acceptable the weld will be put into service with the grind out. Engineering review of a half bead temper repair or weld with post weld heat treatment was considered to be less desirable than the leave-as-is engineering decision.

- Transverse Molecular Alignment Indications Investigation - In response to UNR 277/85-04-02 the licensee presented a GE memo by E.T. Ishizakca to the NRC which attributes the indications to be "mottling" due to X-ray diffration caused by the coarse grain structure in the weld. GE referenced the NDT handbook page 20.24 (which discussed the problems in "fairly thin metallic specimens"). Mr Zong of PECo indicated that the mottling was only evident on film shot with a lower density; whereas, higher density film (which should be more sensitive for defect evaluation) failed to show the mottling. The GE metallographic work indicates the columnar structure area causing the mottling to be associated with submerged arc beads near the OD. The NRC indicated that the Johnson Controls transverse tensile specimen was from the ID. The licensee committed to providing a detailed answer to the unresolved item which would be reviewed to the satisfaction of the NRC. The NRC indicated that consideration was being given to failure analysis investigation by ORNL.

  It was agreed that a NRC, Region I Materials and NDE Specialist would verify the licensee film interpretations at Peach Bottom during the week of February 11-15, 1985.

On February 13, 1985 a Region I inspector reviewed radiographic film of original shop nozzle to safe end welds and the replacement safe end welds for the N2-60° and 210° nozzles. The replacement weld radiographs included the weld root layers with 1-3 hot passes, the intermediate weld level at approximately 1/2" and the final weld condition. Grindout radiographs on the 60° location nozzle and parallax radiographs on both the 60° and 210° nozzles in the area of RT indications were reviewed. The parallax radiographs for the 210° nozzle were noted to have a shift in the outside surface identification markers for the two angles of incident radiation. While there was a technique problem with the 210° nozzle parallax radiography, the radiographs including the parallax or angle views confirmed the RT indications to be in the nozzle original weld metal buildup near the nozzle inside diameter. On February 14, 1985, a second set of parallax radiographs were made, confirming the indications of the 210° nozzle to be near the interior nozzle surface. Subsequent fracture mechanics evaluation determined the acceptance of the 210° nozzle indications to the ASME Code Section XI requirements. The inspector reviewed the radiographic reports dated January 24, 1985 and January 30, 1985 for the 210° and 60° nozzles and the NCR No. CD-P-348 indicating the use as is disposition for the indications in the 210° nozzle based on the ASME Code Section XI Fracture Mechanics Rules.

No violations were identified.

10.0 Unresolved Items

Unresolved Items are matters about which more information is required in order to ascertain if they are violations or deviations. Unresolved items are discussed in paragraphs 6.0 and 8.0.

11.0 Exit Interview

Mr. Reynolds met with the licensee representative and the NRC Resident Inspector at the conclusion of the inspection on January 17, 1985. Mr. Gray met with the licensee on February 13, 1985. The inspectors summarized the scope and their findings of the inspection. No written information was given to the licensee by the inspectors during the course of the inspection.