U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-387/85-13

Docket No. 50-387

License No. NPF-14

Licensee: Pennsylvania Power & Light Company

2 North Ninth Street

Allentown, Pennsylvania 18101

Facility Name: Susquehanna Steam Electric Station, Unit 1

Inspection At: Berwick, Pennsylvania

Inspection Conducted: April 8-12, 1985

Inspectors: S. D. Reynolds, Jr., Lead Reactor Engineer, M&PS — 5/8/85 date

Approved by: J. Durr, Chief Engineering Branch, DRS — 5/13/85 date

Inspection Summary:

Inspection conducted April 8-12, 1985, (Report No. 50-387/85-13)

Areas Inspected: Routine announced inspection by one regional-based inspector of the licensee's activities related to the repair of the reactor pressure vessel steam dryer assembly and support brackets. The inspection involved 37 hours onsite and 4 hours in the regional office.

Results: No violations were identified.

DETAILS

1.0 Persons Contacted

Pennsylvania Power and Light (PP&L)

*J. Todd, Compliance Engineer
*T. Oldenhage, Dryer Task Force Leader
*J. Lindberg, Senior NQA Analyst
*J. Gutshall, Senior Project Engineer
*J. Sager, Consultant to Nuclear Plant Engineer
L. Willertz, Metallurgical Engineer
W. Barberich, Manager, Nuclear Licensing

General Electric Company (GE)

J. Seago, Technical Supervisor (NEBO)
D. Brock, Site Project Manager (DA&ESO)
W. Stonesiter, Welding Supervisor (DA&ESO)
R. Miller, Machining Supv. (Tri-Tool)
M. Quirin, Dryer Project Manager (DA&ESO)
J. Phelps, QC Supvr., (DA&ESO)
M. Herdryx, QC Inspector
J. Walton, Machinist

U.S. Nuclear Regulatory Commission

*R. Jacobs, Senior Resident Inspector
L. Plisco, Resident Inspector
W. Hazelton, MTEB
*Denotes those present at Exit Interview

2.0 Background

NRC Inspection Report 50-387/83-06 reported on a loose parts monitor indication and classified the indication as IFI 83-06-05. Report 50-387/83-25 reported on a crack in the dryer assembly observed visually when the assembly was removed from the reactor pressure vessel (RPV). This crack was a corner attachment of a large vane bank panel enclosing the Peerless chevron separators and was documented in GE FDDR KRI-5002. Report 50-387/83-29 discussed the repair of the observed crack which was accomplished with a "patch plate" technique in accordance with GE FDDR KRI-5002. The patch plate was used rather than removal of the crack and repair due to ALARA considerations.

In February 1985, while conducting an underwater television (TV) optics ISI visual inspection cracks or other problems were observed in the dryer assembly in the following areas: (Reported in ISI 85-141 and 85-126).

- 184°, Alloy 600, dryer support bracket attachment to the weld clad surface of the reactor pressure vessel.

- Austenitic stainless steel dryer upper support ring.
- Austenitic stainless steel vane banks #3, #4, and #6 in weld joint areas (including previously repaired areas). This included corner welds and attachments of the vane banks to the support ring.
- Protrusion of the 3/8" diameter dryer rack tie-rod washer/nut assemblies and cracked washer/nut tack welds.

This information is reported in NCR 85-0113 for the dryer assembly cracks and NCR 85-0117 for the support bracket. Representatives of Region I and NRR were dispatched to the site to observe and review the licensee's activities in the repair of these defects.

The dryer assembly is not classified as safety related.

3.0 Support Bracket Description

There are four dryer support brackets located at azimuths 4°, 94°, 184°, and 274°. These brackets were installed at the site by CB&I during the field fabrication of the reactor pressure vessel (RPV). The brackets are attached to an approximately 16" X 8" X 1/8" (minimum) overlay previously applied to the RPV wall in the bracket area. The weld overlay procedure was CB&I WPS 103-21-43. The weld overlay area covers a horizontal shell course butt weld (Ring #4 to Ring #5) in the RPV and is given a post weld heat treatment with the shell course weld. The filler metal utilized in the weld overlay was ENiCrFe-3.

The four brackets were welded to the ENiCrFe-3 overlay utilizing a balanced (welded both sides) full penetration weld per the CB&I, WPS-309-2F43 weld procedure using ENiCrFe-3 electrodes. The weld joint preparation is shown in a CB&I bracket drawing, 68-3331/32, to be a "J" groove weld preparation with 3/8" root radius, 25° included angle with 3/16" root face and 1/4" root opening. This is considered by standard practices to be a tight included angle for ENiCrFe-3 electrodes, but the root opening and root radius help to minimize this problem. The inspector reviewed the General Electric (GE) -APED, RPV EC Check Off List which indicated the weld procedure fit up, root back gouge, (PT) of back gouge, visual and final PT examinations for the original bracket welds.

4.0 In Situ Examination of Cracked Bracket

The cracks discussed in GE FDDR, KRI-7000, may be described as follows:

The crack network observed visually from the outside surfaces of the 184° dryer bracket goes from the top surface at the area of the weld root and follows closely the pattern of the weld joint preparation on the top surface of the block, then turns outward in an arc. On the one side, there is the appearance of two cracks, one of which is 4" long and one 8" long. The 8" long crack appears to stop its arc approximately 3" out from the vessel wall. The opposite side has a crack approximately 8" long

which also arcs out away from the vessel wall. The visual cracks and extent of cracks were verified by penetrant examinations (PT) of the outer surface of the bracket. No other cracks on the bracket were observed. Visual inspection of the other 3 brackets show no cracks by this inspection method. PT examination of the 4° bracket verified the visual examination results.

Ultrasonic examination reported in FDDR KRI-7000 indicates continuous crack faces from side to side in the bracket in the arc previously described on the outer surfaces.

A GE "boat" (sliver sample removed in accordance with GE procedure PMT-85-DD-1) was taken to include cracks from both sides of the bracket. Initial examination results by GE indicate a fatigue crack with fatigue mark spacing which would indicate the total number of cycles for the crack length to be between 10 - 100,000 assuming the same morphology as that observed in the slivers.

5.0 Visual Inspection of 184° Bracket Crack Specimen

Visual inspection by the NRC inspector indicated the following: Vertical milling saw cuts from both sides of the bracket extending approximately 5" down both sides were sufficient to produce a cut approximately 3" deep in the center of the bracket. This in itself was not sufficient to completely free the triangular piece described in FDDR KRI-7000, step 5, (and sketch on page 19). This removal technique is also shown on page 9 of GE SES-35.0. It was necessary to pry from the edges to break off the last contact point. The crack specimen removed was approximately 3" in length and 1½" deep. The cracked surface was completely black except on the saw cut face, where the pry marks were located and at the last point of contact. It appears that there were two major cracks. One appeared to start approximately 1" below the top of the bracket on the weld joint preparation bevel and progress inward along the weld preparation towards the top center of the bracket.

There were possible circular fatigue marks emanating from this initiation point. Best judgement is that a similar crack started on the opposite side with both cracks meeting at about 3" below the top surface of the bracket and initiated a third crack. Large patterns of the crack face appeared to have fatigue features. Unfortunately the prying marks appeared to mask an area which may have been the initiation site for fatigue on the upper right hand side of the bracket.

The cracked specimen had a ductile pull out area at approximately 1-1½" below the apex which appeared to extend approximately 3/16" into the RPV weld overlay with a pencil point shape at the deepest spot.

The specimen was decontaminated in an ultrasonic bath of deionized water. Observation of the fracture face was easier following decontamination but showed no additional features.

The specimen was shipped to GE NEBO for analysis at their Valecitas Laboratory. Verbal information following a cursory examination examination by GE confirmed transgranular fatigue as the failure mechanism.

6.0 Steam Dryer Assembly/Bracket Loading

The inspector reviewed the information on the bracket loading.

The support ring for the dryer is made from two 3" X 9" cross section cold formed 304 austenitic stainless steel bars. Four beveled corner slotted seismic blocks are welded on the outside of support ring. The seismic blocks act as indexing and locating devices for placement of the dryer on the support brackets. Observations of the dryer in position on the brackets by the licensee, indicated that the dryer did not rock on the bracket. Observations made of the surface markings on the brackets indicated that the dryer was seated with the seismic blocks in contact with the brackets at 4°, 94° and 274° but at 184° the contact area (5/8" in width) was between the support ring and bracket. This created a greater moment on the bracket attachment point for the 184° bracket. The licensee developed sketches of the dryer bracket and mating load point parts for all four bracket areas which were reviewed and forwarded to NRR. The dryer assembly has been in and out of the RPV approximately 5 times. Conclusions from the bracket loading are that the 184° bracket attachment moment exceeded that of the other four brackets and that there was no apparent vertical rocking loading on the brackets. The inspector reviewed the licensee proposed modifications of the seismic block and support ring which will make the dryer sit on the seismic block rather than the support ring and will put the load closer to the RPV wall.

7.0 184° Bracket Replacement

Following removal of the cracked metallurgical sample shown in a sketch, page 19 of FDDR-7000 Rev. 1, the bracket was removed by cutting from both sides with a milling saw. Following removal it was apparent that the crack extended into the RPV ENiCrFe-3 overlay with the maximum depth at a point about 1" below the top of the bracket attachment in the area adjacent to the root weld of the attachment. This area was ground out and given a PT examination. UT thickness measurements of the adjacent area indicated 0.137" of ENiCrFe-3 below the crack grind out area. This exceeded the 1/8" minimum overlay required by the CB&I designed RPV bracket attachment patch, but was less than the 3/16" minimum desired by GE for repair to FDDR KRI-7000. A modified technique was employed for the repair of this localized area which utilized a 60% overlap weld bead sequence. The replacement bracket was machined to produce double "J" joint with a 1/4" root radius and 3/32" root face. The weld joint was welded with GTAW in the root and finished out with the SMAW process. Progressive PT examinations were conducted. As of 4/17/85, the welding was approximately 50% complete.

8.0 Alloy 600 Bracket Forging Review (Independent Measurements)

The inspector reviewed and compared the chemistry, mechanical properties and heat treatment for the cracked bracket and replacement bracket.

Comparison of properties in new and old support brackets supplied to ASME II Code, SB 564 is as follows:

	New	OLD	SB564(1)
T.S.	97.4 KSI	100 KSI	80 KSI
Y.S	40.1 KSI	48.8 KSI	35 KSI
% E	46	37.5	30
% RA	67.7	56.5	--
Soln.	Anneal 1625 F(2)	1700(2)	Annealed
C	0.05	0.07	
Mn	0.23	0.17	
S	0.30	0.22	
Cr	15.67	15.89	
Ni+Co	75.67	75.74	
Cu	0.04	--	
Ti	0.21	0.31	
Cb+Ta	0.28	0.28	
Fe	7.35	7.6	
Al	0.23	0.15	

(1) Bar specification used for ordering forging material is SB166. SB564 does not specify a required heat treatment other than stating "annealed".

(2) For one hour followed by an air cool, This is similar to a hot finished condition, not a normal solution annealed condition.

Typical yield strength properties for forged Alloy 600 in the 1800° F solution annealed condition is 38 KSI and for a 1900° F solution anneal is 35KSI. Typical ENiCrFe-3 weld deposit yield strength on the as welded condition is 52 KSI. Discussions with the licensee indicated that GE metallurgical personnel are not concerned about the possible sensitization from the 1625F/AC heat treatment and prefer to have the increased yield strength rather than the solutionized microstructure. From the VT, PT and cursory failure analysis there is no indication of intergranular related problems in the Alloy 600 brackets.

No violations were identified.

9.0 Bracket Repair Welding Filler Metal Review

The inspector reviewed the certified material test reports (CMTR's) for the ENiCrFe-3 and ERNiCr-3 filler metal. The filler metal meets the current ASME Code, NB2430, requirements which require chemistry verification only and do not require deposited metal mechanical property verification.

No violations were identified.

10.0 Welder Qualification

Welders employed by Catalytic were qualified for work under GE QA Supervision at the Levittown, Pennsylvania facility of GE DA&ESO. The welders were qualified by welding P-1 to P-1, 37° bevel, single vee joint test assemblies with a 1/8" root gap with backing in the 3G and 4G positions. They utilized the GTAW process in the root (1/4" deposited) with ERNiCr-3 filler metal and completed the joint (3/4" deposited) with the SMAW process and ENiCrFe-3 filler metal. The welding was conducted in accordance with General Welding Procedure SES GWP 15.0 and Technique 43.43.3, Rev. 1, dated 3/23/85. Limited access was mocked up for qualification in the 3G position and for training purposes.

Nine welders were qualified with qualification dates from 3/23 to 4/1/85. Test assemblies were inspected radiographically by either Lehigh Testing or ETL with disposition of the film by GE DA&ESO Level III inspectors.

The inspector pointed out that the data indicating the use of limited access restrictions was not listed on or with the Welder Performance Qualification Records. The licensee and GE committed to add this documentation and supplied samples of the additional documents (FE SPCS SDSB-1 and -2, Rev. 0) to be used for this purpose to the NRC inspector. This is not a requirement of SCIX and the restriction to welding is not sufficient to meet the intent of Regulatory Guide 1.71.

The inspector reviewed the qualification records and visually inspected the limited access mock up in the PP&L E&S Welding Qualification Shop.

No violations were identified.

11.0 Quality Assurance and Quality Control

The inspector reviewed the QA and QC Activities of GE who has the NDE and quality responsibilities for the repair. The applicable documents for the repair were reviewed and included the following:

GE (NEBO)

B50YP91 (Rev. 0): Alloy 600 Forgings

PMT-85-DD-1: Removal of Metallographic Boat Sample from SSES Steam Dryer and Support Bracket

SSES-DRY-1 (Rev. 1): Determination of Four Point Support Steam Dryer

TP508-1190 (Rev. 1): Steam Dryer Bracket Examination

TP508.0234 (Rev. 1): UT Thickness Measurements

21A2045 (Rev. 5): Cleanliness Control for Assembly of Reactor Components

21A2042 (Rev. 8): Welding Requirements for Field Modifications

21A2041 (Rev. 1): Repair of Arc Strikes

GE (DA&ESO)

WPS 43.43.1 (Rev. 1): GTAW P43

WPS 43.43.15 (Rev. 0): SMAW P43

WPS 43.43.14 (Rev. 0): GTAW P43

WPS 43.43.12 (Rev. 0): SMAW P43

PQR 43.43.6: GTAW/SMAW - Applies to all above WPS documents

WPS SES 8.8.14 (Rev. 0): GTAW P8

PQR 8.8.2: (for above) GTAW

WPS SES 8.8.8 (Rev. 0): SMAW

PQR 8.8.3: (for above) SMAW

SES PS 5.0 (Rev. 1): Ni Alloy GTAW Filler Metal

SES PS 6.0 (Rev. 1): Ni Alloy SMAW Filler Metal

SES PS 3.0 (Rev. 0): Stainless SMAW Filler Metal

SES PS 4.0 (Rev. 0): Stainless GTAW Filler Metal

SES GWP 15.0 (Rev. 0): General Welding Procedure

SES 36.0 (Rev. 0): Dryer Support Bracket Position Measurements

SES 35.0 (Rev. 1): Dryer Support Bracket Removal

SES 25.0 (Rev. 1): Measuring and Test Equipment

SES 18.0 (Rev. 0): PT

SES 17.0 (Rev. 0): VT

SES 5.0 (Rev. 0): Cleaning

SES 3.0 (Rev. 1): Arc Strike Removal

SES 4.0 (Rev. 1): Etching Procedure

SES 2.0 (Rev. 0): Materials and Processes Procedure (Misc. Materials)

GE (DA&ESO) (FDDR's)

FDDR KRI-7000 (Rev. 1): Repair of Dryer Support Bracket

FDDR KRI-7001 (Rev. 1): Repair of Dryer Support Ring

FDDR KRI-7002 (Rev. 1): Repair of Dryer Banks

FDDR KRI-7003 (Rev. 1): Repair of Dryer Tie Rod Washer/Nut Assemblies

The above FDDR's have not received sign off for "Final Disposition" as they were expedited dispositions.

GE (DA&ESO) (Travelers)

SDR-T-1 (Rev. 0): Steam Dryer Ring Repair to FDDR KRI-7001

SDR-T-2 (Rev. 0): Steam Dryer Repair to FDDR KRI-7002

SDR-T-3 (Rev. 0): Steam Dryer Repair to FDDR KRI-7003

PP&L AD-TY-523 (Rev. 1): Unit 1 Steam Dryer and Support Block Repairs (Administrative Controls and Project Interfaces)

The inspector reviewed licensee's QA/QC activities related to the repair. The licensee's QA organization previously has reviewed, audited and approved the GE general QA program. PP&L NPE signs all applicable drawings in accordance with NDI 8.1.3 and AD-TY-523. PP&L QA conducts surveillance inspections of GE activities in accordance with AD-TY-523. PP&L QA conducts QA surveillance over both GE and PP&L work activities in accordance with NQAP 12.1. PP&L QA takes special surveillance efforts in verifying the accuracy of the transfer of GE "work copy" to "clean copy" QC records.

No violations were identified.

12.0 Factors Affecting Corrosion Conditions

The inspector reviewed factors which may have some effect on the potential for corrosion that may be adverse to the performance of austenitic stainless steels and Alloy 600 materials in the dryer assembly. The steam-condensate-feedwater train do not utilize copper alloys for heat exchanger tubing and the turbine moisture separation system contains no

heat exchanger tubing. The surface condenser, LP feedwater heaters and HP feedwater heaters utilize 304 stainless steel tubes. At the request of the NRC, the licensee provided a water chemistry history consisting mainly of conductivity measurements. The licensee indicated that analysis for sulfur species had been initiated recently but pointed out that there were currently no established specification limits for sulfur species. An evaluation of the chemistry history is being made by NRR CMEB.

No violations were identified.

13.0 Steam Dryer Repair

The steam dryer problems are of three types. The first type is a cracking problem associated with welded joints in vane bank panels which appear to be a continuation of the type of crack repaired in FDDR KRI-5002. Prior to repair, these visually detected cracks will be verified by PT. The repair of these cracks is described in FDDR KRI-7002 and will employ a combination of drilled hole crack stoppers and weld repair as required. Samples will be removed for analysis. Subsequent to this inspection the licensee stated that the visual crack like indications were not verified by PT.

The second problem is large multiple crack patterns in the surface of the support ring. These cracks were being repaired in accordance with FDDR KRI-7001 following analysis of 3 "boat" sliver samples taken to determine the mechanism of cracking and crack depth. The most probable cause of these cracks is intergranular stress corrosion cracking (IGSCC), but it is believed by GE that the crack depth is minimal and limited to a surface cold work phenomenon. These cracks will not be repaired.

The third problem is the protrusion and consequent cracked tack welds in the 3/8" diameter chevron tie rod washer/nut assemblies. The repair of this problem will involve grinding the protruding material flush with the dryer OD surface and welding of patch plates over the tie rods to prevent possible loose parts problems. This will be accomplished in accordance with FDDR KRI-7003. No metallurgical samples will be taken for analysis of this problem.

14.0 Summary of Dryer Related Problems

NRR and Region I personnel met with the licensee to discuss the dryer assembly related problems. NRC requested specific information from the licensee as follows:

1. Failure analysis report based on applicable metallurgical, mechanical, and thermal-hydraulic data on the mechanism of failures of the support bracket, support ring, vane bank cracks and tie rod protrusion related cracks.

2. Specific data on system air-in-leakage problems that may affect the potential for corrosion.

3. A written description of the bracket loading pattern on all brackets.

4. PT examination results on the remaining two brackets.

5. NDE test results conducted on the seismic block to support ring welds.

6. Dryer instrumentation program description and anticipated data this program will supply.

7. Material certifications and fabrication methods used to produce the support rings.

The above seven items are considered unresolved pending submission and review by the NRC (50-387/85-13-01).

15.0 Unresolved Items

Unresolved items are matters about which more information is required in order to ascertain whether they are acceptable items, violations, or deviations. Unresolved items disclosed during the inspection are discussed in Paragraph 14.0.

16.0 Exit Interview

The NRC inspector met with the licensee's representatives (denoted in Paragraph 1) at the conclusion of the inspection on April 12, 1985. The inspector summarized the findings of the inspection. The license acknowledged the inspectors comments. No written information was given to the licensee in the course of the inspection.