U. S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-272/82-34

Docket No. 50-272

License No. DPR-70 Priority ______ Category C

Licensee: Public Service Electric and Gas Company

ATTN: Mr. Richard A. Uderitz

P. O. Box 2360

Hancock's Bridge, New Jersey 08038

Facility Name: Salem, Unit 1

Inspection At: Hancocks Bridge, N.J.

Inspection Conducted: December 28-29, 1982

Inspectors: S. D. Reynolds, Jr., Lead Reactor Engineer 1/10/83 date signed

______________________ date signed

Approved By: L. Nallow /for J. Durr, Chief, Materials and Processes Section 2/17/83 date signed

Inspection Summary:
Inspection on December 28-29, 1982 (Report No. 50-272/82-34)

Areas Inspected: Routine announced inspection by one regionally based Lead Reactor Engineer. Inspection was related to fact finding in response to Licensee Event Report for Reportable Occurrence 82-091/01T, which reported gross corrosion of service water piping welds. The inspector reviewed licensee activities to analyze the failure mechanism and repair or replace the corroded portions of the piping system. The inspection involved 16 hours onsite and 4 hours at regional headquarters.

Results: No violations were identified.

DETAILS

1. Persons Contacted

Public Service Electric and Gas (PSE&G)

*B. Sennstrom, Principal Engineer NCS
L. Miller, Technical Manager
*J. Driscoll, Assistant General Manager
*F. Meyer, Manager Nuclear Site Maintenance
*J. Zupko, Jr., General Manager Nuclear Services
*J. Rogozenski, Principal Engineer
H. Baranek, Assistant Manager Mechanical Plant, Nuclear Department
R. Stanley, Assistant Manager Systems Engineering
D. Tauber, QC Supervisor

Catalytic Construction (Catalytic)

J. Dexter, Field Engineer
C. O'Donnell, Acting Site QA Manager
B. Downs, Welding Engineer
J. Dougherty, Level III NDE
I. Coltrain, MR Rod Attendant
C. Perez, Site QA Manager

*indicates those present at the exit interview.

2. Plant Tour (Unit 1)

The inspector observed service water (SW) piping system maintenance work underway in the Catalytic Fabrication Shop, in the #12 Component cooler heat exchanger (CCHX) room and at various other laydown areas. The housekeeping associated with the maintenance work was reviewed and found acceptable.

3. CCHX SW Piping Weld Corrosion Problem (Unit #1)

Background

Licensee LER 82-091/01T reported weld degradation (caused by corrosion) in the recently installed stainless steel replacement service water pipe welds in the component cooling service water system. Subsequent to the leak identified in the LER, the licensee radiographically examined the subject weld joints with a result that the majority of the circumferential joints in the recently installed service water line appeared degraded by corrosion attack of the pipe joint ID surface.

The NRC inspector was dispatched to the site to review the licensee's corrective actions and modifications for compliance to regulatory requirements and industry standards.

Erosion problems associated with the #11 and #12 copper-nickel shell and tube CCHX's led the licensee to purchase replacement units (two each for #11 and #12) with a plate type HX design. CCHX #12 was removed from service and replaced by two HX's during an outage which ended in March 1982. During this outage, the licensee upgraded the cement-lined service water piping supplying cooling water to the HX with an SA312, Type 316 autogenously GTA longitudinal welded austenitic stainless steel piping system. The pipe system consists of many flanged pipe spool pieces and required circumferential pipe welds to be performed in the vendor's shop and at the site during erection. Details of the welding techniques will be discussed later.

The CCHX SW piping system utilizes ambient temperature river water which receives a 12-15F temperature rise in normal operation. The maximum temperature, therefore, is less than 100F. Although the licensee provides 3-times-daily shock chlorination treatment to the service water, the EPA requirements have limited residual chlorine levels and essentially prohibited them from adequately chlorinating during the warmer months Chlorination is required to minimize biofouling from marine growth during warmer periods.

Laboratory Corrosion Analysis

The licensee supplied information for the Region I Corrosion Data Sheet and initiated a metallurgical failure analysis program conducted by the PSE&G Research Corporation. The NRC inspector reviewed this information and obtained additional information during a technical meeting with the licensee on December 29, 1982.

The piping material is type 316 with the straight pipe ordered to ASME SA312, and elbows and weld neck flanges of similar material. The pipe is of sufficient diameter to be longitudinally welded pipe rather than seamless pipe. SA312 is formed and welded autogenously (w/o filler metal) using the Gas Tungsten Arc Welding (GTAW) process. The pipe and all other product forms are solution annealed (the straight pipe is furnace heat treated following welding).

Pipe spool pieces were circumferentially shop welded by Pullman Power Products (Williamsport, Pa.) with many final field welds required to complete the pipe installation. The shop welds were made with a 316L consumable insert (GTAW) and completed with Submerged Arc Welding (SAW) using 16-8-2 filler metal for the remainder of the joint. The field welds were made with a 316 backing ring joint using the Shielded Metal Arc Welding (SMAW) process and SFA 5.4 type E308 filler metal. The subject piping system is Class 3 requiring only surface inspection of the OD of the pipe weld area.

Review of the Licensee Failure Analysis Report, "Salem No. 12 CCHX SW Piping Failure," No. 67202, dated December 14, 1982 indicated the following:

1. Gross biofouling noted in areas where corrosion was identified.

2. Minimal corrosion noted outside of circumferential weld areas. No specific attack noted in the solution annealed autogenous longitudinal welds.

3. Pitting on ID surface followed by cavernous pitting attack of the "as cast" inter-dendritic structure of the weld metal.

4. Delta ferrite in the weld deposits met licensee specified minimum levels.

5. The pitted areas were "rust" colored (possibly indicative of ferric chloride secondary corrodant generation).

6. Laboratory tests showed weld metal to be slightly anodic to the base metal and also showed Nickel Alloy Type 625 SMAW and GTAW deposits to be cathodic to the base metal.

The NRC inspector reviewed the results of the corrosion investigation along with additional information supplied by the technical staff of the licensee. The solution annealed wrought material appears to be resistant to the cavernous pitting reaction as does the solution annealed cast structure of the autogenous GTA longitudinal weld. The shop welds with the 316L consumable insert (SAW 16-8-2 remainder) appear to be attacked worse than the 316 backing ring E308 SMAW welds. The licensee reported that there was no evidence of attack in the socket fillet joints on the small diameter connections other than at one attachment to a large pipe. This information would appear to indicate that the concentration cell corrosion caused by the biofouling organisms is significantly worse than the cell caused by geometric crevices.

The NRC inspector discussed with the licensee the actions taken by him to review the corrosion performance of other austenitic stainless steel pipe which is exposed to service water. The following NDE data was obtained:

(a) A circumferential weld in a 4" diameter pipe spool in the service water intake was radiographed. This weld was in Bay No. 4 in a pipe that was off the No. 16 service water strainer and had been in service since 1979. No apparent corrosion problems.

(b) A circumferential weld in a 3" diameter pipe spool for service water to the No. 15 fan cooler unit (EL. 130 in containment). The pipe and flange face show no signs of corrosion visually or by radiography and have been service for about 1 year.

(c) A circumferential weld in a 10" service water line at elevation 78, Unit 1, north penetration area was radiographed and indicates no corrosion problems although the spool has been in service 1 year.

Technical Meeting

A meeting attended by Messrs. F. Meyer, J. Rogozenski, H. Baranek and R. Stanley of PSE&G and Messrs. S. Reynolds, and R. Summers, RI, NRC, was held on 12/29/82. The following questions were raised and answered:

(1) Q - What is the extent of the service water pipe corrosion problems?

A - It is limited to the replacement piping recently installed for the #12 CCHX. Most of the other service water pipe is cement-lined carbon steel. Other stainless pipe systems (discussed earlier) show no corrosion degradation.

(2) Q - How is the corrosion observed related to the following parameters?

a. water temperature.

b. clean vs. biofouled conditions.

c. water velocity.

d. backing strip vs. consumable insert welds.

e. longitudinal weld vs. circumferential weld.

f. (weld) unaffected base metal vs. circumferential welds.

g. socket fillet welds vs. circumferential welds.

A - a. water temperature has no noticeable effect due to small temperature rise.

b. significant pitting only occurs in biofouled areas.

c. higher water velocity areas have little fouling and, therefore, little pitting.

d. consumable insert welds more affected than backing strip welds, possibly due to proximity of biofouling to weld root.

e. longitudinal welds are essentially unaffected.

f. base metal not significantly pitted.

g. socket weld crevices not affected, but also not biofouled.

(3) Q - Has PSE&G employed a corrosion consultant to assist on the failure analysis?

A- Not to date, but this is still being considered.

(4) Q - What type of pipe was used?

A - Longitudinally autogenously welded (and solution annealed) SA312 Type 316.

(5) Q - Was the failure due to concentration cell pitting or sulphide corrosion from biofouling?

A - Concentration cell pitting started the reaction that propagated by cavernous pitting.

(6) Q - What is the history of biofouling?

A - Biofouling is not atypical in warmer ambient service water temperatures. It is believed that increased chlorination would minimize or eliminate the biofouling. Efforts are being made to obtain relaxation on regulatory limitations to chlorination methods.

(7) Q - Have secondary effects of service water leakage been addressed?

A - Physical location of piping precludes adverse effect of leakage on other systems.

(8) Q - What method is being used to insure all affected pipe welds will be repaired?

A - All pipe welds associated with the CCHX replacement are being repaired or replaced.

(9) Q - Will the ISI program be augmented to provide additional surveillance of further potential corrosion problems?

A - Yes, but the program is not finalized to date. It is acknowledged that UT examination may not be satisfactory for detecting problems in welds made or repaired with 625 filler metal.

Repair Procedure

The NRC inspector reviewed the licensee's repair procedures and the Catalytic Welding specifications and associated quality systems that will be used to implement the repair. The following two repair methods will be employed on an individual joint "best suited" basis.

1. Completely new circumferential joints will be welded with an open root joint geometry using the GTAW process and ERNiCrMo-3 filler metal followed by the SMAW process and ENiCrMo-3 electrodes.

2. Where applicable, the corrosion defects will be ground out, dye penetrant tested (PT), repaired with either of the aforementioned filler metals and the ID surface of the weld "clad" with one of the 625 type materials. The final surface will be penetrant tested.

During observation of development welding it was noted that the usability of the ERNiCrMo-3 (GTAW) filler metal is considerably less than standard austenitic filler metals; however, the usability of the ENiCrMo-3 (SMAW) electrode is similar to the austenitics. The ERNiCrMo-3 is prone to crater cracking on tack welds and the tack welds are essentially impossible to properly re-fuse. Special techniques using vee blocks will be used to minimize the need for tack welds in the root of joint welds.

The NRC inspector reviewed the following documents for compliance to regulatory requirements and the applicable ASME III and IX codes:

(a) Catalytic Procedure 13A Amendment 2 dated 6/21/80 - General Welding Specification.

(b) Catalytic Procedures SS(N) - 1001 (SMAW) and SS(N) - 1024 (GTAW) and related PQR's.

(c) Method of qualifying welders for piping replacement and repair (cladding and butt weld test assemblies).

(d) Guided bend specimens for "cladding" and joint welding (inspected coupons).

(e) Reviewed welder qualification records specific to the repair.

(f) Witnessed developmental welding to determine effects of filler metal diameter (3/32 and 1/8) on usability in open butt roots in 2G and 5G positions.

(g) Inspected replacement pipe (SA312 welded type 316 originally order for CCHX #11 replacement).

(h) Reviewed records of training, testing, experience and qualification of selected Catalytic NDE inspectors.

(i) Reviewed QC package OP-939192-1307.08.

These items reviewed are acceptable for the repair operation.

During review of the quality documents associated with filler metal storage in the Catalytic Fab Shop Rod Issue Room and QC records associated with the joint welding, it was observed that there is a discrepancy in heat identification and recording of filler metal identification. Both Huntington Alloy Products (HAP) and Arcos coated electrodes are being used. The Arcos electrodes have the military identification stamping only (1N12). All QC records reviewed including filler metal withdrawal records identify the electrodes to the SFA specification. There is no record of the actual stamped identification. The heat number (4050) for the 3/32" HAP electrodes is listed on the storage ovens for the same size Arcos electrodes with the Arcos name on the storage oven list. This is also erroneously listed on filler metal withdrawal slips observed being used for welding in CCHX #12 room. The licensee and Catalytic were informed of this problem and since the inspection have taken sufficient action to resolve the item.

No violations were identified.

4. Exit Interview

The NRC inspector met with the licensee's representatives (denoted in paragraph 1) at the conclusion of the inspection on December 29, 1982. The inspector summarized the findings of the inspection. The licensee acknowledged the inspector's comments.