U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

Region I

Report No. 50-247/81-04

Docket No. 50-247

License No. DPR-26 Priority -- Category C

Licensee: Consolidated Edison Company of New York, Inc.
4 Irving Place
New York, New York 10003

Facility Name: Indian Point Nuclear Generating Station, Unit 2

Inspection at: Buchanan, New York

Inspection conducted: January 26-January 29, 1981

Inspectors: Samuel D Reynolds Jr
S. D. Reynolds, Jr., Reactor Inspector — 3/26/81 date signed

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_____ date signed

Approved by: W. J. Cloutier
L. E. Tripp, Chief, Materials and Processes Section — 3/27/81 date signed

Inspection Summary:
Inspection on January 26-29, 1981 (Report No. 50-247/81-04)
Areas Inspected: The NRC inspector investigated the status of the fan cooler heat exchanger (FCHX) replacement, the new FCHX design, the procedures utilized by the licensee to evaluate the condition of the service water piping supplying the FCHX. The NRC inspector reviewed a number of documents which pertained to the FCHX replacement and service water piping system. The investigation was performed by a Regional based inspector and involved 29.5 inspector hours on site and 29.0 inspector hours at Region I to review submitted documents.
Results: No items of noncompliance were noted. The service water piping system was fabricated in accordance with standard industrial practices for cement lined pipe, but which are not completely commensurate with B31.1 practice.

Region I Form 12
(Rev. April 77)

## DETAILS

1. Persons Contacted

The personnel listed below were contacted:

Consolidated Edison Company of New York (CONED)

*Ed Dadson, Quality Assurance and Research
*James P. Deane, Quality Assurance NDE Specialist
*Henry H. Hoffman, Quality Assurance Project Coordinator
*Paul H. Kinkel, Manager, PGM
*Zenon A. Kravets, Engineering
*Charles C. Limoges, Reactor Engineer
*John M. Makepeace, Manager, Technical Services, NPG
J. Mark, Materials Engineer, Astoria Laboratories
E. McGrath, Vice President, Power Generation
*Paul F. McTigue, Power Generation Staff Assistant
*Joseph R. Mor, Quality Assurance and Research
*Rudy Schuster, Quality Assurance and Research
*Michael F. Shatkouski, Plant Manager
*Peteris Skulte, Senior Engineer, Mechanical Engineering
*William B. Warner, Technical Consultant
*Walter G. Wedler, Quality Control Engineer
*P. Zarakas, Vice President, Engineering

*Present at exit interview.

2. Summary

The licensee is replacing all of the FCHX Units with newly designed heat exchangers which feature an improved maintenance design. It is now possible to plug individual tubes and ID Coil Eddy Current test tubes. The new system utilizes electrically insulated flanged connections between Cu-Ni and carbon steel to minimize galvanic corrosion. The piping system within 10 feet of the Cu-Ni FCHX headers will be replaced with new cement lined pipe. The remainder of the piping system within the containment vessel has been evaluated and will be repaired or replaced where pitting corrosion encroaches a 3/16" minimum wall thickness of sound metal.

3. Review of Status of Service Water Piping

The NRC inspector reviewed the licensee's program for inspection, evaluation, modification and repair of the service water system (within the containment vessel (CV)) supplying cooling water to the fan cooler units.

The licensee reported that their review of the FCHX service water piping leaks within the containment vessel indicated all piping leaks were within

ten feet of the FCHX copper-nickel headers. The NRC inspector had confirmed this on an earlier inspection. The licensee indicated that new cement-lined pipe will replace the original piping within 10 feet of the headers. The 10" OD cement-lined pipe will be attached to the copper-nickel pipe by electrically insulated flanged joints to eliminate a galvanic couple cell at the attachment.

The NRC discussed the acceptance criteria for the existing piping with representatives of the licensee's Engineering Department. The original pipe fabrication and erection was in accordance with United Engineers and Constructors, Inc. Specification 9321-01-248-35 Addendum No. 1, dated January 2, 1968. This specification requires fabrication to B31.1 with special welding joints and techniques to limit complete joint penetration and subsequent damage to the cement-lining as indicated in Section IV, C, 4. ("All passes shall be made slowly and with care not to burn through the land or into the lining of the pipe.") Review of the service water piping specification indicates that slight gaps in the cement-lining at the weld joints and incomplete penetration of the carbon steel butt welded joint are not rejectable characteristics of the cement-lined piping system per specification. The carbon steel service water piping welds did not require volumetric examination by ultrasonic or radiographic techniques and no examinations were performed.

The NRC inspector reviewed American Water Works Association AWWA C205-62, which was referenced in the UE & C specification for the application of the cement motar protective lining. This specification does not detail welded joint fabrication methods for the joining of cement-lined pipe, but rather describes the cement-lined pipe sections.

The pipe specified was A53 Grade B (Seamless) 10" OD standard gauge (40 gauge), which is nominally 0.365" with a tolerance of 12 1/2 percent (or 0.319 minimum). It should be noted that the UE & C specification requires the same minimum wall thickness for 12" to 24" OD piping, if detailed for the same service water piping system. The licensee reported that the piping system is designed for pressures less than 150 psig (relief valve setting) and nominally operates at considerably lower pressures. The licensee indicated that the minimum design wall for the A53, Grade B pipe is 0.1185". The seismic bending stress requirement for a 24 foot span of 10" diameter pipe (3000 psi) would require a minimum uniform wall thickness of 0.1875". (The calculated hoop stress for 150 psig ID pressurization is 4820 psi versus an allowable stress of 15,000.) The pipe wall thickness as built was in excess of all minimum design requirements.

The licensee's Engineering Department indicated that localized corrosion attack (pitting), which locally decreased the wall thickness to a remaining thickness greater than 3/16, was acceptable and would meet pressure retaining and seismic engineering requirements. The licensee indicated that weld

face reinforcement will not be counted in the final determination of the 3/16" thickness, but was initially utilized in radiographic density difference calculations.

The NRC inspector reviewed the licensee's program for conducting a systematic evaluation of the 10" cement-lined service water piping weld joints within containment. The program consisted of evaluation by visual, TV camera internal examination, ultrasonic and radiographic techniques. The licensee developed a double wall volumetric examination procedure utilizing gamma ray (Ir 192) isotopic sources. The intent of the radiographic evaluation was not to conduct an examination in accordance with ASME Section V requirements, but rather to develop a volumetric technique which would produce data for engineering evaluation of existing pipe weld joints (in place) with cement lining, insulation on the pipe and stainless steel jacketing on the pipe.

The licensee's radiographic evaluation method utilized a reference standard test coupon, which was a jacketed, insulated, and cement-lined 10" pipe with grooves of varying depth machined on the OD of the pipe. A total of 25 radiographic exposures were made of the test coupon with various film densities from 1.4-4.3. A computer plot was made with the density information obtained to relate film density with differences to 3/16" wall thickness. Fourteen pipe sections removed from the service water line were evaluated for remaining wall thickness at pitting corrosion sites. These 14 pipe sections were examined using a radiographic technique which was subsequently reviewed by the NRC inspector. The technique compared the film density at specific corrosion sites with the film density adjacent to the corrosion site on the weld reinforcement. The film density difference was converted to metal thickness. The metal thickness was then checked with a Krautkramer D-Meter (digital readout thickness meter) in accordance with CONED QA 8100 and Supplement #1 of QA 8100 for verification of the D-Meter on an Ultrasonic Testing CRT presentation. The longitudinal wave CRT technique utilized Branson 301 equipment with a 1/4", 10 MHz delay line transducer. The radiographic density difference thickness determination was compared with the digital readout thickness with excellent correlation. In 10 of the 14 samples, the RT results were compared with the UT and macrosection thickness measurement. Again the correlation was excellent. The NRC inspector reviewed prints of the film with density difference calculations and UT thickness determinations on the following test assemblies:

a. $SW_{(1)}$ 385 Area A
b. $SW_{(1)}$ 385 Area B
c. $SW_{(1)}$ 386
d. $SW_{(1)}$ 134
e. Test piece #1
f. Test piece #2

(1) Service water piping system weld.

The licensee utilized the aforementioned radiographic technique to develop data on the thickness of pipe remaining at corrosion sites in all of the 10" service water pipe welds within containment. The radiographic results were reviewed within NDE and pipe welding consultant hired by the licensee. The licensee's Engineering Department, in conjunction with the pipe welding consultant, developed an acceptance criteria document, QA 8101 "Proposed Interim Sorting Criteria (for) 10" Dia. Service Water Pipe Welds". This document originally included weld face reinforcement in the thickness determination, but was later revised to eliminate reinforcement. A total of 264 10" diameter pipe welds were evaluated in accordance with the QA 8101 criteria. As of the date of the inspection, 23 will be replaced and 44 are scheduled for repair based on the acceptance criteria and elimination of those welds that failed radiographic inspection due to non-corrosion related defects or passed the ultrasonic thickness test. Review of the status of the pipe welds by the NRC inspector with the licensee using the piping layout drawings indicates that the licensee had considered all of the following factors, but could not establish any correlation of pitting corrosion sites to them.

1. Direction of flow of service water.

2. Flow around piping elbows.

3. Whether pipe line was a supply line or return line.

4. Vertical pipe axis orientation.

5. Horizontal pipe axis orientation.

None of the corrosion sites extended 360 degrees around the pipe and most of the affected areas were less than one inch in pipe circumference length.

4. Review of the Use of Austenitic Stainless Steel Pipe

The NRC inspector discussed the usage of austenitic stainless steel for service water piping with the licensee. The licensee indicated that service experience with stainless steel spool pieces at the Indian Point Plant in locations outside containment with low temperature untreated Hudson River water with varying chloride levels has shown pitting corrosion within 2 years of service. The licensee indicated that some pipe sections showed minimum or negligible corrosion, but that their engineering judgment was that the total reliability of cement-lined carbon steel pipe was equal to or superior to austenitic stainless steel pipe for the service environment. The licensee stated that the original construction specifications permitted both materials for this service. The licensee will not conduct further engineering studies of the use of austenitic stainless steel for service water piping.

5. Review of Status of Fan Cooler Replacement Units

The NRC inspector reviewed the status of the fan cooler heat exchanger (FCHX) replacement. Licensee review of maintenance problems with the original FCHX units indicated that brazed joint reliability and lack of accessibility for individual tube plugging were major deficiencies with the original design. The licensee Engineering Department developed a new design that would elminate these deficiencies and increase FCHX reliability in other areas. The new design eliminates all brazed joints including the brazed tubing return bends, introduces gasketed water boxes, rolled double groove tube to tube sheet joints, U tubes, and increases the minimum tube wall by approximately 40 percent (20 BWG to 18 BWG). The tubes are hydraulically expanded into the plate type extended surface rather than mechanical (ball type) expansion in the original unit. The elimination of ball expansion eliminates mechanical score marks on the ID.

The licensee purchased and received the FCHX units of the aforementioned design from CVI Corporation of Columbus, Ohio. The NRC inspector reviewed the following CVI FCHX drawings;

-- C 489-7011, Change C (12/6/80)
-- C 489-7007, Change A (12/8/80)
-- C 489-7013, Change B (12/9/80)
-- C 489-7010, Change B
-- C 489-7009, Change B

The NRC inspector visually observed the status of the replacement operations in the CV. As of the time of inspection, two of the five FCHX units were in place with the vertical supply headers also in place, but with none of the Cu-Ni elbows between the supply headers and water boxes in place. Temporary carbon steel elbows are being used for alignment purposes. The remaining FCHX units were in the CV, but not in place.

It was reported by the licensee in the final shop examination of the FCHX units included successful passage of a 180 psig tube side air/bubble leak test.

The new units appear to be of good workmanship and will permit maintenance operations not possible with the original units. The design penalty for increased maintenance capability is the introduction of large numbers of gasketed joints.

6. Review of Corrosion Evaluation (in Progress) of the Service Water Piping System

The NRC inspector reviewed the status of the corrosion evaluation of the service water piping conducted by the licensee's NDE specialists. Visual examination of service water piping leakage by the licensee and NRC inspector (on a previous inspection) indicated that the leakage sites were limited to areas close to the FCHX Cu-Ni headers. The leakage sites were limited

to weld joint areas; however, it is considered that this is coincident with designed breaks in the continuity of the cement lining and not related to the welding process per se. The welding technique produces an approximately 1/8 inch crevice which has an adverse effect on the corrosion resistance of the pipe ID. Samples of characteristic service water piping corrosion have been sent to Battelle Memorial Institute for further evaluation. At present, there is no way to determine if all pitting corrosion sites are active or if the pitting mechanism is intermittant and greatly affected by chloride ion (and conductivity) seasonal or drought related changes in the river water chemistry.

7. Service Water Piping - Review of Documents

The NRC inspector reviewed documents associated with the original field fabrication of the service water piping (in the CV) supplying cooling water to the fan coolers. The documents reviewed were as follows:

a. UE & C Sketch F-7120-A Revison 3, 2/6/68.

b. USAS B 31.1.0-67 (Power Piping).

c. UE & C Specification 9321-01-248-35, dated 3/31/67 and addendum 1, dated 1/2/68.

d. Portland Cement Association Research Department Bulletin 168.

e. CONED Indian Point 2 FSAR Section 14, Appendix A.

f. CONED Acceptance Criteria for Inservice Inspection of 10" Service Water Piping in VC Bldg of IP2, dated 2/3/81.

g. CONED Clarification on Cement Lining Tightness at Butt-Welded Joints of Steel Pipe and Fittings dated 2/3/81. (Lined in accordance with AWWA C205 and AWWA C602.)

h. Service Water Piping System Inspection (CONED), H. Hoffman, dated 1/23/81.

i. Test Procedure No. QA 8100 "Ultrasonic Method for Measuring Wall-Thickness Utilizing the Krautkramer D-Meter" (CONED QA Dept.), Revision 0, dated 1/9/81 and Supplement No. 1 to Test Procedure QA 8100.

j. Acceptance Criteria for Inservice Inspection of 10" Service Water (SWN) Piping in VC Building of IP #2 - CONED.

k. Safety Evaluation as per 10 CFR 50.59 - NS-2-75-054 Revision 1, dated 1/20/76 (to R. Altadonna, from R. L. Spring).

l. Safety Evaluation NS-2-81-11, Project Number 90196-14, Reference CL-8105, "Installation of an Inspection/Maintenance Part in 10" Nuclear Water Pipe" dated 1/16/81 (to Z. Kravets, from R. L. Spring).

m. Safety Evaluation NS-2-80-167, Project Number 11004-10 "Add Flanged Joints, with gaskets to outlet and Inlet Manifold on Fan Cooler Units No. 21 through 25" dated 12/5/80 (to L. Burbige, from R. L. Spring).

n. Safety Evaluation NS-2-81-25 dated 2/2/81 (to W. J. Burns/L. Burbige, from R. L. Spring).

o. Safety Evaluation NS-2-81-02 Part 1, Project 90196 "Installation of Fan Cooler Cooling Coils and Motor Cooling Coils for Modification Procedure FFI-802-32 Part II" dated 1/7/81 (to R. Altadonna, from R. L. Spring).

p. Preliminary PGM-FO, Fan Cooler Unit-Water Box Removal and Installation Instructions dated 2/6/81.

q. Memo on CVI Fan Cooler, Water Box Bolting Design, dated 12/25/80 (to P. Kinkel, from W. Warner).

r. Fan Cooler Unit Replacement Schedule RV 306 Status, dated 2/6/81 (CONED).

s. Program for Inspection and Analysis of the Fan Cooler Unit Heat Exchangers, Indian Point Unit 2 (CONED), dated 2/6/81.

t. Inservice Inspection Program for FCU Service Water System in Containment - Indian Point Unit 2 (CONED), dated 2/6/81.

u. Technical Procedure QA 8101, "Method of Qualifying Radiographic Procedure for Evaluation of Pipe Wall Thinning", Revision O, dated 2/7/81 (CONED).

v. Test Procedure QA 8102, "Radiographic Evaluation Criteria 10" Diameter Service Water Pipe Welds".

w. Preliminary PGM-FO, Fan Cooler Unit-Tube Plugging Instructions.

y. Proposed Interim Sorting Criteria 10" Diameter Service Water Piping Welds.

z. CVI Corp. Drawings

C 489-7010 Change C 12/6/80
C 489-7007 Change A 12/8/80
C 489-7013 Change B 12/9/80
C 489-7009 Change B

aa. CONED Drawings

D 209575-0 Rev 0 1/15/81
D 209579-0 Rev 0 1/15/81
D 209582-0 Rev 0 1/15/81
D 209588-0 Rev 0 1/15/81
D 209591-0 Rev 0 1/15/81
D 209595-0 Rev 0 1/15/81
D 209599-0 Rev 0 1/15/81
D 209603-0 Rev 0 1/15/81
D 209607-0 Rev 0 1/15/81
D 209611-0 Rev 0 1/15/81
D 209615-0 Rev 0 1/29/81
D 209625-0 Rev 0 1/29/81
D 209627-0 Rev 0 1/29/81
D 209631-0 Rev 0 1/29/81
D 209637-0 Rev 0 1/29/81
D 209641-0 Rev 0 1/29/81
D 209650-0 Rev 0 1/29/81
D 209654-0 Rev 0 1/29/81
D 209670-0 Rev 0 1/29/81
D 209674-0 Rev 0 1/29/81
D 208105-1 Rev 1 1/23/81
A 208105-1 Rev 1 1/23/81
A 208117-1 Rev 1 1/22/81
A 200731 Rev 10 2/2/81
A 200732 Rev 9 2/2/81
A 200733 Rev 9 2/2/81
A 200736 Rev 8 1/29/81
A 200737 Rev 8 1/29/81
A 200730 Rev 13 2/2/81
A 208143-0 1/29/81

ab. AWWA C 205-62 "Cement-Mortar Protective Lining and Coating for Steel Water Pipe.

ac. Inspection of Concrete and Steel Surfaces in Contact with Service Water - V. Gannella, 11/10/80 (CONED).

ad. Service Water Piping System Inspection (Program Outline), H. Hoffman, dated 1/23/81.

References b and c indicate the specifications used for the fabrication of the cement lined service water piping system.

The 1967 USAS 31.1.0 Specification for pipe welding does not specifically state that girth butt welds shall have complete penetation, as the 1973

revision states in paragraph 127.4.2. The intent of the 1967 specification can be determined, however, from interpretation of 127.4.2 (e), which states that "girth butt welds may be examined by any or all of the methods stated in Table 127.4.6" and also states "Sections of welds that are shown by radiography or other examination to have any of the following types of imperfections shall be judged unacceptable...:

1. Any type of crack or zone of incomplete fusion or penetration."

The licensee statements in their documents that specify conformance to B 31.1 and a joint design which inhibits full joint penetration (of as much as 0.125" on 0.365" wall pipe) to prevent damage to the cement-lined pipe are not technically compatible. The reported weld crown reinforcement specified in the licensee's document "Clarification on Cement Lining Tightness" is in excess of the maximum permitted reinforcement specified in B 31.1.0-67 paragraph 127.4.2 (d).

Review of the FSAR does not clearly establish the classification of the service water piping system. There is no specific indication that the piping is identified as safety related pipe.

The service water piping was not originally fabricated in accordance with the strict intent of B 31.1; however, the deviation from B31.1 requirement for a full penetration weld was a design requirement in the UE&C specifications to assure a high quality finished product. The fabrication technique which limited complete penetration in the pipe weld to protect the cement lining from weld-induced damage was in accordance with industry standards for cement-lined pipe fabrication and is not an item of noncompliance. Similar incomplete penetration techniques are reported to be standard techniques used by the licensee at other locations and by other utilities. The NRC inspector confirmed the standard utilization of incomplete penetration joints in cement-lined pipe in discussions with a technical representative of the Portland Cement Association. This discussion confirmed the licensee's technical comments on the mechanism of corrosion inhibition for carbon steel provided by the cement lining. The Portland Cement Association provided a copy of their R&D Laboratories Research Department Bulletin 168 "Influence of the Cement on the Corrosion Behavior of Steel in Concrete". This document indicated that the protection mechanism was basically provided by the Ca (OH) in the hydrated cement, but also indicated that the protective film is impaired by high levels of chlorides. The Portland Cement Association technical representative indicated that maintenance of passivity of the steel required a contiguous coverage of the steel by the cement and breaks in the lining would negate this corrosion inhibition effect.

8. Exit Interview

The inspector met with licensee representatives (denoted in paragraph 1) at the conclusion of the inspection on January 29, 1981. In addition, the NRC Resident Inspector, Mr. T. Rebelowski, attended the meeting. The inspector summarized the purpose and scope of the inspection, identified the inspection findings and identified additional documents required for review at the Regional Office (subsequently received) to complete the inspection.