U. S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-247/90-05

Docket No. 50-247

License No. DPR-26

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

Facility Name: Indian Point Unit 2

Inspection At: Buchanan, New York

Inspection Conducted: February 28 to March 8, 1990 and
April 2 to April 6, 1990

Inspectors: N. J. Kaplan — 4-26-90
H. J. Kaplan, Senior Reactor Engineer — date

A Lohmeier — 4-26-90
A. Lohmeier, Reactor Engineer — date

Approved by: Jack Strosnider — 4/27/90
J. Strosnider, Chief, Materials and Processes Section, Engineering Branch, DRS — date

Inspection Summary: Routine Unannounced Inspection on February 28 to March 8, 1990 and April 2 to April 6, 1990 (Inspection Report No. 50-247/90-05)

Areas Inspected: During the February 28 to March 8 inspection period the NRC inspection focused on licensee activities related to cracking in the upper girth welds in steam generators 21, 22, 23, and 24. The inspection activities included review of magnetic particle (MT) inspection procedure and results, visual examination by the NRC inspector of the girth weld in SG 23, and review of anticipated weld repair activities. During the April 2 to April 6, 1990 inspection period the inspector reviewed the inspection records of the weld repairs in SG 22, the inspection records of the feedwater nozzle and feedwater ring supports, and the results of the inspection of the transition cone covering the area between the upper and lower girth welds.

Results: Cracking was found in the girth welds of all four steam generators. It was concluded that the licensee and subcontractors were conducting the inspection activities in a systematic and controlled manner. A review of the planned weld repair activities of certain ground out cavities in SG 22 indicated

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conformance to ASME Section XI requirements. Inspection revealed cracking in a portion of the transition cone below the upper girth weld. No indications have been found in the lower girth weld. Cracking has been detected in the bore and inner radius of the feedwater nozzle and feedwater ring and nozzle supports. The licensee is continuing to perform inspections and is developing repair plans and procedures.

DETAILS

1.0 Persons Contacted

Consolidated Edison Company

S. Bram, Vice President, Nuclear Power
S. Brozski, Senior Quality Assurance Engineer
J. Curry, Chief, Plant Engineer
V. Ellwanger, Principal Engineer
D. Hinshaw, Project Manager
R. Landwaard, Quality Assurance Engineer
M. Miele, General Manager, Technical Supervisor
J. Quinn, General Manager, Nuclear Power Generator

U.S. Nuclear Regulatory Commission

F. Crescenzo, Senior Resident Inspector

The inspector also contacted other licensee employees during the course of the inspection.

2.0 Inspection Scope

This inspection was conducted to review the licensee's activities regarding inspection and repair of cracking in the shells of steam generators 21, 22, 23 and 24.

3.0 Background

During the Spring 1989 outage, inservice inspection (ISI) disclosed circumferential cracks in the upper shell to transition girth welds in steam generators (SGs) 21, 22, 23 and 24. Cracking of the girth welds was previously encountered during the 1987 outage. Repair at that time consisted of removal of the defects by grinding without any weld repair, followed by magnetic particle inspection. SG 22 was the worst vessel from the standpoint of depth and frequency of indications. On the basis of metallographic samples removed from SG's 22 and 24 during the 1989 outage, the licensee concluded that the cracking was most likely due to corrosion-fatigue. The corrosion aspect was related to previous poor secondary water chemistry (oxygen and copper); the fatigue aspect was related to thermal transients resulting from injection of cold feedwater during startup, plant operation in the hot standby mode, and certain plant transients. Seventy-five (75) indications were found during the 1989 inspection; five (5) in SG 21, forty-nine (49) in SG 22, fifteen (15) SG 23 and six (6) in SG 24. Of these, only ten (10) cavities in SG 22, ranging in length between 4" and 11", and exceeding 3/4" in depth were weld repaired. These cavities were not welded out to the surface, but partially filled to leave a maximum groundout of 3/4 in. (an acceptable groove from a stress and fatigue standpoint). After weld repair, the entire girth weld was subjected to a

1125°F - 4 hour local stress relief. Subsequent magnetic particle inspection, however, disclosed fifty-five (55) indications in previously ground out cavities, two (2) indications in the weld repair areas and one (1) in the original weld metal. The plant was returned to service after the new cracks were ground out and magnetic particle inspected. To eliminate the corrosion fatigue mechanism, the licensee made two modifications: (a) removal of the downcomer resistance plates to prevent the cold water from concentrating in the area of the girth weld during injection of auxiliary feed water and (b) installation of a timer to delay closure of the main feed water flow bypass regulating valve following a trip, to minimize thermal shock. Prior to the 1989 startup, the licensee committed to reinspect certain portions of the girth welds in all four SG's as well as certain portions of the inner radius of the feedwater nozzle and the feedwater ring support brackets (which also exhibited cracks during the 1989 ISI) at the mid-cycle of the present fuel cycle. The subject Inspection Report 90-05 covers the results of this mid-cycle inspection.

Findings

February 28 to March 8, 1990 Inspection Period

Prior to the inspection of the girth welds, the inspector reviewed Applied Technical Service (ATS) Magnetic Particle Inspection Procedure No. 140.1, Rev. 2. ATS is a subcontractor of Welding Service, Inc. (WSI), the licensee's major contractor. The procedure was found to conform to the requirements of ASME Section XI IWA-2300 and 2221, 1980 edition, Winter 81 addenda. At the request of the inspector, the ATS personnel demonstrated the capability of the method (alternating current with yoke) prescribed for the impending SG inspection using a test sample with fine cracks. The method was the same as that used in the 1989 outage. The cracks were clearly visible when the sample was subjected to a spray of ferromagnetic particles. A review of representative AWS personnel certifications (February 1990) indicated conformance to SNT-TC-1A requirements. Documentation was provided to the inspector that indicated that the licensee had reviewed and approved the above NDE documents. Magnetic particle inspection of the girth welds was preceded by slight buffing of the weld areas to remove the light oxide layer on the surface.

Although the original commitment was limited to 1/3 of the circumference of SG's 22 and 23, the inspection was subsequently extended to cover 100% of the girth welds in SG's 21, 22, 23, and 24 because of linear crack like indications found at the start of the inspection of each generator. A total of ninety-five (95) indications were found (as compared to 75 in 1989); forty-eight (48) in SG 21, twenty-three (23) in SG 22, fourteen (14) in SG 23 and ten (10) in SG 24. The length of the indications ranged between 1/8" and 7". Fifty-eight (58) of the 95 indications were 1/2" or less in length. Other significant observations regarding the indications were as follows: (a) many of the short indications (1/2" and smaller) disappeared after light buffing, (b) fifty-seven (57) of the indications were located in the original weld metal, (c) none of the indications were located in the 1989 weld repaired areas, (d) many of the

indications appeared to be associated with in-line pitting, and (e) the deepest cavity was located in SG 22 and measured 1.13". The presence of pitting was confirmed by the inspector during his examination of some of the indications in SG 23. It also was noted that, although there was no cracking observed in the areas weld repaired in 1989, there was some pitting on the surface of these areas.

In anticipation of weld repairing certain cavities in SG 22, WSI's automatic Tungsten Inert Gas (TIG) temper bead Procedure AO-3174-N432, Rev. A was demonstrated on a mockup located on the turbine floor. The mockup simulated accessibility, cavity configuration and orientation. The inspector noted that the welding head rode on a rail that followed the contour of the ID of the simulated vessel. It is noted that the process is completely automated with remote capability. During welding, the process is continuously monitored by video equipment. It is essentially the same procedure used for the repair welding in the 1989 outage, except for one major difference; i.e., the procedure does not employ a 1100°F post weld heat treatment, but depends on precise heat input, a 300°F preheat, and a 500°F post weld heat treatment to produce a tempered heat affected zone. In order to use the procedure as approved by ASME Section XI Code Case N-432, the licensee obtained NRC approval for a relaxation of qualification requirements because mockup material was not available with impact properties stipulated by Code. On the basis that testing of the mockup used, and testing of similar materials did not show any deterioration of HAZ properties (and all other test requirements were met) relief request No. 29 was granted by NRC on March 2, 1990.

The inspector examined the deposited ER80SD2 layers in the mockup and found the weldment to be free of defects. The inspector also verified that the mockup was welded using the welding parameters (current, voltage and travel speed) specified in the procedure.

WSI also provided the inspector calibration records dated March 4, 1990 for the controls of the automatic welding equipment and the associated procedure WSI-GT-CAL-2. The inspector's review of the calibration records found no discrepancies.

The inspector also reviewed WSI procedure WSI-11-60012-10 for attaching the welding machine track to the wall of the steam generator and WSI-IP-60012-11 for its removal. The inspector determined that the procedure utilized the manual tungsten inert gas (TIG) process with a specified maximum limitation of 70 amperes as qualified by laboratory tests. Removal of the "tack" welds was to be accomplished by grinding or cutting, followed by light grinding or buffing to a maximum depth of 1/16' followed by blending and magnetic particle inspection.

On Wednesday, March 14, 1990, a meeting was held at NRC Headquarters in Rockville, Maryland and the licensee discussed the findings of their inspections in detail. The licensee reported that the maximum crack growth for the last seven month cycle was essentially the same as the previous eighteen month cycle-.0025 in/day vs. 0024 in/day as determined for SG 22.

The licensee also reported the metallurgical findings provided by Westinghouse from two boat samples removed from girth welds in SG's 21 and 22. The boat sample from SG 21, taken from a shallow grind out area, contained a small crack whereas the boat sample from SG 22, taken from a previously weld repaired area, did not include any cracks. With regard to the crack in SG 22 the metallographic study revealed similar results obtained from boat samples taken during the 1989 outage, i.e. the cracking most likely occurred by corrosion fatigue. Westinghouse also reported no significant differences in the chemical analysis and metallurgical characteristics of the original weld metal and HAZ (as deposited by the SG fabricator) as compared to the weld metal and HAZ found in the 1989 repaired areas.

Westinghouse presented the results of a fracture analysis which indicated that failure of the vessel was unlikely because (a) the critical flaw size was very large, (b) leak-before-break had been demonstrated, (c) all surface cracks would be removed and (d) postulated crack growth was within allowable guide lines. The licensee was requested to modify the analysis to reflect the limiting transient conditions attendant with recent feedwater system modifications using ASME Section XI fracture analysis criteria.

The licensee reported the preliminary results of the magnetic particle inspection of the feedwater ring support brackets. Linear indications were found at many shell locations adjacent to the support bracket-to-shell welds. Linear indications were also found in the straps holding the feedwater ring to the support brackets. Although most of the indications were in the shell adjacent to the toe of the welds, some indications were found in the reinforcing fillet welds around the lugs, in the feedwater ring, and in the feedwater nozzle inner radius.

The licensee is in the process of grinding out the indications as well as completing the inspection of all relevant areas around the feedwater nozzle support lugs.

Included in the inspection were other regions of the pressure vessel such as the 8" upper and lower handhole, secondary manway, 6" sludge lance hole, and a 2" instrumentation tap. No indications were found at these locations.

The licensee presented photographs of the 1989 examination of the lower support flow slots in all four SG's and the top support plates in SG 22 and 23. As documented in a letter to NRC in July 1989, the photographs showed that essentially no change occurred from previous examinations, which had found "hour glassing" of the flow slots and cracks in the ligaments between the flow slots and the first row tube holes.

April 2 to April 6, 1990 Inspection Period

The inspector reviewed the welding and inspection records of the repair in the upper girth weld in SG 22 and the inspection activities covering the cone section in the transition area between the upper and lower girth welds. The records and discussions with key personnel indicated that repair of nine cavities had been completed successfully with no major rewelding required. The nine cavities were partially filled and contoured to maximum final depth of .70". During welding the inspector noted that the essential welding parameters were continuously monitored by WSI QA personnel as evidenced by a review of their detailed surveillance reports. After welding the repair areas, including 10" above and below and on either side of the welds (as required by Code Case N-432), were inspected by radiography, MT and ultrasonics. Except for ultrasonic indications which were believed to be due to geometrical factors associated with the partially filled cavities the repair welds were found to be free of indications. Ultrasonics and MT of 70% of the circumference, however, revealed indications in a circumferential band about 8 to 10 inches below the girth weld which were completely in base metal. The number of MT indications totaled twenty four (24), with most in the range of one (1) to six (6) inches in length and a maximum depth of .57 inches. Ultrasonics verified the presence of these indications. However, the indications were not visible on the radiographs. The inspector's review of typical radiographs verified that the indications were not visible on the radiographs. Because of indications noted in the area below the girth weld, the licensee extended the ultrasonic (UT) inspection to cover 30% of the remaining area down to and including the lower girth weld for approximately four (4) feet. This UT inspection which included a longitudinal weld did not reveal any indications. It is noted that no indications by any method were detected in the area 10 inches above the upper girth weld and in the lower girth weld itself. The ultrasonic testing was also performed in SG 21 and 23 in an area covering 360 degrees of the circumference and 13 inches below the centerline of upper girth weld. Seven (7) indications were observed in SG 21 and nine (9) in SG 23. SG 24 had not been inspected to date. The presence of indications in the base metal of SG's 21 and 23 conclusively eliminated weld repair, with or without stress relief, as being responsible for these indications since unlike SG 22, SGs 21 and 23 were not weld repaired. To provide additional metallurgical evidence the licensee removed a boat sample which included a defect from the area 10 inches below the girth weld in SG 22. The licensee also reported that visual inspection of six level instrumentation ports did not reveal any visible defects.

The licensee continued to MT inspect and find linear indications in the toe of the weld between the structural supports and the SG wall for the feedwater ring and the feedwater nozzle in all four SGs as well as the inner radius and the bore of the nozzles themselves. In order to provide better accessibility the licensee removed the thermal sleeves in each of the four feedwater nozzles. Subsequently, inspection of the inside of the four bores showed linear indications 1/2 to 1 inch long in the lower 120 degree segment. In addition, linear indications were found in the

feedwater nozzle to pipe welds. The licensee removed a metallurgical boat sample to include a defect from the ID bore. The licensee is planning to remove all linear indications and repair as necessary as determined by analyses. The licensee has committed to transmitting all weld procedures and qualification records for NRC review.

4.0 Management Meeting

The results of the initial inspection were discussed with licensee management at the exit on March 8, 1990 and during several subsequent conference calls with NRR. At no time during the inspection was written material provided to the licensee by the inspector.