U. S. ATOMIC ENERGY COMMISSION
DIVISION OF COMPLIANCE
HEADQUARTERS

Report of Inspection

CO Report No. 247/68-2

Vendor: CONSOLIDATED EDISON COMPANY
CONSTRUCTION PERMIT NO. CPPR-21

Date of Inspection: April 22-24, 1968

Date of Previous Visit to Combustion Engineering Chattanooga Plant: March 11-13, 1968

Inspected By: G. W. Reinmuth G. W. Reinmuth 5/21/68
Reactor Inspector (Programs Standards) (Date)

Reviewed By: L. Kornblith, Jr. L. Kornblith, Jr. 5/22/68
Assistant Director for Technical Programs (Date)

Proprietary Information: Entire Report

SCOPE

An announced visit was made to the Combustion Engineering Company's (C-E) Chattanooga, Tennessee plant to witness the hydrostatic pressure test of the reactor pressure vessel for Consolidated Edison Company's Indian Point 2 plant. Fabrication records for the vessel were also reviewed.

SUMMARY

The hydrostatic pressure test of the Indian Point 2 reactor pressure vessel was successfully completed. Initial bolt-up of the closure head and all phases of the pressure test were witnessed.

Fabrication of the vessel is essentially complete. Some test work remains as well as final cleaning and shipping preparations. Shipment is scheduled for May 28. Part of the testing includes a post hydro test ultrasonic inspection, the final phase of a special three stage ultrasonic program designed to determine if fabrication has an effect upon defects.

A final review of the records was also accomplished during the visit. No significant deviations were noted, either by this inspector or by representative of the U. S. Testing Company, Inc., who are acting as agents for the licensee.

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DETAILS

I. Persons Contacted

Persons participating in the principal discussions and activities were:

W. Magalhaes, Purchasing Dept., Consolidated Edison Co.
E. Dadson, Quality Control Engineer, U. S. Testing Co., Inc.
G. Falla, Quality Control Engineer, U. S. Testing Co., Inc.
R. Von Osenski, Vessel Design Engineer, Westinghouse
S. Dziewit, Quality Control Site Representative, Westinghouse
C. Powell, Expeditor, Westinghouse
R. Schulz, Quality Control Engineer, Westinghouse
T. Lordi, Quality Control Engineer, Westinghouse
E. S. Proctor, Manager Quality Control, C-E
E. Maclin, Chief, Quality Control, C-E
W. B. Bunn, Manager Manufacturing Engineering, C-E

II. Status of Vessel

Fabrication of the Indian Point 2 (IP-2) vessel is essentially complete. Following the hydrostatic pressure test, code required magnetic particle tests, vessel cleaning and shipping preparations must be completed. The Consolidated Edison Company has also specified that additional ultrasonic inspection be performed. (See Section III.D.1. of this report.) May 28, 1968 is the specified shipment date from the C-E plant.

III. Details of Vessel Review

A. Head Installation

Installation of the vessel head was in progress upon arrival at the plant. The principal steps in the bolt-up procedure included the following:

1. Bolt-up to hydrostatic preload by the use of Biach hydraulic tensioners was accomplished in three passes. That is, each stud was tightened to a predetermined point, as measured by the pump pressure of the tensioners (3). After all studs were tightened to the first predetermined pressure, the sequence was repeated to a higher pump pressure. Three such cycles were conducted to the final preload point.

2. Studs were tightened in sets of three in a predetermined sequence to assure an equal distribution of load upon the vessel and head flanges

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3. At the end of each loading cycle, bolt elongations were measured by the use of a measuring rod inserted in a hole provided in the center of the studs for this purpose. At the end of each tightening cycle, the bolt elongations should be the same for each stud if the tensioners are properly calibrated and the procedure is followed. These elongations were recorded at the end of each tightening cycle. The nominal stud elongation required for the 3125 psi hydrostatic test pressure was 0.063 inches which allowed 0.002 inches above the minimum as working tolerance. If the measured elongation was not between the 0.061 and 0.063 inch limit, a final adjustment was made on the stud to bring it within this limit.

4. Following the hydrostatic pressure test, reduction of the stud loads during the closure head removal operation was also accomplished in three passes.

5. The actual stress placed upon a stud for the hydro test was approximately 46,500 psi which is less than 50% of the nominal yield strength of the material.

Actual installation of the vessel head proceeded in a straightforward manner with no unusual delays or problems experienced. Representative measurements and operations were observed to confirm that the prescribed procedure was being followed.

B. Hydrostatic Pressure Test

The hydro test was successfully completed at 3125 psi (125% of design pressure) during the evening of April 23. The test was witnessed by this inspector. A temporary delay (12 hours) occurred in pumping up to pressure when an O-ring plug slipped out of one of the small, lower dome instrumentation penetrations. It was successfully resealed from the exterior of the vessel. Pump-up resumed shortly thereafter.

City tap water was used for the hydro test. Inquiries as to the chloride content disclosed it to vary between 10-30 ppm. The measured value at the plant on the previous day was 11 ppm chlorides and 125 ppm total solids. C-E personnel expressed no concern about this level of chlorides as long as the hydro test temperature remained in the 100°F - 125°F range.

The measured water temperature at the time of vessel closeup was 120°F. The internal thermocouples were removed when the head was placed on the vessel, approximately 36 hours prior to the hydro test. Additional thermocouples had been placed on the outside wall of the vessel at strategic points, however, to measure metal temperatures. At the time of the hydro, these thermocouples read between 105-108°F, well above the required vessel NDT + 60°F test temperature.

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Upon reaching test pressure (3125 psi), the ASME Code inspector, Mr. McClellan, verified the reading and requested that it be held for ten minutes. After the ten-minute interval, the pressure was lowered to the 2500 psi design value at which point Mr. McClellan checked the vessel for leaks. None were found. The pressure was then lowered. The total time the vessel was exposed to pressure above 2500 psi was approximately one hour.

C. Deviation Record Review

Fabrication records for the IP-2 vessel were reviewed during a previous visit. (See CO Report 247/67-2, dated June 15, 1967.) As a continuation of the record sampling, the deviations added to the file since the previous visit were examined. The following were typical of the problem areas experienced during the later stages of fabrication:

1. A number of deviations concerned the dimensions of the CRD housings. The housings are of an unusual configuration which required careful and precise machining within tight tolerances. Twenty-six of the 97 housings contained dimensional deviations from specifications upon receipt from the supplier. Five of these required replacement, the others were accepted or brought within tolerances by further machining. C-E stated that for future vessels, they would probably manufacture the housings themselves in view of the problems they experienced with the IP-2 contract.

2. Optical checks of the closure head keyways disclosed an out-of-tolerance condition. Westinghouse refused to waive the condition; C-E was required to perform additional machining to meet the specification.

3. Minor dimensional deviations were noted in the closure head O-ring grooves and the flange closure surfaces. These were detected during routine dimensional inspections. Each of the conditions noted required correction since these dimensions are important to the proper sealing of the closure head to the vessel.

4. Stud and stud hole threads in the vessel were found to be out-of-tolerances following initial machining. Rework was required. The success of the rework was verified by the trouble free bolt-up during the hydro test.

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5. The hydro test was delayed for approximately a week when the lower head instrumentation tubes were found to be either bent slightly or undersized. Again Westinghouse refused to waive the condition since these tubes must pass a minimum diameter in-core ion chamber. C-E hand broached the tubes to bring them into tolerance.

D. Miscellaneous Topics

1. Ultrasonic Testing

To determine whether fabrication processes cause defects, or result in changes in existing defects, the Consolidated Edison Company specified that additional ultrasonic tests (UT) be performed on the IP-2 vessel. The series of UT included inspection of the vessel plates in the flat condition, after forming and after the hydrostatic pressure test. This is the first instance known, where UT has been specified at all three stages on the same vessel by the same organization. The tests also included the principal nozzle and flange forging welds.

The results of the first two tests did not disclose any detectable changes in the materials. The results of the post hydro inspection have not been reported at this time. More detailed comparisons should be reported in the IP-2 Vessel Fabrication Report and will be reviewed when that document is made available.

While 100% volumetric examination was not performed after vessel assembly, the program included a large number of areas which provides a good sample of the critical areas. For instance, the entire core area, the main nozzles and the transition area between the flange and dome section on the closure head were tested by both the shear and longitudinal ultrasonic wave procedure. Defect areas recorded included anything down to 25% scope indication of the 3% notch reject calibration level. A wheel-type transducer, hand manipulated from the inside of the vessel was used in all tests. Where cladding roughness might have caused erroneous results, the cladding was polished or ground to provide better test conditions.

C-E expects that this UT series will answer some of the outstanding questions as to the effects of fabrication upon flaws.

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2. Westinghouse Shop Representation

Since the last visit to the C-E plant, Westinghouse has assigned a full time, quality control inspector (Mr. Dziewit) to the Chattanooga shop. Mr. Dziewit is an experienced man, having held many responsible inspection and supervisory positions in quality control in the shipbuilding and heavy fabrication industry over a period of 18 years.

3. U. S. Testing Company Activities

Mr. Dadson had accompanied this inspector during the previous visit and was also in attendance during this inspection. He stated his organization had been monitoring the progress of the IP-2 vessel by visiting the C-E plant on approximately a monthly basis. His firm is also performing vendor inspections for Consolidated Edison for other IP-2 components.

With respect to the C-E fabrication of the IP-2 pressure vessel, Mr. Dadson stated he had found no discrepancies between the work and the specifications. He said this was not true with some of the other vendors, pointing out that on five occasions, he had detected and reported significant specification deviations. He did not elaborate as to which companies or components.

4. Parameter, Inc., Comment Follow-up

In the previous inspection report of the IP-2 vessel, the breaking of the bottom dome plate was described. (See CO Report 247/67-2, page 6.) The plate was subsequently replaced, thus the importance to the as-built IP-2 vessel is marginal. However, since the replacement plate also experienced an edge crack during fabrication, Mr. Lofy, of Parameter, raised the general question of the effects of flame cutting upon the residual stresses. In making further inquiries into this area, the following information was obtained:

a. It is well known that most fabrication methods (forming, heat treatment, cutting, welding, machining, etc.) introduce some type of stresses into the material. The entire fabrication process and the sequence of the various steps take into consideration the state of the material at any one time to prevent damage.

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b. In the case of the broken dome plate, several accumulative conditions led to the break. These were:

(1) The break occurred before quench and temper when the material is known to be brittle. (NDT - 80° to 100°F.)

(2) At the time of the break, the piece was highly stressed because of the forming operation which had just been completed.

(3) A square notch had been cut into the piece by removal of a test section - a perfect crack starter.

(4) The test section had been flame cut which leaves a high surface stress condition - also conducive to crack starting.

(5) The piece had been allowed to cool below the recommended preheat. The break occurred during the winter time when the normal shop temperature is reduced.

(6) The piece was reported to have been bumped while being supported on four legs.

These cumulative conditions were considered to be the cause of the break.

c. As to the crack occurring in the piece used in the IP-2 vessel, C-E records indicated the crack was detected, that a proper repair was accomplished according to prescribed procedures, and that the prescribed nondestructive tests demonstrated the repair to be sound and free of further cracks. While the flame cutting (trimming) of the piece may have been a contributing factor to the crack, the elimination of flame cutting as a fabrication tool would not necessarily guarantee that cracks or stresses during fabrication would be eliminated. The two events led to the realization by C-E that added attention needed to be devoted to their process controls at this stage of fabrication. Improvements have been introduced such as prescribing flame cutting patterns which eliminate sharp corners or notches.

No further cracking problems of this type have been observed in subsequent vessels.

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E. Exit Interview

No formal exit interview was held since all activities were conducted in the presence of C-E personnel or other licensee agents. Mr. Proctor, Manager of Quality Control for C-E, was informed that no significant problems with the IP-2 vessel were apparent to this inspector.