U. S. ATOMIC ENERGY COMMISSION
HEADQUARTERS
DIVISION OF COMPLIANCE

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CO Report No. 219/66-3
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Title: JERSEY CENTRAL POWER AND LIGHT CO.
LICENSE NO. CPPR-15

NIAGARA MOHAWK POWER CORP.
LICENSE NO. CPPR-16

CONNECTICUT LIGHT AND POWER CO. (MILLSTONE POINT)
LICENSE NO. CPPR-20

CONSOLIDATED EDISON CO. (INDIAN POINT NO. 2)
LICENSE NO. Pending

CONSUMERS POWER COMPANY (PALISADES PLANT)
LICENSE NO. Pending

Date of ~~Visit~~: May 10-12, 1966

G. W. Reinmuth

By: G. W. Reinmuth, Reactor Inspector (Prog. Stnds.)

SUMMARY

The Combustion Engineering (CE) plant in Chattanooga, Tennessee, was visited to witness ultrasonic tests of plate material, to review the status of several pressure vessels in varying stages of completion and to obtain further details concerning current fabrication practices.

The two General Electric (G-E) vessels (Jersey Central and Niagara Mohawk) are on schedule with on time delivery expected. CE is currently working on one other G-E licensed reactor vessel (Millstone Point), its own contract (Consumers Power Company of Michigan) and four Westinghouse commercial contracts.

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CE has fabricated ultrasonic equipment having both longitudinal and shear wave capability for testing plate material. Testing in both modes is accomplished simultaneously with 100% area coverage. The modified equipment has resulted in a substantial time saving. Present plans are to use the equipment (or equivalent) for all future test work of plate material.

A review of current practices used by CE further demonstrates the detail and quality checks employed by the company to produce a quality product. Comparison of these procedures against code requirements indicates the requirements are not only met but in most cases exceeded.

DETAILS

I. Scope of Visit

G. W. Reinmuth, Division of Compliance, visited the Combustion Engineering (CE) plant in Chattanooga, Tennessee, on May 10-12 to review the status of several pressure vessels. Ultrasonic tests of plate material also were witnessed and fabrication procedures reviewed during the visit. F. J. Long, Reactor Inspector from Region II (Atlanta) participated in the visit on May 11-12.

Discussions were held with the following persons:

T. L. Bailey, Manager, Nuclear Components Quality Control, CE.
E. S. Proctor, Chief Inspector, Quality Control, CE.
J. Anderson, Inspection Supervisor, CE.
Mr. Gillette, Ultrasonic Test Technician, CE.
Mr. Phillips, Ultrasonic Test Technician, CE.
L. C. Northard, Supervisor of Materials and Process Engineering, Manufacturing Engineering, CE.
C. C. Roof, Quality Control Representative, G-E.

II. Results of Visit

A. Status of Pressure Vessels

1. Jersey Central Vessel

Fabrication is on schedule with the hydrostatic test tentatively scheduled for mid-June. The July 21 shipping date appears to be realistic at this time.

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2. Niagara Mohawk Vessel

Substantial progress has been made on this vessel in that the work was said to be but one week behind Jersey Central. At the first of the year, a four-month lag existed. Hydrostatic testing is expected in mid-July and shipment by September 1.

NOTE: Final machining of the control rod holes in the bottom of the vessel is in progress on both units. Following this operation, the vessels are turned end for end for drilling and tapping of the top flange stud holes. A feature of the design is the use of a replaceable insert sleeve in the top flange into which the stud bolts are turned. On the Niagara Mohawk vessel, six weld slag inclusions had been found in the instrumentation and access nozzles on the top head. At the time of the visit, radiographing of the dug out areas was in progress to assure that all faults had been removed. Radiography was utilized in addition to dye penetrant and magnaflux testing of the areas and demonstrates the effort expended to assure a flaw-free product.

Additional ultrasonic and magnaflux tests will be performed on five seam welds on both the Jersey Central and Niagara Mohawk vessels before and after the hydrostatic test. These additional tests were felt necessary by G-E and CE following a weld flux problem described in the last inspection report. (See CO Report No. 219/66-1, dated February 14, 1966.) Similar tests were performed on the Tarapur vessels for the same reason. Thus far, the test results have shown no undesirable effects, i.e., propagation of minor, code acceptable, imperfections.

3. Connecticut Light and Power Co. (Millstone Point)

Ultrasonic testing (longitudinal and shear wave) of twenty of the plates for this vessel has been completed. Two of the twenty were rejected. Disposition of reject material is a cost problem for CE since the plates are purchased from the mill in the as-rolled condition. The mill provides material of specified physical properties but does not conduct ultrasonic or other tests to assure flaw-free plates suitable for Section III reactor vessels

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(unless specified and for a price). Since CE assumes this risk, return of a faulty plate to the mill must be negotiated. In this specific case, the mill agreed to accept return of the two reject plates, valued at approximately $60,000.

The value of a plate demonstrates the confidence level placed in the ultrasonic testing method. One of the two rejected plates was sectioned through the flaw area to confirm the test result. Photographs shown to the inspectors indicated a lamination several inches long at the approximate mid plane of the plate.

In addition to the ultrasonic tests, Charpy impact tests had been completed on eight of the eighteen accepted plates. Five of the eight plates met the G-E specification of 30 ft-#'s @ 10°F and will be selectively placed in the higher stress areas of the vessel. The remaining three plates indicated values of 30 ft-#'s at 40°F. This value is acceptable for areas of lower stress and non-core regions. Charpy tests on the remaining plates and drop weight tests will be conducted. Following these tests, the plate edges are milled for magnaflux testing. (See Addendum A for step-by-step fabrication of a typical shell course.)

4. Consolidated Edison Co. (Indian Point No. 2)

All plate material has been received, inspected and forming operations started. Test results on this vessel were not obtained during this visit.

5. Consumers Power Company (Palisades Plant)

Some plate material has been received. Ultrasonic tests of two of these plates were observed during the visit. (See Section B for further details.)

6. Other Contracts

CE has contracts with Westinghouse to supply two 173" ID and one 155" ID reactor vessels in addition to the Indian Point No. 2 vessel. The specific facilities destined to receive these units was not stated. However,

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the 155" vessel is being fabricated from parts previously prepared for City of Los Angeles Malibu reactor. The shell sections (3) have been up-graded to Section III requirements, and machined to a smaller wall thickness. Welding together of two of the shell courses was in progress at the time of the visit.

B. Ultrasonic Test Observations

One of the specific purposes of the visit was to witness the CE technique of ultrasonically inspecting the plate material.

Because of recent emphasis upon both longitudinal and shear wave testing and 100% coverage of the plate surface, CE has fabricated a test trolley which incorporates both longitudinal and shear wave crystal detectors. These detectors are commercially available units, encased in a wheel (about 8" diameter) which is rolled over the surface to be tested. The trolley fabricated by CE provides a means for properly tracking the detector wheels over the surface and provides sufficient weight to assure a good surface contact. With this equipment, surface grinding or other preparation is unnecessary. Ordinary tap water serves as the couplant. Testing is accomplished by rolling the trolley over the surface, the operator maintaining an upright position. A second operator observes the two scopes for flaw indications. Testing of a complete plate, 100% coverage, requires 2-3 hours, an approximate 75% reduction in time over the former method of manual crystal manipulation.

Calibration of the longitudinal wave detector is by the back reflection method in accordance with Code Case 1338-2. The sensitivity is adjusted so that a 50-75% screen height indication is received from the back reflection from the bottom of the plate. This signal appears on the right hand side of the scope. A flaw causes loss of the back reflection signal and movement of the indication toward the left side of the screen depending upon location and size of the flaw. Complete loss of the back reflection signal indicates a flaw equal or greater than the size of the crystal (1 1/8" diameter). In practice, when a flaw of this size is found, the area is probed with a manual detector unit to define the shape and size of the imperfection. Acceptance standards are specified in each vessel contract and in general exceed the minimum code requirements.

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Calibration of the shear wave detector is accomplished through use of a calibration block containing a flaw of specified size according to ASME Code, Section III, Paragraph N-324.3(b). The acceptance standard is established according to N-324.3(a). No flaws in a perpendicular plane have been detected using the shear wave method. (Approximately 24 plates were tested up to the time of the visit.)

CE personnel (Mr. Proctor) stated that all future ultrasonic inspections of plate material would be performed with the described equipment or the equivalent. Inspections will include both longitudinal and shear wave and cover 100% of the surface area.

Since the quality of ultrasonic inspections still are largely dependent upon the equipment operators, the experience level is a relevant consideration. The two CE employees (Gillette and Phillips), who perform all of the ultrasonic inspections at CE, have a total of 22 years of experience. They are knowledgeable in both the equipment and the theory of application. CE places considerable confidence in their capabilities as evidenced by a willingness to reject material worth several thousands of dollars.

C. Fabrication Procedures

General descriptions of procedures utilized by CE have been discussed in previous inspection reports. In these reports, reporting of a greater amount of detail has not been attempted because of the exceptionally large volume and a reluctance by the fabricators to release specific fabrication information. (CE considers the material in many cases to be proprietary.)

To further demonstrate the voluminous detail involved in pressure vessel manufacture, the step-by-step process to which a single plate is subjected was supplied by CE. (See Addendum A for the entire sequence.) It may be noted the process involves 78 individual steps, 35 checkpoints requiring sign-off by the Quality Control Department (indicated by #) and nine checkpoints (indicated by 0) by the Production Department which are made independent of the Quality Control Department checks.

The process shown by Addendum A is the typical type of sequence placed upon the "shop traveler" which follows the component through the shop. Further detail is provided on the traveler including specific procedure references, time accountability, job numbers, dates and sign-off provisions.

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D. ASME Code, Section III Considerations

In reviewing Section III of the ASME Code, it may be noted that in many instances alternate options are allowable. During the visit, CE personnel were questioned about some of these alternatives to determine the usual methods or practices actually used. Following are brief summaries of some of these areas:

1. Article I, General Requirements, N-110 Scope recommends that the brittle fracture transition temperature (NDT) be periodically checked by surveillance specimens. CE states that they prepare and provide suitable specimens as a standard requirement for all vessels.

2. Article 3, Materials, N-310 General prescribes base materials. At the present time, CE uses SA-302 Grade B modified in accordance with Code Case 1339 (permits nickel content of 0.4 to 1.0 percent for improved impact properties) for plate material and SA-336 modified to Code Case 1332 Paragraph 5 for forging materials.

3. Article 3, Materials, N-330 prescribes special mechanical property requirements and tests. CE states preparation of test samples and testing is conducted according to the code, specifically ASTM-A370 and E23-60 for Charpy impact tests and ASTM-E208 for drop weight tests.

   For forged materials, test samples are prepared from excess ingot material according to N-313.2(2). The method authorized by N-313.2(3) is not utilized.

4. Article 3, Materials, N-321.2 prescribes procedures for weld repairs by the material manufacturer (mill). In practice, the mills do not perform repairs. The usual practice is to perform a temporary repair (of a repairable flaw) at the CE plant prior to heat treatment. After heat treatment, the temporary repair is removed and a permanent repair made according to code prescribed procedures. No particular problems are experienced by CE in performing these operations.

5. Article 3, Materials, N-323 covers testing and repair procedures applicable to castings. CE does not use castings in the manufacture of pressure vessels at this time.

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E. Miscellaneous

1. Magnetic Particle Testing Methods (MT)

Article 6, Inspection, N-626 of the ASME Code specifies the procedures to be used for MT. In discussing these procedures, CE stated their practice is to use the dry power, DC prod method almost exclusively. The only exception is use of a wet fluorescent method for testing stud bolts.

Mr. Proctor pointed out that the AC yoke method was not allowable according to the code and expressed some discontent with the requirement. He indicated the DC prod method has a high potential for leaving prod or burn marks (about 1/8" diameter and 0.002" deep) and in practice a fairly high incidence is experienced. Additional visual inspections and hand grinding are necessary to assure removal. Mr. Proctor felt an equivalent quality inspection could be accomplished with the AC yoke method without producing the prod marks.

Following this conversation, the vessels in the shop were scanned for evidence of prod marks - none was observed.

2. Ultrasonic Testing of Cladding

Westinghouse and General Electric specification requirements are fundamentally similar, however, one difference noted was testing of the clad to base metal bond; General Electric requires ultrasonic testing, whereas, Westinghouse does not.

3. During the visit, hot forming of a 6" plate approximately 24' x 10' was observed. The section was formed into a half cylinder for ultimate use in a conventional steam boiler drum. CE stated they have hot formed plates up to 14" thick with their 6000-ton beam press.

4. C. Roof, G-E site representative, stated that he felt the removal of plate and other part markings after vessel completion as required by the code was not desirable. The

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accuracy of pin pointing repair areas on the original radiograph orientations is reduced by removal. He indicated that the Navy allows retention for this specific reason.

5. In discussing field fabrication of pressure vessel, CE personnel stated they felt existing techniques and equipment could be adapted without difficulty. They fully expect to be able to supply field fabricated vessels whenever the need occurs.

ADDENDUM A

LOWER INTERMEDIATE SHELL COURSE
(6-1/2" Thk. Pl. x 135-9/16" x 243-17/32")

Receiving inspection of plate. #

Grind and polish for U. T. testing.

U. T. plates.

Mill ends of flat plate.

Grind rolled edges as required for M. T.

M. T. rolled edges of plate for C-E information O #

Chip and grind defects found by M. T. as required prior to forming.

Furnace for hot forming.

Hot form.

Quench and temper. #

Cold form plate.

Inspect forming. #

Layout burn lines.

Layout material test plates and stamp.

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- Inspection Point by Quality Control Department.

O - Inspection Point by Manufacturing Department.

Preheat and burn material test plate.

Send test plate to Met. Lab.

Layout for machining long seams.

Inspect layout. #

Hold for engineering release. #

Preheat and burn excess stock.

Fit-up lugs for machining long seams.

Weld handling lugs.

Machine long seam weld. preps.

Remove handling lugs and clean up.

M. T. area of lugs. O #

Send shell segments to nuclear plant.

M. T. weld prep. O #

Up-end three (3) shell segments for fit-up.

Fit-up three (3) shell segments and strap.

Inspect fit-up. #

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- Inspection Point by Quality Control Department.

O - Inspection Point by Manufacturing Department.

Weld tie straps.

Grind three (3) seams for weld overlay.

Set-up to weld three (3) long seams.

Fit, weld run-out tabs.

Preheat, weld three (3) long seams approx. 1½" deep. # W.I.F.

Remove tie straps from I. D.

M. T. backside of three welds. O #

Chip defects and backgroove as required.

M. T. chipped area. O #

Manual weld chipped area. # W.I.F.

Holding heat, weld I. D. of all three long seams complete. W.I.F. #

Finish welding O. D. of three (3) long seams. W.I.F #

Inspect prior to stress relief, also inspect roundness. #

Interstage stress relief.

Review furnace charts and release furnace operation. #

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- Inspection Point by Quality Control Department.

O - Inspection Point by Manufacturing Department.

W.I.F. - Weld Inspection or Weld Information Form.

Remove run-out tabs.

Inspect for roundness. #

Bore I. D., machine O. D. and square both ends. (20' VBM).

Inspect machining and record dimensions. #

Grind areas that did not clean up.

M. T. inside and outside of three (3) long seams and all inside and outside base metal surfaces. O #

Remove arc strikes.

Inspect long seam welds prior to R. T. #

R. T. the three (3) long seams.

Review film and release. #

Preheat to 300°F and Arcair to remove defective areas from long seams.

Grind gouged surfaces and any base metal areas requiring repair.

M. T. grind outs. Mark location of any base metal defects exceeding 3/8" deep for R. T. later. O #

Preheat shell course.

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- Inspection Point by Quality Control Department.

O - Inspection Point by Manufacturing Department.

Weld all defects in long seams and required base metal repairs. # W.I.F.

Grind inside and outside weld repairs for M. T. and prepare for cladding.

M. T. all weld repairs. O #

Holding preheat, clad shell course. # W.I.F.

Grind arc breaks and prepare for repair welding.

Manual repair arc breaks. # W.I.F.

Inspect clad and repair prior to furnace. #

Interstage stress relief.

Review furnace charts and release furnace operation. #

Place shell on power rolls and clean I. D. for P. T.

Strip clad at girth seams.

Grind clad smooth over area requiring X-ray.

P. T. clad. #

Repair P. T. indications. # W.I.F.

P. T. repairs. #

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- Inspection Point by Quality Control Department.

O - Inspection Point by Manufacturing Department.

W.I.F. - Weld Inspection or Weld Information Form.

U. T. Clad.

Machine weld prep that attaches to lower shell. #

Inspect machining and record dimensions. #

M. T. weld prep that attaches to lower shell course. 0 #

NOTE: (X-ray repairs with girth seam)

Hold for fit-up to lower shell course.

\# - Inspection Point by Quality Control Department.

0 - Inspection Point by Manufacturing Department.