U. S. ATOMIC ENERGY COMMISSION
HEADQUARTERS
DIVISION OF COMPLIANCE

February 14, 1966

CO REPORT NO. 213/66-2
219/66-1
220/66-2
247/66-1
245/66-1

Title: CONNECTICUT YANKEE ATOMIC POWER CO.
LICENSE NO. CPPR-14

JERSEY CENTRAL POWER AND LIGHT CO.
LICENSE NO. CPPR-15

NIAGARA MOHAWK POWER CORP.
LICENSE NO. CPPR-16

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

CONNECTICUT LIGHT AND POWER CO. (MILLSTONE POINT)
LICENSE NO. Pending

Date of Visit: February 2-4, 1966

G. W. Reinmuth

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

SUMMARY

A visit was made to the Combustion Engineering (CE) plant in Chattanooga, Tennessee, to obtain additional details concerning reported welding problems, to witness the hydrostatic pressure test of the Connecticut Yankee vessel, and to review fabrication records.

The initial hydrostatic test of the Connecticut Yankee vessel was unsuccessful because of loss of seal on one of the plugged openings. The test was not witnessed because of a week's delay in preparing the vessel for retest.

Numerous imperfections in the main nozzle to vessel welds were experienced on the Connecticut Yankee vessel. The cause was attributed to overlapping of successive weld passes resulting in slag inclusions. A contributing cause was a change from a manual to an automatic welding procedure. Repairs were considered satisfactory by the buyer (Westinghouse) and the code inspector.

(continued)

Summary (continued)

A spot check record review of the Connecticut Yankee vessel disclosed nothing unusual except the nozzle weld problem. Pre-flaw radiography records are not retained as a permanent part of the record.

A second welding problem, different from that in the Connecticut Yankee vessel, occurred while fabricating the Jersey Central and Niagara Mohawk vessels. Weld cracking in a transverse direction was attributed to high manganese content from a faulty batch of welding flux. To effect repairs, the bad welds were completely cut out and the components rewelded using a different type of flux. Both CE and G-E personnel stated the defects would have been detected by normal code required radiography procedures had earlier visual detection not occurred. All parties were found to have responded in a responsible manner to investigate and correct the problem.

Management changes were made in the CE organization during the past year. The effects of these changes were not evident at this time.

DETAILS

I. Scope of Visit

G. W. Reinmuth, Division of Compliance, visited the Combustion Engineering (CE) plant in Chattanooga, Tennessee, on February 2-4, 1966, to review the status of pressure vessels being fabricated for the following companies:

A. Connecticut Yankee Atomic Power Co. (ConnYankee)
B. Jersey Central Power and Light Co. (Oyster Creek)
C. Niagara Mohawk Power Corp. (Nine Mile Point)

Miscellaneous information was also obtained about vessels for the Los Angeles Department of Water and Power (LADWP), the Consolidated Edison Co. (Indian Point 2), and the Connecticut Light and Power Co. (Millstone).

The principal purposes of the visit were:

A. To witness the hydrostatic pressure test of the Connecticut Yankee vessel.

B. To review the record file of the Connecticut Yankee vessel.

C. To gather information regarding welding problems experienced with the Niagara Mohawk and Jersey Central vessels.

(continued)

Scope of Visit (continued)

D. To discuss management changes in the Combustion Engineering Co.

Discussions were held with the following persons:

W. G. Benz, Jr., Director, Nuclear Components, CE
T. L. Bailey, Manager, Nuclear Components Quality Control, CE
E. S. Proctor, Chief Inspector, Quality Control, CE
J. S. Meek, Project Engineer, CE
Ray L. Wilson, Radiographer, CE
R. E. Tome, Stress Analysis Engineer, Westinghouse
Walter Desmerchais, Tool Design Engineer, Westinghouse
Charles Powell, Expeditor, Westinghouse
C. C. Roof, Quality Control Representative, G-E
C. Anderson, Maintenance Supervisor, Connecticut Yankee Atomic Power Co.

II. Results of Visit

A. Status of Pressure Vessels

1. ConnYankee Vessel

Fabrication is essentially complete. Preparations were in progress to perform the final hydrostatic pressure test during the visit. The first attempt was unsuccessful resulting in a one-week delay to prepare for a second attempt. Following a successful hydrostatic test, approximately two weeks' final work will be required to prepare the vessel for shipment.

2. LADWP Vessel

Repairs to one shell course had been completed. (See CO Inspection Report, dated May 27, 1965, for details.) This shell course, along with the other incomplete sections, are in storage. Other than the above repair, no further work has been performed since the Compliance visit in May 1965.

In discussing the future status of the LADWP project with Westinghouse personnel, it was stated that if a construction permit for the LADWP reactor is issued, a new start would be made on the pressure vessel in accordance with ASME Code, Section III requirements. Additional work probably would be authorized to re-qualify the sections now in storage to meet Section III requirements with the objective of selling the components to another customer. All work completed to date on the sections in storage were performed in accordance with Section VIII requirements.

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Results of Visit (continued)

3. Jersey Central Vessel

Fabrication is approximately 80% complete with delivery still scheduled for July 1966. All shell sections, the bottom closure, and nozzles, had been assembled into a single composite unit. Magnetic particle testing of the outside surface of the vessel was observed during the visit.

4. Niagara Mohawk Vessel

Fabrication is approximately four months behind the Jersey Central vessel. Delivery must be made before the Great Lakes freeze-up in the fall of 1966. At this time, no obstacles to meeting this schedule are evident.

5. Consolidated Edison Co. (Indian Point 2)

All basic plate material has been received from the steel supplier and initial cutting and bending operations were in progress.

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

Some of the steel plate material has been received from the supplier.

B. Connecticut Yankee Vessel Details

1. Hydrostatic Pressure Test

The initial attempt to perform the hydro test was unsuccessful because of a loss of seal in one of the plugged vessel openings. For this reason, the test was not witnessed by the Compliance inspector. (Subsequent to the visit, verbal information was received from CE that the hydro test had been successfully completed on February 12.)

One difference between the Westinghouse and General Electric (G-E) procedures is the manner in which the vessel openings are plugged. Westinghouse utilizes "O" ring sealed plugs, whereas, G-E requires temporary welded caps. While either method is satisfactory, the first risks delays in resealing in the event of loss of seal as experienced in this particular test. On the other hand, additional work is required by the G-E method because the final machining of the nozzle surfaces must be performed after the hydro test is completed.

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Results of Visit (continued)

The following information was obtained with regard to the hydro test procedures:

a. Temperature of the vessel was to be 90°F as determined by thermocouples attached to the outside surface of the vessel in several selected locations (maximum NDT plus 60°F). Heat-up was observed to be in progress with the temperature at 84°F two days prior to the first pressurization attempt.

b. Test pressure was to be 150% of design or 3750 psi. Design pressure (2500 psi) was to be held for a minimum of 30 minutes.

c. Bolt up of the head was to be performed in three passes with tightening up to pre-specified values. A Connecticut Yankee representative (C. Anderson) was at the site specifically to observe this phase of the operation. While CE's procedures differed in detail from those in use at the Yankee (Rowe) plant, Mr. Anderson considered the CE procedures adequate.

From observations of the work in progress, the proposed test procedures and conversations with responsible personnel, it is concluded that the test to be performed would meet the requirements of the ASME Code.

2. Nozzle Weld Problems

Defects were discovered in seven of the eight primary recirculation nozzle welds on the ConnYankee vessel. The defects were described as weld slag inclusions, caused by overlapping of the weld at the end of a circumferential pass. Another contributing factor was the change from a hand process, used on the Southern California Edison vessel, to an automatic welding process. While the number of defects was relatively high (eighteen in one nozzle, eleven in another, nine in two and two in the remainder, including one defect extending the entire circumference of the nozzle), the pattern was random in nature.

Of interest to the overall problem of defects, detection, repair, and compliance with the Code requirements is the following information:

(continued)

Results of Visit (continued)

Initial detection of defects was accomplished by routine radiography procedures utilizing a betatron machine. These defects were ground out and repaired according to prescribed procedures. Because of shop scheduling considerations, re-radiographing of the repaired defects was delayed for several months. During this time, a new linear accelerator (Varian Linarc) was placed in service to supplement the betatron. The new machine was used on the re-radiographing of the repairs. The Linarc provided better resolution than the betatron and, as a result, disclosed a substantial number of defects previously overlooked. It should be noted, however, that both machines met the sensitivity requirements of the ASME Code.

The additional defects were repaired, re-radiographed and accepted as meeting both Code requirements and the Westinghouse specifications. Evidence of acceptance was observed by the signatures on the radiography records of the Code Inspector, Mr. Yeargen; the Quality Control Manager of Westinghouse, J. K. White; and the CE radiographer, R. L. Wilson. A 100% review and sign-off by all of the above parties was performed on the nozzle welds. CE was requested to show the CO inspector radiographs of the affected areas prior to repair of the defects. Mr. Proctor indicated that these had been destroyed because the Code required retention of only the final radiographs of the completed and repaired welds. Representative samples of the final radiographs were reviewed and repaired areas pointed out by the CE radiographer. They appeared to be satisfactory.

3. Bottom Instrumentation Hole Misalignment

A one-week delay resulted from an alignment error in drilling 19 instrumentation access holes in the bottom closure head. The error occurred initially during the drilling of ½" guide holes for the 1½" finished holes. In setting up for final drilling, compensation for the error was made in the wrong direction which in turn resulted in a total misalignment of 3/8".

To correct the problem, the final size of the holes was increased from 1½" to 1-7/8". Instrumentation sleeves having thicker walls were substituted to fill the enlarged holes. In discussing the possible effects of the enlarged holes upon the stress calculations, Mr. Tome indicated that the original reinforcing pads around the holes had a sufficient design margin to accommodate the enlarged holes. This avoided the problem of additional weldments and stress relieving operations.

(continued)

Results of Visit (continued)

4. Vessel Handling

It was observed that the outside of the vessel had been gouged by the handling cables when moved from the horizontal to vertical position. The gouges were approximately 1/16" in depth and several inches in length. Mr. Proctor indicated that these areas would be ground smooth and retested by magnetic particle methods.

It was also noted that temporary handling lugs had been welded onto the vessel at several locations. Mr. Proctor pointed out that each of these was welded to a permanent "pad" which was attached to the vessel specifically for this purpose. Since the pad areas were of sufficient size to prevent heat affected zones being formed from the temporary welds, no further stress relieving operations were required upon removal of the temporary lugs.

5. Record Review

A lengthy record file is accumulated during the fabrication of a vessel of this size and complexity. A thorough review of this file to determine absolute compliance with the fabrication specifications would be a formidable task and require several man-days by a person completely knowledgeable of the detailed specification requirements, the ASME Code, and the record system employed by CE.

To meet the objective of the Division of Compliance, only a sampling of the record was attempted. Among the specific items sampled were the following:

a. Mechanical test reports of the plate material supplied by the steel vendor. (See Addendum A for typical test results.)

b. Test reports on metal "O" ring properties.

c. Certifications indicating closure stud processing and threading met CE's purchase specifications.

d. Certifications that the carbon steel nozzle forgings met specifications.

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Results of Visit (continued)

e. Certifications that the steel plate material had been tested according to CE specifications, including ultrasonic tests, magnetic particle and visual inspection. This certification had been provided by a member of the CE Quality Control Department. His remarks were, "The attitude of the inspectors was good. Operators were well-qualified and conscientious." This comment is meaningful when considering the tediousness and constant attention to detail required during ultrasonic and magnetic particle inspection.

f. Approximately 25% of the "shop traveler" records were reviewed. These are the records which accompany the vessel parts through the shop during fabrication and are essentially both instructions and check-off records. (The system was described in a previous CO Inspection Report, dated February 25, 1965.) The shop traveler file is approximately 600 pages long and provides the real details of shop practices.

In reviewing this extensive file and comparing observations with those made in the past, the following findings were reached by the inspector:

a. A greater effort has been made by CE to provide records that are better organized and more complete.

b. Only those records considered mandatory to show compliance with Code and specification requirements are retained. A chronological or descriptive record of fabrication problems, such as the nozzle weld problems, was not observed. If a future record review were found necessary to determine the exact fabrication history, considerable reliance upon personnel's memory would probably be necessary. (In brief, if an investigator had no previous knowledge of a problem, area, the record would not show a complete story.)

c. The change from the former "checksheet" system to the "shop traveler" is a distinct improvement. It provides greater assurance that oversights will not occur.

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Results of Visit (continued)

C. General Electric Pressure Vessels (Jersey Central, Niagara Mohawk)

1. Weld Problems

A welding problem, different in nature from that previously described, occurred in the fabrication of the G-E vessels.

During welding of the dome to torus sections of the upper closure head on the Jersey Central vessel, weld cracking in a transverse direction was observed and reported by the welder and floor inspector. While CE was discussing the probable cause and corrective procedures with G-E, similar type cracking was observed in the nozzle to shell welds on the Niagara Mohawk vessel. In both instances, the cracks were observed visually prior to completion of the weld.

CE initially considered the cause to be loss of preheat, however, G-E's position was that a weld metal problem existed and urged CE to make weld chemistry tests. G-E reasoned that loss of preheat would result in longitudinal cracks, whereas, transverse cracks would be caused by a different mechanism.

While discussions between CE and G-E continued, the radiographs of the upper vessel flange to shell weld on the Jersey Central vessel disclosed extensive cracking, again in the transverse direction.

Results of chemical tests subsequently conducted on the weld metal removed from the above flange weld indicated excessive manganese content. Further investigation disclosed the cause to be the welding flux, a fine coffee grind size powder used with the welding wire during the automatic welding process. Tests of the flux showed the manganese content high and a lack of homogeneity. The faulty flux (Arcosite B5, Lot No. 5C6F-1) was stated to be limited to a single but large lot of material. (CE has 25,000 pounds in storage, now considered unusuable.)

The extent of use of the faulty flux was determined by CE to involve only the Niagara Mohawk, Jersey Central and the two Tarapur vessels presently in the shop. In questioning CE and G-E personnel, all stated that the cracks observed visually would have been detected through normal Code required radiography procedures of the finished weld as was the case with the Jersey Central flange weld. To further assure that the problem did not involve Code violations or possible safety implications, G-E authorized additional funds to CE for further

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Results of Visit (continued)

investigation of some of the welds on Tarapur vessel No. 1. These tests involved additional ultrasonic tests before and after the hydrostatic test. Good correlation was obtained between pre-hydro ultrasonic tests and radiograph indications of small areas of imperfections which were classified as small and meeting Code requirements. The post-hydrostatic ultrasonic test of these same areas disclosed no spreading or growth in the imperfections. Further tests are in progress on the No. 2 Tarapur vessel.

To repair the three areas of flaws observed in the Niagara Mohawk and Jersey Central vessels, the welds were completely removed, mating surfaces re-machined and the joints rewelded using a flux of a different type from an alternate vendor. No further difficulties were experienced.

2. Miscellaneous

Magnaflux testing using a manual probe method on the external surface of the Jersey Central vessel was observed. To assure coverage over all surfaces, a 6" grid pattern is chalked on the external surface of the vessel and each square checked off when tested. The operators appeared to be doing a thorough job. It was noted that suspect areas were retested at several probe points to assure adequate definition of possible imperfections.

D. CE Management Changes

During 1965, two major management changes were made. W. G. Benz, Jr., was appointed Director of Nuclear Components and replaced W. W. Sawdon. T. L. Bailey replaced T. H. Gamon as Manager of Nuclear Components Quality Control. (See Addendum B for organization chart.) The reasons for or the effect of these changes were not evident. However, in discussing the changes with inspection personnel, all expressed confidence that the changes represented an improvement. In particular, the Quality Control Department expected more understanding of their problems from Mr. Benz because of his background in the Production and Quality Control Departments.

E. Exit Interviews

A short interview was held with Mr. Benz to explain the purpose of the Division of Compliance inspection efforts. Like his predecessor, Mr. Benz expressed a willingness to provide as much information as necessary to meet AEC needs.

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Results of Visit (continued)

During the visit, interviews also were held with R.E. Tome, Westinghouse; E. S. Proctor, Chief Inspector, CE; T. L. Bailey, Manager, Quality Control, CE; and C. C. Roof, General Electric, to discuss various aspects of the jobs in progress. The more significant points discussed are covered in the body of this report.

Attachments:
Addendum A
Addendum B

Test Data on Connecticut Yankee Pressure Vessel

Mechanical Test Report (Jan. 25, 1965)
(From Lukens Steel Co.)

Head Plates

A 3T x T test sample was removed from each head plate represented (total of 6). The test samples were heat treated at 1550°-1600°F, held at temperature 4 hours, dip quenched plus 1225° ± 25°F, held at temperature 4 hours plus 1150° ± 25°F, held at temperature 24 hours, furnace cooled to 600°F.

The test specimens were removed from the center of the length and width of the 3T x 3T x T test sample at the ¼ thickness level.

Shell Plates

The shell plates (total of 9) were heat treated at 1500°-1600°F, held at temperature 4 hours, dip quenched plus 1225° ± 25°F, held at temperature 4 hours. A test sample was then removed and given an additional heat treatment of 1150° ± 25°F, held at temperature for 20 to 30 hours, furnace cooled to 600°F.

The test specimens were removed at least one thickness from the quenched edge at the ¼ thickness level.

Orientation of Test Specimens

The Charpy V notch specimens were oriented with the length of the notch perpendicular to the plate surface.

ADDENDUM A

Charpy Test Results on Head Plate Segments (6)
Ft/# Values - 3 Sample Average

Test Temp.	Average ft/# 9" Plate	Average ft/# 9" Plate	Average ft/# 9" Plate	Average ft/# 6¼" Plate	Average ft/# 6¼" Plate	Average ft/# 6¼" Plate
-40°F	8.1	29.5	18.0	19.0	41.6	12.8
+10°	39.0	58.8	39.1	49.8	74.1	86.1
60°	38.5	106.6	65.8	85.8	103.3	80.5
110°	51.0	129.1	93.3	118.6	115.0	117.8
212°	82.0	(160°F) 132.6	98.0	140.1	114.6	122.3
Drop Wt. NDT	-10°F	-20°F	-10°F	-15°F	-30°F	-10°F

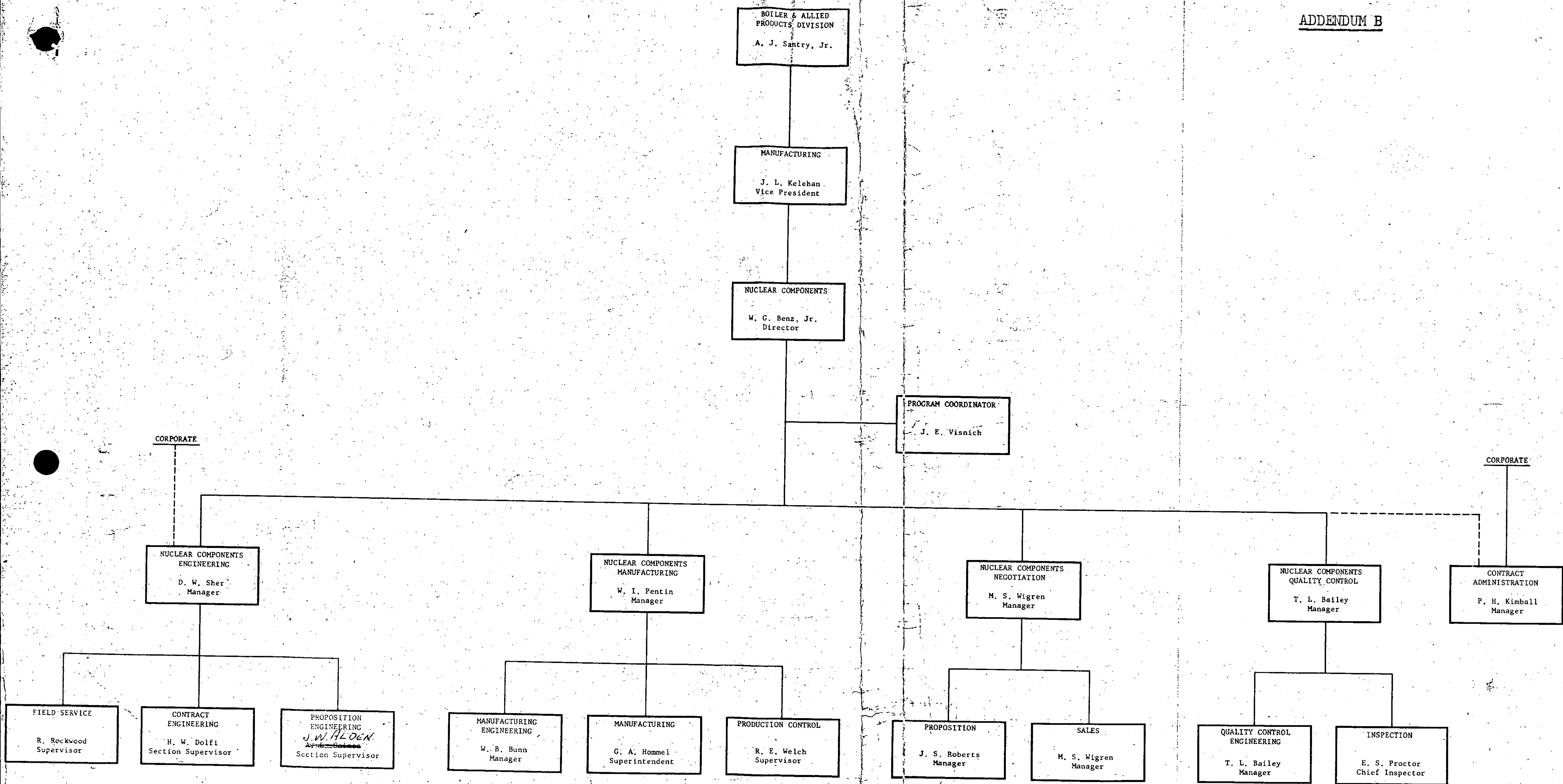
ADDENDUM A

Charpy Test Results on Shell Plate Segments (9)
10 3/4" Plates - 3 Sample Average #/ft.

Test Temp.	Plate No. W-9807-1	Plate No. W-9807-2	Plate No. W-9807-3	Plate No. W-9807-4	Plate No. W-9807-5	Plate No. W-9807-6	Plate No. W-9807-7	Plate No. W-9807-8	Plate No. W-9807-9
-40° f	17.3	8.3	8.5	-	20.0	13.8	22.0	14.1	10.0
10	52.8	40.0	39.1	35.3	51.1	68.5	53.7	34.3	16.8
60	87.0	83.5	58.6	62.8	68.8	48.5	86.0	58.6	74.8
110	77.0	112.0	89.2(120°)	95.3	97.7(120°)	79.3	106.0	80.6	102.8
160	82.5	126.0	-	124.5	-	-	125.3	-	119.0
212	91.3	130.5	120.1	141.7	111.2	99.1	-	93.5	-
Drop Weight NDT	-20°F	-20°F	-10°F	-30°F	-15°F	-10°F	-20°F	-10°F	-15°F

ADDENDUM A

ADDENDUM B



COMBUSTION ENGINEERING, INC.

BOILER AND ALLIED PRODUCTS DIVISION
NUCLEAR COMPONENTS DEPARTMENT

DATE: 6-11-65 CODE: BDN-1

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