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EVALUATION OF RT_{NDT}, USE, AND CHEMICAL COMPOSITION OF CORE REGION ELECTROSLAG WELDS FOR QUAD CITIES UNITS 1 AND 2

by

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(See Section 4.0 for document signatures.)

Prepared for

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ABSTRACT

This document contains FTI's best estimate of the initial RT_{NDT}, initial Charpy V-notch upper-shelf energy (CvUSE), and chemical composition (copper, nickel and phosphorus) values for the longitudinal electroslag welds within the core region of Quad Cities Units 1 and 2. Based on a review of existing weld procedure qualifications (PQs) and surveillance weld data, initial RT_{NDT} is estimated to be 23.1°F, with a standard deviation of 13.0°F. The initial CvUSE for the electroslag welds is estimated to be 105.4 ft-lbs, with a standard deviation of 16.1 ft-lbs. The electroslag welds are estimated to contain 0.190 weight percent (w/o) copper, 0.311 w/o nickel, and 0.013 w/o phosphorus (with standard deviations of 0.048, 0.051, and 0.003 w/o, respectively). A chemistry factor of 114.43 is calculated based on the copper and nickel contents for the electroslag welds at Quad Cities Units 1 and 2.

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1. INTRODUCTION

This document presents FTI's (Framatome Technologies, Inc.) best assessment of the initial (i.e., beginning of life) reference temperature (RT_{NDT}) value, the initial Charpy V-notch upper-shelf energy (CvUSE) value, and the chemical composition of electroslag welds in the Quad Cities Units 1 and 2 reactor vessels. In particular, the electroslag welds of interest are longitudinal welds among the plates comprising the Mark 57 (Mk-57) and Mk-58 shell courses. The Mk-57 and Mk-58 shell courses are within the core region. Figure 1-1 illustrates the arrangement of these shell courses in the reactor vessels of Quad Cities Units 1 and 2.

This assessment is a result of the collection and compilation of weld PQs and other data pertinent to the fabrication of the Quad Cities reactor vessels, as well as other boiling water reactor (BWR) vessels fabricated in the same time frame. This document does not include information with regard to chemical composition or Charpy impact data on specific shell courses or non-electroslag welds.

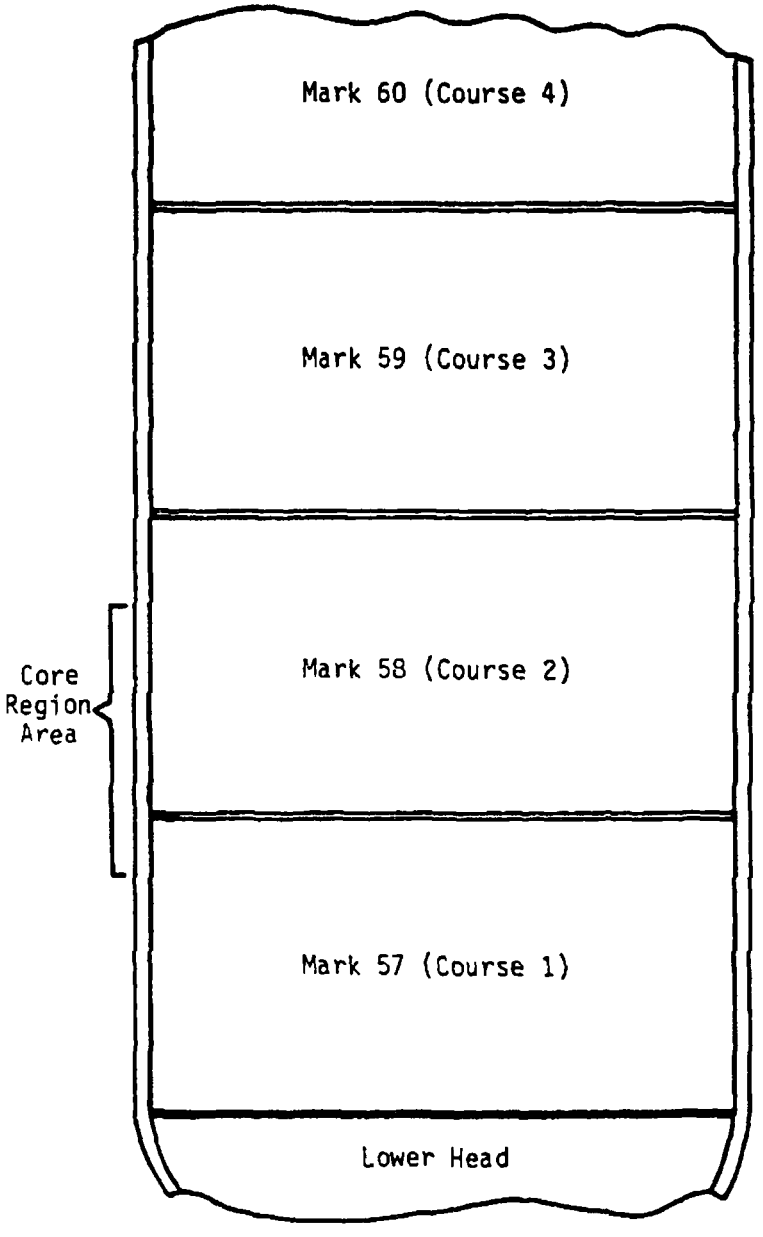
The following list identifies the number of electroslag (ES) welds in each of the two shell courses of the Quad Cities Units 1 and 2 reactor vessels.

Unit ID	Shell Course	No. of ES welds
Quad Cities 1	Mk-57	4
	Mk-58	4
Quad Cities 2	Mk-57	3
	Mk-58	3

All longitudinal welds within the individual shell courses of Units 1 and 2 are electroslag welds. [Note: The Mk-57 and Mk-58 shell courses of the Quad Cities Unit 1 reactor vessel were fabricated using three individual plates, one of which was initially in two sections; thus, each of these two shell courses has four longitudinal welds.]

FIGURE 1-1.

QUAD CITIES REACTOR VESSEL
SHELL COURSE ARRANGEMENT IN CORE REGION



2. FABRICATION HISTORY

The plate material supplied for fabrication of the Quad Cities Units 1 and 2 reactor vessels was ASME SA-302, Grade B[1] high strength alloy carbon steel (modified to Code Case 1339[2]) provided by Lukens Steel. During fabrication, the individual plates in each shell course were rolled to contour; then, the plates were welded together with longitudinal seams using electroslag and submerged arc welding processes. Figures 2-1 and 2-2 and Figures 2-3 and 2-4 illustrate the plate and weld layouts for the Mk-57 and Mk-58 shell courses of Quad Cities Units 1 and 2, respectively. All electroslag welds of interest were made using Hi-Mn-Mo filler wire with Linde #124 flux.

Following assembly of each shell section, the following heat treatment was performed:

- Heat to 1675-1725°F, hold for 6.5 hours; brine quench
- Heat to 1600-1650°F, hold for 6.5 hours; brine quench
- Heat to 1175-1225°F, hold for 6.5 hours; liquid quench

The two core region shell courses (Mk-57 and -58) were fabricated by Babcock & Wilcox (B&W) for Quad Cities Unit 1 and Unit 2. The circumferential weld joining the Mk-57 shell course to the Mk-58 shell course of the Quad Cities Unit 1 reactor vessel was completed by B&W; the circumferential weld for the Quad Cities Unit 2 reactor vessel was completed by Chicago Bridge & Iron, Company (CB&I).

Although an extensive records search was completed,* very little information could be located with regard to either the specific weld materials or test results for the ES weld consumables used on the longitudinal weld seams of the core region shell courses of the Quad Cities reactor vessels. Therefore, applicable test data for weld PQs -- performed in the general time frame that the electroslag longitudinal welds in both Quad Cities units were fabricated -- have

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* Records were searched at the FTI facilities in Lynchburg, Virginia, as well as the Babcock & Wilcox facilities in Mt. Vernon, Indiana, and Barberton, Ohio, to locate all available documentation.

been included as one source of typical RT_{NDT} data for this type of weld. Copies of the weld PQs of interest are included in the Appendix. It is believed that the weld PQs included in the Appendix are the only weld PQs that are applicable to the core region shell courses welded by the electroslag welding process for the two Quad Cities units.

FIGURE 2-1.

QUAD CITIES UNIT 1
PLATE AND WELD LAYOUT FOR MK-57 SHELL COURSE

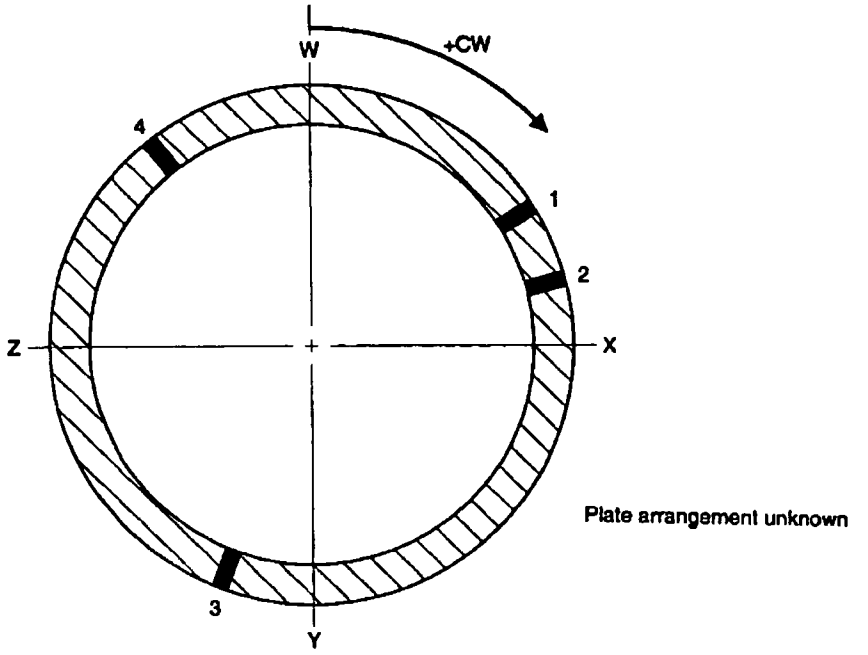

TABLE 2-1.

QUAD CITIES UNIT 1
PLATE AND WELD IDENTIFICATION FOR MK-57 SHELL COURSE

ID	Location	Wire or Plate Heat No.	Flux Lot No.	Fab.'d by
Long. seam 1 (ES)	55°	U*	U*	B&W
Long. seam 2 (ES)	77°	U*	U*	B&W
Long. seam 3 (ES)	197°	U*	U*	B&W
Long. seam 4 (ES)	317°	U*	U*	B&W
6-122-1	--	B5524-1	--	---
6-122-2	--	A0610-1	--	---
6-122-11	--	C1485-2	--	---
Mk-57 to Mk-58 circ. weld (SA)	--	72445 406L44	8688 8688	B&W

ES: Electroslag weld SA: Submerged arc weld U: Unidentified

*: Records indicated that the electroslag welds for Mk-57 were performed using the following weld wire/flux lot combinations: 0L0794/8467, 37C065/8445, 35A320/3496, and 36A168/3496. However, data for specific longitudinal seams are not identified.

FIGURE 2-2.

QUAD CITIES UNIT 1
PLATE AND WELD LAYOUT FOR MK-58 SHELL COURSE

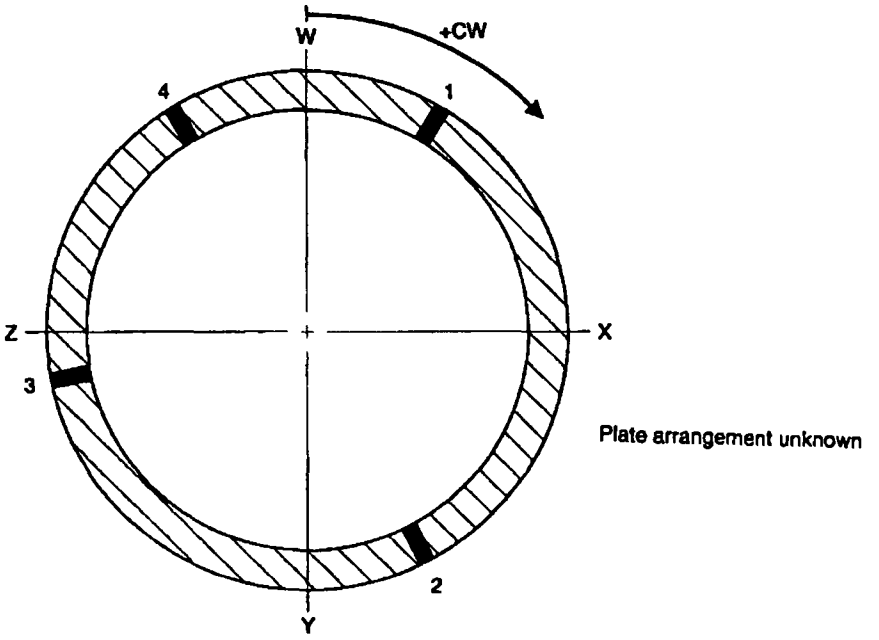

TABLE 2-2.

QUAD CITIES UNIT 1
PLATE AND WELD IDENTIFICATION FOR MK-58 SHELL COURSE

ID	Location	Wire or Plate Heat No.	Flux Lot No.	Fab.'d by
Long. seam 1 (ES)	22°	U*	U*	B&W
Long. seam 2 (ES)	141°	U*	U*	B&W
Long. seam 3 (ES)	261°	U*	U*	B&W
Long. seam 4 (ES)	323°	U*	U*	B&W
6-122-4	--	C1505-2	--	---
6-122-6	--	C1498-2	--	---
6-122-13	--	A0931-1	--	---
Mk-57 to Mk-58 circ. weld (SA)	--	72445 406L44	8688 8688	B&W

ES: Electroslag weld SA: Submerged arc weld U: Unidentified

*: Records indicated that the electroslag welds for Mk-57 were performed using the following weld wire/flux lot combinations: 0L0794/8467, 37C065/8445, 35A320/3496, and 36A168/3496. However, data for specific longitudinal seams are not identified.

FIGURE 2-3.

QUAD CITIES UNIT 2
PLATE AND WELD LAYOUT FOR MK-57 SHELL COURSE

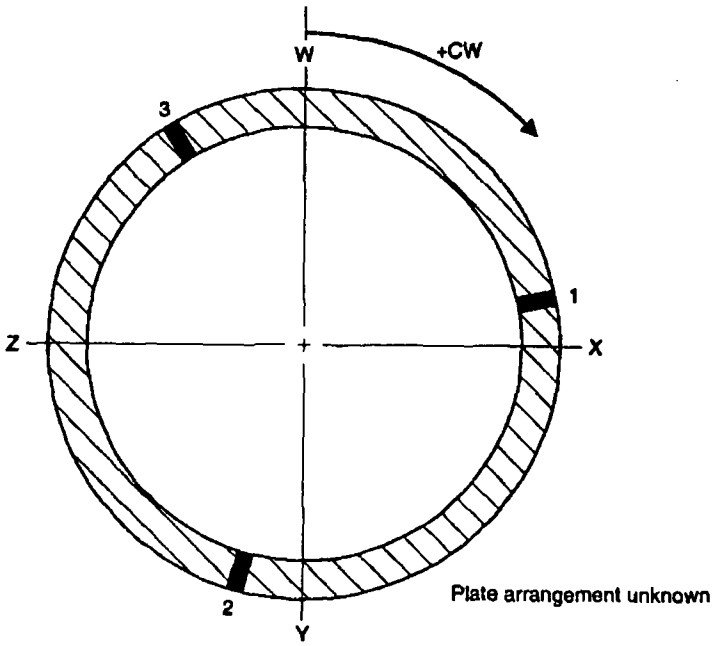

TABLE 2-3.

QUAD CITIES UNIT 2
PLATE AND WELD IDENTIFICATION FOR MK-57 SHELL COURSE

ID	Location	Wire or Plate Heat No.	Flux Lot No.	Fab.'d by
Long. seam 1 (ES)	77°	U	U	B&W
Long. seam 2 (ES)	197°	U	U	B&W
Long. seam 3 (ES)	317°	U	U	B&W
6-122-8	--	C1516-2	--	---
6-122-10	--	C1501-2	--	---
6-122-14	--	C1722-2	--	---
Mk-57 to Mk-58 circ. weld (SA)	--	S-3986	3870	CB&I

ES: Electroslag weld SA: Submerged arc weld U: Unidentified

FIGURE 2-4.

QUAD CITIES UNIT 2
PLATE AND WELD LAYOUT FOR MK-58 SHELL COURSE

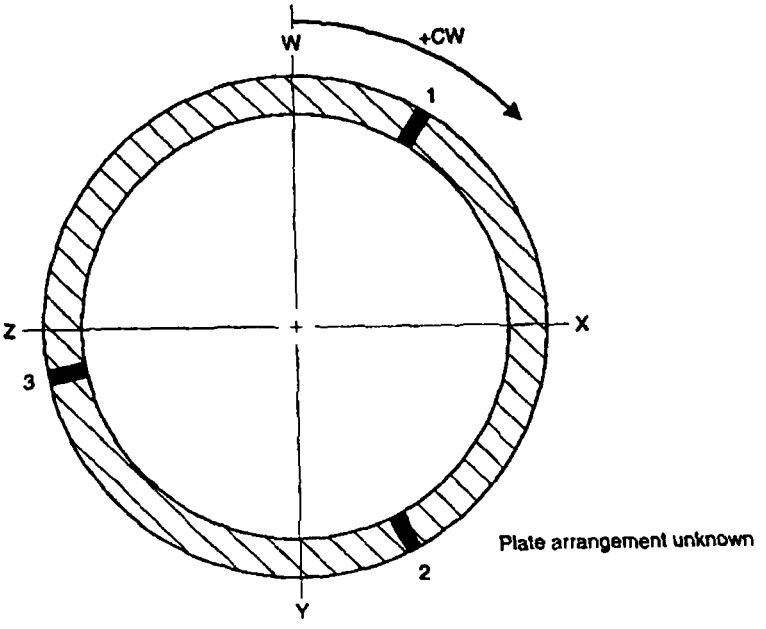

TABLE 2-4.

QUAD CITIES UNIT 2
PLATE AND WELD IDENTIFICATION FOR MK-58 SHELL COURSE

ID	Location	Wire or Plate Heat No.	Flux Lot No.	Fab.'d by
Long. seam 1 (ES)	22°	U	U	B&W
Long. seam 2 (ES)	142°	U	U	B&W
Long. seam 3 (ES)	262°	U	U	B&W
6-139-16	--	C2753-2	--	---
6-139-22	--	C2868-1	--	---
6-139-25	--	C3307-2	--	---
Mk-57 to Mk-58 circ. weld (SA)	--	S-3986	3870	CB&I

ES: Electroslag weld SA: Submerged arc weld U: Unidentified

3. RT_{NDT}, CvUSE, AND CHEMICAL COMPOSITION

Both mechanical property and chemical composition data are lacking on electroslag welds for Quad Cities Units 1 and 2. For this reason, the available data discussed in this report are based primarily on weld PQs and known weld wire chemistry data. Weld PQs contain mechanical properties and, usually, chemical composition data as well. While this data cannot represent actual reactor vessel welds exactly, the procedures, consumables (i.e., weld wire and flux), and thickness of the welded plates are similar to the actual welds. Generally, weld amperage, voltage, and oscillation speeds are equivalent or similar for the PQs. Although the welding procedures are similar, an accumulated thermal history is not available for the beltline reactor vessel welds at Quad Cities Unit 1. For Unit 2, however, CB&I has reported that the Mk-57 and Mk-58 shell courses received the following accumulated post weld heat treatment:*

Mk-57	27 hours, 56 minutes
Mk-58	44 hours, 22 minutes.

Stress relief heat treatments were completed at temperatures in the range of 1100 to 1150°F.

3.1 RT_{NDT} Determination

The electroslag weld PQs included in this document contain Charpy impact data as well as respective stress relief times implemented for each weld PQ. As shown by the data in Table I below, stress relief heat treatments were typically performed for either 18 or 30 hours; one weld PQ had a stress relief time of 42 hours. The weld PQs for the electroslag welds in Quad Cities Units 1 and 2 used a RACO (Reid Avery Company) Hi-Mn-Mo weld wire and a Linde #124 flux; therefore, only data from weld PQs using this same RACO wire/flux combination are included. The Charpy V-notch impact data are reported for tests completed at 10°F using a load of 240 ft-lbs.

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* As reported in Attachment B to the CECo response to Generic Letter 92-01 for Dresden Units 2 and 3 and Quad Cities Units 1 and 2.[3]

TABLE I

Charpy V-Notch Impact Data for Electroslag Weld PQs

Weld PQ	Charpy Data	Drop Wt. T_{NDT} (°F)	Stress Relief Time
PQ-1092-C	38 33 41	--	18
PQ-1138-A	52 30 50 (Surf)	--	18
	30 53 36 (1/4T)	10	
PQ-1300	39 42 43	--	30
PQ-1309-A	60 50 35	--	18
PQ-1309-B	58 36 44	--	18
PQ-1667	47 39 27	--	30
PQ-1822	36 70 42	30	30
	64 45		
PQ-1851	84 71 57	10	30
PQ-1928	30 33 33	25	30
PQ-1929	80 40 55	50	30
PQ-1930	10 72 70	30	30
	75 16 14		
	39		
PQ-1931	47 24 33	20	30
	57 50		
PQ-2563	59 47 49 (Surf)	--	42
	27 34 32 (1/4T)	10	

From a statistical standpoint, the above Charpy data are sufficiently close with regard to Charpy impact behavior that the values can be considered as one group of data. Therefore, all drop weight data identified above are equally weighted in the calculation for initial RT_{NDT} discussed below.

No drop weight specimens were tested for the Quad Cities Units 1 and 2 surveillance electroslag weld metals, nor were any tested for the electroslag welds at other plants fabricated using the same RACO weld/flux combination as the Quad Cities units. The surveillance electroslag weld Charpy impact data that are available, however, are shown below in Table IIA.

TABLE IIA

Charpy V-Notch Data for Surveillance Electroslag Weld Metal[4-11]

Plant ID	T_{CV30}	T_{CV50}	T_{35MLE}	USE
Quad Cities Unit 1	10°F	35°F	25°F	>100 ft-lbs
Quad Cities Unit 2	-30°F	20°F	- 5°F	125 ft-lbs
Browns Ferry Unit 1	8°F	33°F	20°F	93 ft-lbs
Browns Ferry Unit 2	-10°F	10°F	- 2°F	116 ft-lbs
Browns Ferry Unit 3	-31°F	-21°F	-27°F	124 ft-lbs
Dresden Unit 2	-10°F	40°F	5°F*	101 ft-lbs
Dresden Unit 3	40°F	110°F	65°F	70 ft-lbs
Peach Bottom Unit 2	4°F	43°F	27°F	110 ft-lbs
Peach Bottom Unit 3	2°F	47°F	34°F	110 ft-lbs

[* Conservatively estimated based on data from Capsule No. 8,[9] since value was not determined for unirradiated ESW surveillance material.]

The following Charpy impact data are also available for electroslag welds tested for the Peach Bottom Unit 2 surveillance program to determine an initial RT_{NDT} value representative of the electroslag welds:

TABLE IIB

Electroslag Weld Test Data[10]

Test Weld ID	T_{Cv50}	Test Weld ID	T_{Cv50}
1	18.8	6	-20.7
2	3.0	7	15.9
3	31.7	8	12.5
4	32.1	9	18.9
5	26.7		

As defined in the ASME Code, Paragraph NB-2331,[12] the RT_{NDT} is established in accordance with the following requirements:

1. Determine a temperature, T_{NDT}, that is at or above the nil-ductility transition temperature by drop weight tests.

2. At a temperature not greater than T_{NDT} + 60°F, each Charpy specimen shall exhibit at least 50 ft-lbs absorbed energy and at least 35 mils lateral expansion. If these requirements are met, T_{NDT} is the RT_{NDT}.

3. If the requirements of 2. are not met, additional Charpy tests shall be performed (in groups of three specimens) to determine the temperature, T_{Cv}, at which they are met. Then, RT_{NDT} is (T_{Cv} - 60°F). RT_{NDT} is the greater of T_{NDT} and (T_{Cv} - 60°F).

4. When a Charpy test has not been performed at T_{NDT} + 60°F, or when a Charpy test is performed at T_{NDT} + 60°F and the specimens do not exhibit a minimum of 50 ft-lb absorbed energy and 35 mils lateral expansion, a temperature representing these minimum requirements may be obtained from a full Charpy curve developed from the minimum of Charpy data of all tests performed.

Using the weld PQ T_{NDT} data and the available surveillance Charpy impact data for the electroslag welds, the RT_{NDT} is controlled by the T_{NDT} requirement. Based on these data, the initial RT_{NDT} for the electroslag welds in Quad Cities Units 1 and 2 is calculated using the T_{NDT} data reported in the weld PQs. The T_{NDT} values range from 10 to 50°F. Taking the mean of these values results in an estimated initial RT_{NDT} value of 23.1°F for the electroslag welds, with a standard deviation (σ_i) of 13.0°F.

3.2 CvUSE Determination

The initial CvUSE data for electroslag welds were obtained from available surveillance data and are presented in Table IIA. The unirradiated CvUSE values range from 70 to 125 ft-lbs. Taking the mean of these values results in an estimated initial CvUSE value of 105.4 ft-lbs for the electroslag welds, with a standard deviation of 16.1 ft-lbs.

3.3 Weld Compositions (Cu, Ni, and P)

Electroslag weld chemical composition data (in weight percent [w/o]) are available from three different sources: weld PQs, weld wire compositions, and surveillance capsule specimens.

As shown in Tables III through VI, each group is similar in its own respect. In evaluating the data, the average weld compositions (and standard deviations) were calculated using only the data from the weld PQs and surveillance capsule specimens since this weld data is believed to be more representative of the actual (longitudinal) electroslag welds located in the reactor vessel shell courses. The weld wire composition data were not included in these calculations.

TABLE III

Procedure Qualification Chemical Composition Data

Weld PQ	C	Mn	P	S	Si	Cr	Ni	Mo	Cu
PQ-1092-C	0.20	1.28	0.017	0.018	0.18	0.08	0.31	0.53	0.24
PQ-1138-A	0.19	1.50	0.017	0.027	0.19	0.09	0.35	0.55	0.25
PQ-1300	0.18	1.26	0.015	0.017	0.16	0.11	0.33	0.51	0.30
PQ-1309-A	0.18	1.34	0.012	0.017	0.14	0.10	0.30	0.47	0.22
PQ-1309-B	0.17	1.31	0.015	0.015	0.14	0.12	0.29	0.51	0.23
PQ-1667	0.19	1.41	0.019	0.015	0.07	0.06	0.25	0.57	0.20
PQ-1822	0.19	1.40	0.015	0.015	0.14	0.09	0.27	0.54	0.23
PQ-1851	0.18	1.49	0.014	0.011	0.15	0.06	0.36	0.49	0.18
PQ-1928	0.19	1.49	0.016	0.014	0.16	0.06	0.38	0.55	0.19
PQ-1929	0.18	1.50	0.016	0.013	0.17	0.08	0.30	0.48	0.20
PQ-1930	0.16	1.52	0.012	0.014	0.15	0.07	0.26	0.51	0.20
PQ-1931	0.20	1.52	0.015	0.021	0.12	0.05	0.38	0.59	0.19

TABLE IV

Weld Consumables Chemical Composition Data

Wire ID	C	Mn	P	S	Si	Cr	Ni	Mo	Cu
W-8349	0.14	1.79	0.010	0.012	0.04	--	--	0.47	--
34A167	0.14	1.76	0.010	0.014	0.04	--	--	0.49	--
36A168	0.12	1.70	0.010	0.019	0.03	--	--	0.52	--

TABLE V

Surveillance and Beltline Weld Chemical Composition Data[13-17]

Specimen & Plant ID	C	Mn	P	S	Si	Cr	Ni	Mo	Cu
MA1 QC1[a,13*]	0.17	1.56	0.011	0.017	0.19	0.06	0.28	0.45	0.17
TD1 QC2[b,13]	0.18	1.75	0.011	0.013	0.17	0.09	0.20	0.49	0.18
MA4 QC1[a,14]	0.158	--	0.012	0.006	0.05	0.063	0.25	0.45	0.136
	--	--	--	--	--	--	0.26	--	0.19
MAD QC1[a,14]	0.236	--	0.012	0.004	0.08	0.063	0.26	0.45	0.138
	--	--	--	--	--	--	0.38	--	0.19
M7L QC1[a,14]	--	--	--	--	--	--	0.30	--	0.20
MBU QC1[a,14]	--	--	--	--	--	--	0.33	--	0.24
M6D QC1[a,14]	--	--	--	--	--	--	0.39	--	0.16
MDC QC1[a,14]	--	--	--	--	--	--	0.40	--	0.21
MD4 QC1[a,14]	--	--	--	--	--	--	0.33	--	0.19
MBY QC1[a,14]	--	--	--	--	--	--	0.40	--	0.21
TAE QC2[b,15]	0.209	--	0.008	0.017	0.115	0.079	0.313	0.503	0.129
							0.32		0.14
TAT QC2[b,15]	0.216	--	0.008	0.018	0.126	0.091	0.359	0.522	0.122
							0.33		0.16
TBP QC2[b,15]	--	--	--	--	--	--	0.34	--	0.16
TB1 QC2[b,15]	--	--	--	--	--	--	0.37	--	0.17
T6K QC2[b,15]	--	--	--	--	--	--	0.39	--	0.17
TBM QC2[b,15]	--	--	--	--	--	--	0.37	--	0.17
T72 QC2[b,15]	--	--	--	--	--	--	0.41	--	0.20
TAP QC2[b,15]	--	--	--	--	--	--	0.32	--	0.12

* Number designates reference from which data was taken.

TABLE V (cont.)

Specimen & Plant ID	C	Mn	P	S	Si	Cr	Ni	Mo	Cu
ESW Weld D3[c,18]	0.21	1.78	0.011	0.015	0.32	0.07	0.30	0.51	0.20
KAE D3[c,17]	0.220	–	0.009	0.016	0.176	0.064	0.332	0.550	0.191
	–	–	–	–	–	–	–	–	0.29
KAL D3[c,17]	0.197	–	0.008	0.019	0.144	0.056	0.282	0.520	0.171
	–	–	–	–	–	–	0.33	–	0.18
K6L D3[c,17]	–	–	–	–	–	–	0.41	–	0.24
K6A D3[c,17]	–	–	–	–	–	–	0.38	–	0.23
KBM D3[c,17]	–	–	–	–	–	–	0.36	–	0.22
K6T D3[c,17]	–	–	–	–	–	–	0.38	–	0.19
KAJ D3[c,17]	–	–	–	–	–	–	0.34	–	0.21
KAD D3[c,17]	–	–	–	–	–	–	0.34	–	0.21
Peach Bottom 2,3[d,e]	0.17	1.41	0.015	0.013	0.09	0.05	0.21	0.53	0.21

[a] Quad Cities Unit 1

[b] Quad Cities Unit 2

[c] Dresden Unit 3.

[d] Beltline weld data

[e] Based on nine electroslag weld prolongations from the Peach Bottom Unit 2 reactor vessel; all were made from the same weld heat.

It should be noted that the data taken from References 14, 15, and 17 were not included in these calculations as individual data points; instead, the mean values of these data were determined and included in the calculations for Quad Cities Units 1 and 2. Additional data is listed below for the surveillance electroslag welds for Browns Ferry Units 1, 2, and 3 and Peach Bottom Units 2 and 3.

TABLE VI

Surveillance Electroslag Weld Data[6,10,11]

Plant ID	C	Mn	P	S	Si	Cr	Ni	Mo	Cu
Browns Ferry 1	--	--	0.012	--	--	--	0.30	--	0.10
Browns Ferry 2	--	--	0.010	--	--	--	0.33	--	0.20
Browns Ferry 3	--	--	0.011	--	--	--	0.28	--	0.11
Peach Bottom 2	--	1.43	0.010	--	--	0.08	0.32	0.49	0.09
Peach Bottom 3	--	1.46	0.012	--	--	0.08	0.32	0.49	0.10
	--	1.55	0.009	--	0.19	--	0.40	0.50	0.11
	--	1.57	0.009	--	0.19	--	0.41	0.51	0.11

The compositional data for the weld PQs; the surveillance weld data for Dresden Unit 3 and Quad Cities Units 1 and 2; and the beltline and surveillance weld data for the Browns Ferry and Peach Bottom units were averaged to determine estimated values for copper, nickel, and phosphorus contents for the ES welds at Quad Cities Units 1 and 2. The results are as follows:

Element	Content (w/o)	Std. Deviation w/o
Copper	0.190	0.048
Nickel	0.311	0.051
Phosphorus	0.013	0.003

Applying these best estimate chemistry values to the Position C.1 procedures of Regulatory Guide 1.99, Revision 2,[18] a chemistry factor of 114.43 is calculated for the Quad Cities Units 1 and 2 longitudinal electroslag welds.

4. CERTIFICATION

This report provides justifiable estimates for initial RT_{NDT} and chemical composition (copper, nickel, and phosphorus) for the longitudinal electroslag welds in the core region of the Quad Cities Units 1 and 2 reactor vessels.

C.A. Campbell 1/10/96
C.A. Campbell Date
Materials and Structural Analysis

This report was reviewed and was found to be an accurate assessment of the work reported.

M.J. DeVan 1/15/96
M.J. DeVan Date
Materials and Structural Analysis

Verification of independent review.

K.E. Moore 1-15-96
K.E. Moore, Manager Date
Materials and Structural Analysis

The document has been approved for release.

D.L. Howell 1/15/96
D.L. Howell, Program Manager Date

5. REFERENCES

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2. ASME Boiler and Pressure Vessel Code, "Code Cases," American Society of Mechanical Engineers, New York, New York.

3. Letter and Attachments from Marcia A. Jackson, Commonwealth Edison Company, to Dr. Thomas E. Murley, U.S.NRC, Subject: Dresden Station Units 2 and 3, NRC Docket Numbers 50-237/249; Quad Cities Station Units 1 and 2, NRC Docket Numbers 50-254/265; LaSalle County Station Units 1 and 2, NRC Docket Numbers 50-373/374. (Response to Generic Letter 92-01.) Dated July 1, 1992.

4. Yanichko, S.E., et al., "Analysis of the Third Capsule from the Commonwealth Edison Company Quad Cities Unit 1 Nuclear Plant Reactor Vessel Radiation Surveillance Program," WCAP-9920, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania, August 1981.

5. Perrin, J.S., et al., "Quad Cities Nuclear Plant Unit No. 2 Reactor Pressure Vessel Surveillance Program: Capsule Basket No. 12 and Capsule Basket No. 13, Battelle Columbus Laboratories, Columbus, Ohio, September 19, 1975.

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14. Norris, E.B., "Quad Cities Nuclear Power Station Unit 1 Reactor Vessel Irradiation Surveillance Program -- Analysis of Capsule No. 8," SwRI-7857, Southwest Research Institute, San Antonio, Texas, August 1984.

15. Norris, E.B., "Quad Cities Nuclear Power Station Unit 2 Reactor Vessel Irradiation Surveillance Program -- Analysis of Capsule No. 18," SwRI-7484-002/1, Southwest Research Institute, San Antonio, Texas, March 1984.

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APPENDIX

Electroslag Procedure

Qualifications

M 501-2

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

ECORD OF PROCEDURE OR OPERATOR QUALIFICATION TEST QCD 2E4-122

JOB NO.	DATE	PROCEDURE NO.
610-v098 Initial Application	10-14-65	PQ-1092C-2 W-182-3 WS-40

WELDING PROCESS	SINGLE PASS	MULTIPLE PASS	MULTIPLE ARC
Electroslag	[X] Double Electrode	[ ]	[ ]

MATERIAL SPECIFICATION: P-3 (A-302-B Mod)

PLATE	PIPE	METAL THICKNESS	FILLER METAL GROUP NO.	WELD CLASSIFICATION NO.
[X]	[ ]	6-1/4"	Reid Avery Hi-Mn-Mo	Pressure

BACKING STRIP USED	PRE HEAT TEMPERATURE	INTER PASS TEMPERATURE	FLUX NAME OR COMPOSITION
[ ] YES [X] NO	70°F Min.	Not Applicable	Linde #124 20 X 150

WELD CHARACTERISTICS (VOLTS) (A.C. OR D.C.): Alternating Current 48-52 Volts 600 Amps

GAS FLOW RATE	POSITION OF PLATE OR PIPE	ULTRASONIC TEST	LIQUID PENETRANT
Not Applicable	Vertical	Acceptable/No Defects	Not Applicable

MAGNETIC PARTICLE	RADIOGRAPH	MACRO EXAMINATION	MICRO EXAMINATION	POST HEAT TREATMENT
Acceptable/No Defects	No Acceptable/Defects	Not Required	Not Required	See Attached Sketch

SIZE OF ELECTRODE	INERT GAS COMPOSITION	TRAVEL SPEED INCHES PER MIN.
1/8" Dia.	Not Applicable	Oscillation Speed 48"/Min. Dwell Time 5 Sec

WELDERS NAME	CLOCK NO.	SYMBOL
R. Reese	6136	None

REMARKS: Procedure qualification for welding P-3 material in the vertical position by electroslag process using 1/8" Dia. (RACO) Hi-Mn-Mo filler wire with Linde #124 flux.
(Groove Configuration Attached)

WELD CHEMICAL ANALYSIS

	MN	SI	P	S	Cr	NI	MO	CU		
				Not Required						

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS WIDTH	DIMENSIONS THICK.	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULT. TENSILE STRENGTH PSI	FRACTURE OR LOCATION
			See Attached Sketch			

SIDE BEND TEST	FREE BEND TEST
Four Side Bends - Acceptable (No Defects)	Not Required

ALL WELD METAL TENSILE

SPECIMEN NO.	DIA.	AREA SQ. IN.	YIELD POINT PSI.	TENS. STR. PSI	ELONG % IN 2"	RED AREA %
			Not Required			

CHARPY IMPACT TESTS — TYPE _____ @ _____ °F _____ FT. LBS. ENERGY LOAD

SPECIMEN NO.	FT. LBS.	SPECIMEN NO.	FT. LBS.
	See Attached Sketch		

WE CERTIFY THAT THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED WELDED, AND TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF ASME, U.S.C.G.; ABS; USN MIL-STD-278 OR NAVSHIPS 250-1500-1.

PQ-1092C-2

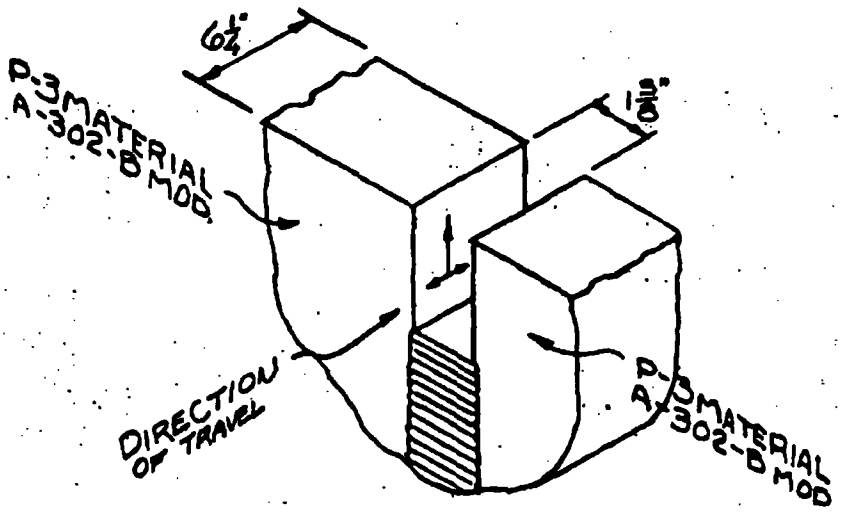
DATE 10-28-65 SIGNED

WITNESSED C. Zenon, D.C.A.S.O

BABCOCK & WILCOX COMPANY

BY Paul E Campbell

Code #235



ELECTROSLAG DOUBLE ELECTRODE WELD A.C.
48-52 VOLTS 600 AMPS OSCILLATION SPEED 48"/MIN. DWELL TIME 5 S.
⅛" DIA. (RACO) HI-MN-MO FILLER WIRE - LINDE* 124 FLUX

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO	DIMENSIONS		AREA	ULTIMATE	ULT. TENSILE	FRACTURE
	WIDTH	THICK	SQ. IN.	LOAD LBS	STRENGTH PSI.	
PQ1092C-2	1.000"	3.060"	3.060"	284,500	92,960	WELD
PQ1092C-2	1.000"	2.732"	2.732	251,000	91,880	WELD
PQ1092C-2	1.007"	2.829"	2.848	266,000	93,400	WELD
PQ1092C-2	1.006"	3.092"	3.092	285,000	92,170	WELD

CHARPY V-NOTCH IMPACTS @+10°F 240 FT LBS

LOCATION	FT LBS	FT LBS	FT LBS
BASE METAL	60.0	70.0	63.0
HEAT AFFECTED ZONE	40.0	52.0	70.0
WELD METAL	38.0	33.0	41.0

HEAT TREATMENT

PRELIMINARY QUENCH 6½ HOURS @1675°-1725°F BRINE QUENCH
FINAL QUENCH 6½ HOURS @ 1600°-1650°F BRINE QUENCH
TEMPER 6½ HOURS @ 1175°F-1225°F WATER QUENCH
STRESS RELIEF 18 HRS @ 1100°-1150°F FURNACE COOL

PQ 1092 C-2
WELDED IN VERTICAL POSITION.
DATE 11-2-65

)-30356

CORD OF TEST RESULTS

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

JECT	CUSTOMER General Electric Atomic Power Equipment Department
ASME Code Weld Test Plate (Electro Slag)	CUSTOMER ORDER NO. 205-55501

T NO..	ASSOCIATED PROCESS QUALIFICATION NO.	B&W CONTRACT NO.
-1138-A	PQ-1092 C-2	510-0098

SCRIPTION OF TEST Postweld - Heat Treatment - Preliminary Quench 1750-1800°F. HOLD 6-1/2 hours. Quench to below 400°F. Final Quench 1600-1650°F. HOLD 6-1/2 hours. Brine Quench to below Temper 1175-1225°F. HOLD 6-1/2 hours. Water Quench to below 400°F. Stress Relieve -1150°F. HOLD 18 hours. Furnace cool to below 600°F.

WELD CHEMICAL ANALYSIS

C	Mn	Si	P	S	Cr	Ni	Mo	Cu		
	1.50	.19	.017	.027	.09	.35	.55	.25		

BASE METAL CHEMICAL ANALYSIS

C	Mn	Si	P	S	Cr	Ni	Mo	Cu		
	1.37	.28	.015	.020	.14	.69	.51	.24		

ND TEST: TYPE Side NUMBER 4 RESULTS Satisfactory

DUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMAN NO.	WIDTH	THICKNESS	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULT. TENSILE STRENGTH PSI	LOCATION OF FRACTURE
-A	1.001"	2.934"	2.936 sq "	252,000	85,820	Weld
-A	1.001"	2.944"	2.947 sq "	262,000	88,900	Weld
-A	1.000"	2.682"	2.682 sq "	244,500	91,160	Weld
-A	1.000"	2.850"	2.850 sq "	250,000	87,700	Weld

L WELD METAL TENSILE

SPECIMAN NO.	DIAMETER	AREA SQ. IN.	YIELD POINT PSI	TENSILE STRENGTH PSI	E LONG % IN. 2"	RED AREA %
-A	.505"	.2 sq in	66,500	87,500	25.0	60.6
-A	.504"	.2 sq in	66,500	87,000	25.5	60.7

HARPY IMPACT TESTS

TYPE V-Notch AT +10 °F 240 FT. LBS. ENERGY LOAD.

LOCATION	FT. LBS.	LATERAL EXPANSION
Weld Surface	52.0, 30.0, 50.0	.044, .031, .041
Weld 1/4 T	30.0, 53.0, 36.0	.023, .046, .029
1/4 T Base Metal	64.0, 58.0, 70.0	.042, .041, .053
1/4 T HAZ	76.0, 68.0, 76.0	.052, .047, .051

DROP WEIGHT IMPACT TESTS

LOCATION	HEIGHT	WEIGHT
Weld 1/4T	4'	60#
Base Metal 1/4T	4'	60#
HAZ 1/4T	4'	60#

TEMPERATURE °F

+20	+10	0	-20	-40	-50	-60	-70	-80
F,NF	F	F	F					
NF			NF	NF,NF	NF,F	F		
NF			NF			F,NF	F,NF	F

F = FAILURE NF = NO FAILURE

DATE January 24, 1966 WITNESSED _____ BY Paul F Campbell
THE BABCOCK & WILCOX COMPANY

BDM 501-2

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

RECORD OF PROCEDURE OR OPERATOR QUALIFICATION TEST QCD 2E4-122

TED JOB NO.	DATE	PROCEDURE NO.
610-0111 INITIAL APPLICATION	5-26-66	PQ-1300 WS-40

WELDING PROCESS	SINGLE Pass	MULTIPLE PASS	MULTIPLE ARC
Electroslag	[X] Double Arc	[ ]	[ ]

MATERIAL SPECIFICATION: P-3 (SA-302, Grade B)

PLATE	PIPE	METAL THICKNESS	FILLER METAL GROUP NO.	WELD CLASSIFICATION NO
[X]	[ ]	6-3/8"	RACO Hi-Mn-Mo	Pressure

IS BACKING STRIP USED	PRE HEAT TEMPERATURE	INTER PASS TEMPERATURE	FLUX NAME OR COMPOSITION
[ ] YES [X] NO	70°F. MIN.	Not Applicable	LINDE #124

WELD CHARACTERISTICS (V&A) (A.C. OR D.C.): Alternating Current 48-52 Volts 575-625 Amps

GAS FLOW RATE	POSITION OF PLATE OR PIPE	ULTRASONIC TEST	LIQUID PENETRANT
Not Applicable	Vertical	Acceptable/No Defects	Not Applicable

MAGNETIC PARTICLE	RADIOGRAPH	MACRO EXAMINATION	MICRO EXAMINATION	POST HEAT TREATMENT
Acceptable/No Defects	No Acceptable/Defects	Acceptable	Not Required	See Reverse Side

SIZE OF ELECTRODE	INERT GAS COMPOSITION	TRAVEL SPEED INCHES PER MIN.
1/8" Diameter	Not Applicable	Not Applicable Oscillation 48"/MIN. Dwell Time 5 sec

WELDERS NAME	CLOCK NO.	SYMBOL
R. Reese	----------	----------

REMARKS: Procedure qualification for welding P-3 material in the vertical position by Electroslag process using 1/8" Dia. (RACO Hi-Mn-Mo Filler Wire with LINDE #124 Flux. See Reverse Side for Groove Configuration.

WELD CHEMICAL ANALYSIS

	MN	SI	P	S	Cr	Ni	Mo	Cu	
	1.26	.16	.015	.017	.11	.33	.51	.30	

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS WIDTH	DIMENSIONS THICK.	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULT. TENSILE STRENGTH PSI	FRACTURE OR LOCATION
		See Reverse Side				

SIDE BEND TEST	FREE BEND TEST
Four Side Bends - Acceptable/No Defects	Not Applicable

ALL WELD METAL TENSILE

SPECIMEN NO.	DIA.	AREA-SQ. IN.	YIELD POINT PSI.	TENS. STR. PSI	ELONG % IN 2"	RED AREA %
			Not Required			

CHARPY IMPACT TESTS — TYPE V-Notch @ 10 °F 240 FT. LBS. ENERGY LOAD

LOCATION	FT. LBS.	LOCATION	FT. LBS.
Heat Affeced Zone	104.0, 76.0, 114.0	Weld Metal	39.0, 42.0, 43.0
Base Metal	94.0, 76.0, 82.0		

WE CERTIFY THAT THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED WELDED, AND TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF ASME, U.S.C.G.; ABS; USN MIL-STD-278 OR NAVSHIPS 250-1500-1.

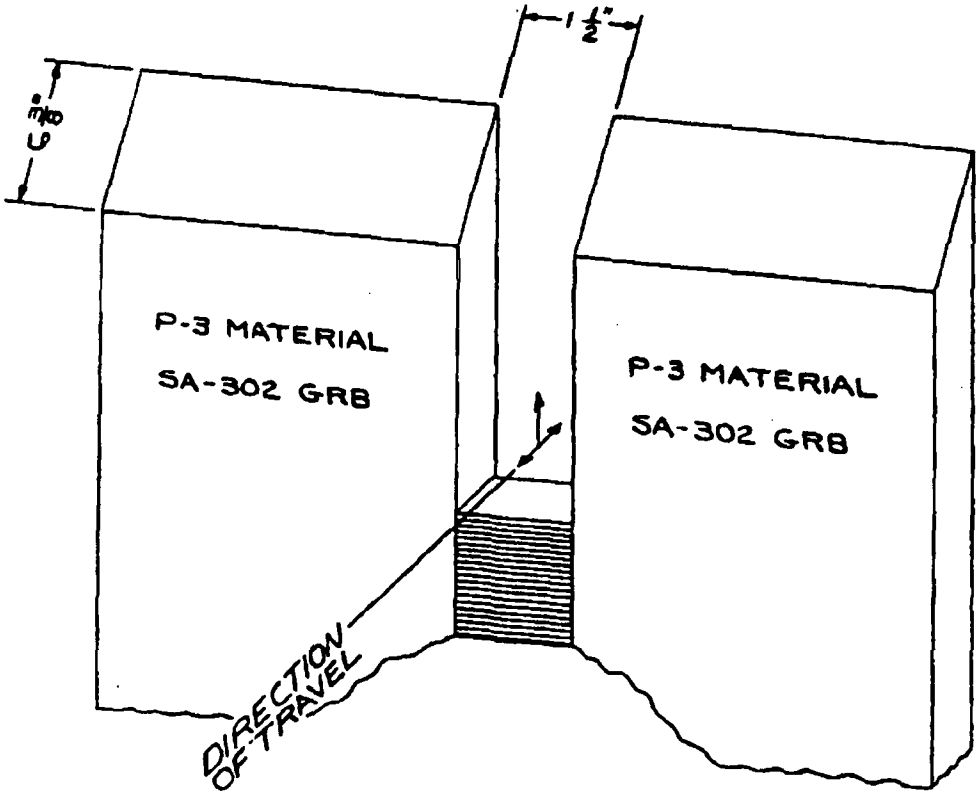
PQ-1300
235

October 17, 1966 SIGNED

BABCOCK & WILCOX COMPANY

WITNESSED R. Remark, D. C. A. S. O.

BY Paul E Campbell



ELECTROSLAG WELD A.C. 48-52 VOLTS 575-625 AMPS
4 3/4" MIN OSCILLATION SPEED 5 SEC DWELL TIME
1/8 DIA (RACO) HI-MN-MO FILLER WIRE WITH LINDE #124 FLUX

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS		AREA SQ. IN.	UTIMATE LOAD LBS.	ULT. TENSILE STR. P.S.I.	FRACTURE
	WIDTH	THICK.				
PQ1300	1.007"	3.175"	3.197"	266,000	83,200	WELD
PQ1300	1.001"	2.785"	2.788"	237,000	84,980	WELD
PQ1300	.992"	2.956"	2.932"	236,000	80,500	WELD
PQ1300	1.008"	3.937"	3.968"	332,000	83,660	WELD

HEAT TREATMENT
6 1/2 HRS @ 1675°-1725°F - BRINE QUENCH
6 1/2 HRS @ 1600°-1650°F - BRINE QUENCH
6 1/2 HRS @ 1175°-1225°F - LIQUID QUENCH
30 HRS @ 1100°-1150°F - FURNACE COOL

PQ1300
WELD IN VERTICAL POSITION
10-22-66

BDM 501-2

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

RECORD OF PROCEDURE OR OPERATOR QUALIFICATION TEST QCD 2E4-122

ASSOCIATED JOB NO.	DATE	PROCEDURE NO.
610-0098 INITIAL APPLICATION	6-7-66	PQ-1309-A

WELDING PROCESS	SINGLE PASS	MULTIPLE PASS	MULTIPLE ARC
Electroslag and Automatic Submerged Arc	[X] Double Arc	[ ]	[ ]

MATERIAL SPECIFICATION: P-3 (A-302-B)

PLATE	PIPE	METAL THICKNESS	FILLER METAL GROUP NO.	WELD CLASSIFICATION NO
[X]	[ ]	6-1/4"	RACO Hi-Mn-Mo & ASW Mn-Mo-Ni	Pressure

IS BACKING STRIP USED	PRE HEAT TEMPERATURE	INTER PASS TEMPERATURE	FLUX NAME OR COMPOSITION
[ ] YES [X] NO	ES 70°F MIN-ASA 300°F MIN.	ES - Not Applicable ASA - 500°F. Max.	Electroslag LINDE # Auto Sub Arc LINDE #

WELD CHARACTERISTICS (V&A)	(A.C. OR D.C.)	
Alternating Current	Electroslag 48-52 Volts	600 Amps
	Automatic Submerged Arc 30-34 Volts	450-500 Amps

GAS FLOW RATE	POSITION OF PLATE OR PIPE	ULTRASONIC TEST	LIQUID PENETRANT
Not Applicable	ES-Vertical ASA-Flat	Acceptable/No Defects	Not Applicable

MAGNETIC PARTICLE	RADIOGRAPH	MACRO EXAMINATION	MICRO EXAMINATION	POST HEAT TREATMENT
Acceptable/No Defects	No Acceptable/Defects	Not Required	Not Required	See Reverse Side

SIZE OF ELECTRODE	INERT GAS COMPOSITION	
1/8" Diameter	Not Applicable	Travel Speed Inches Per Min. ASA - 10" - 12" /MIN. ES Oscillation 48"/MIN. Dwell Time 5 sec.

WELDERS NAME	CLOCK NO.	SYMBOL
R. Reese - T. Starnes - V. Clonts	6136 - 6376 - 6149	None - YS - U-11

REMARKS: Procedure qualification for welding P-3 material by Combination Electroslag and Automatic Submerged Arc process. Electroslag weld in the vertical position using 1/8"Dia. (RACO)Hi-Mn-Mo Filler Wire with LINDE #124 Flux. Auto Sub Arc in the flat position using 1/8"Dia. (ASW)Mn-Mo-Ni Filler with LINDE #80 Flux.

WELD CHEMICAL ANALYSIS See Reverse Side-Groove Configuration

C	MN	SI	P	S	Cr	Ni	Mo	Cu	
				See Reverse Side					

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS WIDTH	DIMENSIONS THICK.	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULT. TENSILE STRENGTH PSI	FRACTURE OR LOCATION
			See Reverse Side			

SIDE BEND TEST	FREE BEND TEST
Four Side Bends - Acceptable/No Defects	Not Required

ALL WELD METAL TENSILE

SPECIMEN NO.	DIA.	AREA SQ. IN.	YIELD POINT PSI.	TENS. STR. PSI	ELONG % IN 2"	RED AREA
			Not Required			

CHARPY IMPACT TESTS	TYPE V-Notch @ +10 °F 240 FT. LBS. ENERGY LOAD		
SPECIMEN NO.	FT. LBS.	SPECIMEN NO.	FT. LBS.
	See Reverse Side		

WE CERTIFY THAT THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED WELDED, AND TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF ASME, U.S.C.G., ABS, USN MIL-STD-278 OR NAVSHIPS 250-1500-1.

PQ-1309-A

275

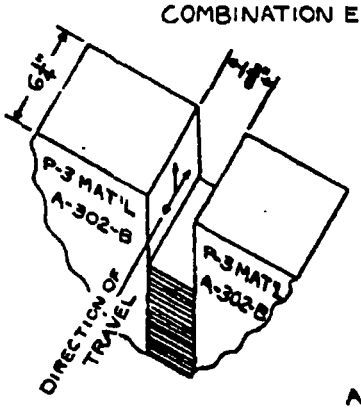
June 23, 1966 SIGNED

BABCOCK & WILCOX COMPANY

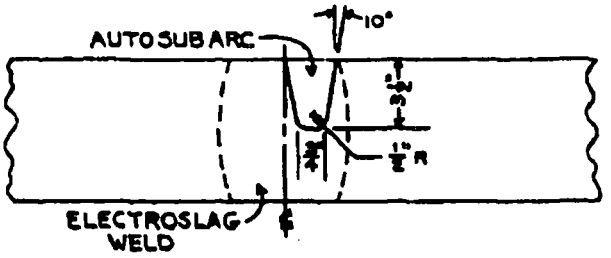
WITNESSED R. Y. Brown, G. E. APED

BY Paul E Campbell

COMBINATION ELECTROSLAG & AUTO SUB ARC WELD



DOUBLE ARC ELECTROSLAG WELD
A.C. 48-52 VOLTS 600 AMPS
OSCILLATION SPEED 48"/MIN DWELL TIME 5 SEC
⅛" DIA (RACO) HI-MN-MO FILLER WIRE
LINDE * 124 FLUX



AUTOMATIC SUBMERGED ARC WELD
A.C. 30-34 VOLTS 450-500 AMPS 10"-12"/MIN TRAVEL SPEED
⅛" DIA (AMERICAN STEEL & WIRE) MN-MO-NI FILLER WIRE-LINDE * 80 FLUX

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS WIDTH	DIMENSIONS THICK	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULT TENSILE STRENGTH PS.I	FRACTURE
PQ1309A	1.000"	2.980"	2.980	253,000	84,900	SLAG WELD
PQ1309A	1.000"	2.510"	2.510	217,500	86,660	SLAG WELD
PQ1309A	1.001"	3.009"	3.010	255,000	84,720	SLAG WELD
PQ1309A	.998"	2.506"	2.501	220,000	87,960	SLAG WELD

CHARPY U-NOTCH IMPACTS @ +10°F 240 FT. LBS. ENERGY LOAD

LOCATION	FT. LBS.	FT. LBS.	FT. LBS.
AUTO SUB ARC WELD	33.0	42.0	34.0
HEAT AFFECTED ZONE OF SUBARC IN ELECTROSLAG WELD	93.0	90.0	87.0
BASE METAL	89.0	80.0	95.0
ELECTROSLAG WELD	60.0	50.0	35.0

CHEMICAL ANALYSIS

	C.	MN.	P.	S.	SI.	CR.	NI.	MO.	CU.
ELECTROSLAG WELD	.18	1.34	.012	.017	.14	.10	.30	.47	.22
BASE METAL	.18	1.14	.012	.018	.25	.15	.57	.48	.20
AUTO SUB ARC WELD	.08	1.65	.015	.016	.46	.07	.48	.43	.19

HEAT TREATMENT PRIOR TO SUB ARC WELD	1 HR/IN @ 1675°-1725°F	BRINE QUENCH
HEAT TREATMENT PRIOR TO SUB ARC WELD	1 HR/IN @ 1600°-1650°F	BRINE QUENCH
HEAT TREATMENT PRIOR TO SUB ARC WELD	1 HR/IN @ 1175°-1200°F	LIQUID QUENCH
FINAL STRESS RELIEF, AFTER WELDING	18 HRS @ 1100°-1150°F	FURNACE COOL

PQ1309A
ELECTROSLAG WELD IN VERTICAL POSITION
AUTO SUB ARC WELD IN FLAT POSITION
DATE 6-29-66 CHEMISTRY REVISED 7-22-66

BDM 501-2

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

F ORD OF PROCEDURE OR OPERATOR QUALIFICATION TEST QCD 2E4-122

ASSC TED JOB NO.	DATE	PROCEDURE NO.
610-0098 INITIAL APPLICATION	6-8-66	PQ-1309-B

WELDING PROCESS	SINGLE	MULTIPLE PASS	MULTIPLE ARC
Electroslag and Manual Metal Arc		X	

MATERIAL SPECIFICATION P-3 (A-302-B)

PLATE	PIPE	METAL THICKNESS	FILLER METAL GROUP NO.	WELD CLASSIFICATION NO.
X		6-1/4"	RACO Hi-Mn-Mo & B&W 8015	Proprietary

IS BACKING STRIP USED	PRE HEAT TEMPERATURE	INTER PASS TEMPERATURE	FLUX NAME OR COMPOSITION
☐ YES ☒ NO	Electroslag 70°F MIN M.M.A. 300°F MIN.	Electroslag Not Applicable M.M.A. 500°F. MAX.	E.S. LINDE # 124

WELD CHARACTERISTICS Electroslag-Alternating Current 48-52 Volts 600 Amps
Manual Metal Arc-Direct Current Reverse Polarity 22-26 Volts 185-265 Amps (See Reverse Side)

GAS FLOW RATE	POSITION OF PLATE OR PIPE	ULTRASONIC TEST	LIQUID PENETRANT
Not Applicable	Vertical	Acceptable/No Defects	Not Applicable

MAGNETIC PARTICLE	RADIOGRAPH	MACRO EXAMINATION	MICRO EXAMINATION	POST HEAT TREATMENT
Acceptable/No Defects	No Acceptable/Defects	Not Required	Not Required	See Reverse Side

SIZE OF ELECTRODE	INERT GAS COMPOSITION	TRAVEL SPEED INCHES PER MIN.
1/8", 5/32", & 3/16"Dia	Not Applicable	E.S. Oscillation 48"/MIN Weld Time

WELDERS NAME	CLOCK NO.	SYMBOL
R. Reese - E. Sylvester D. Sinnett - U. Palinkas - G. Thompson	6136 - 6188 6125 - 6092 - 6276	None - [illegible] HU - BZ - UB

REMARKS Procedure qualification for welding P-3 material by combination Electroslag and Manual Metal Arc process in the vertical position. Electroslag using 1/8"Dia. (RACO)Hi-Mn-Mo Filler Wire with LINDE #124 Flux. Manual Metal Arc using 5/32" & 3/16"Dia. (B&W)8015 Electrodes. See Reverse Side for Groove Configuration.

WELD CHEMICAL ANALYSIS

	MN	SI	P	S	Cr	Ni	Mo	Cu		
				See Reverse Side						

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS WIDTH	DIMENSIONS THICK.	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULT. TENSILE STRENGTH PSI	FRACTURE OR LOCAT
		See	Reverse Side			

SIDE BEND TEST	FREE BEND TEST
Four Side Bends - Acceptable/No Defects	Not Required

ALL WELD METAL TENSILE

SPECIMEN NO.	DIA.	AREA SQ. IN.	YIELD POINT PSI.	TENS. STR. PSI	ELONG % IN 2"	RED ARE
			Not Required			

CHARPY IMPACT TESTS TYPE V-Notch @ +10 °F 240 FT. LBS. ENERGY LOAD

SPECIMEN NO.	FT. LBS.	SPECIMEN NO.	FT. LBS.
	See Reverse Side		

WE CERTIFY THAT THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED WELDED, AND TESTED IN ACCORDANCE WITH THE REQUIREMENTS OF ASME, U.S.C.G., ABS, USN MIL-STD-278 OR NAVSHIPS 250-1500-1.

PQ-1309-B
275

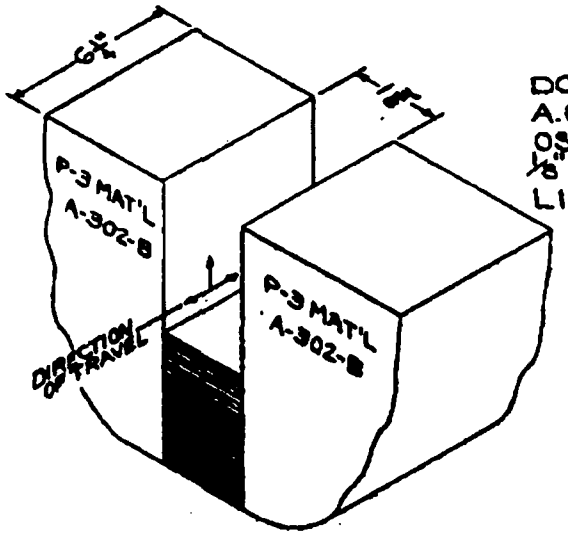
June 30, 1966 SIGNED

BABCOCK & WILCOX COMPANY

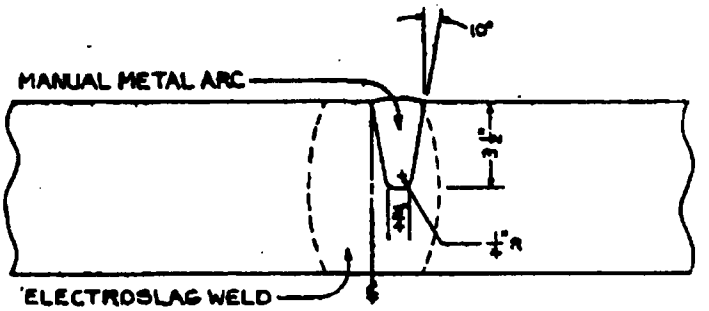
WITNESSED W. J. Titterington, Sr., G.E.

BY Paul E Campbell

COMBINATION ELECTROSLAG & MANUAL METAL ARC WELD



DOUBLE ARC ELECTROSLAG WELD
A.C. 48-52 VOLTS 600 AMPS
OSCILLATION SPEED 4-8"/MIN DWELL TIME 5 SEC
1/8" DIA (RACO) HI-MN-MO FILLER WIRE
LINDE #124 FLUX



MANUAL METAL ARC DCRP
5/32" DIA (B&W) 8015 ELECTRODES 22-24 VOLTS 185-195 AMPS
3/16" DIA (B&W) 8015 ELECTRODES 24-26 VOLTS 250-265 AMPS

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS WIDTH	DIMENSIONS THICK.	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULT TENSILE STRENGTH P.S.I.	FRACTURE
PQ1309B	1.000"	3.010"	3.010	249,000	82,720	M.M.A. WELD
PQ1309B	1.002"	2.783"	2.788	230,000	82,500	SLAG WELD
PQ1309B	1.002"	2.736"	2.742	228,000	83,150	SLAG WELD
PQ1309B	1.003"	2.784"	2.793	228,000	81,640	SLAG WELD

CHARPY V-NOTCH IMPACTS @ +10°F 240 FT. LBS. ENERGY LOAD

LOCATION	FT. LBS.	FT. LBS.	FT. LBS.
MANUAL METAL ARC WELD	97.0	91.0	96.0
HEAT AFFECTED ZONE OF M.M.A. IN ELECTROSLAG WELD	47.0	95.0	74.0
BASE METAL	98.0	53.0	95.0
ELECTROSLAG WELD	58.0	36.0	44.0

CHEMICAL ANALYSIS

	C	MN	P	S	SI	CR	NI	MO	CU
ELECTROSLAG WELD	.17	1.31	.015	.015	.14	.12	.29	.51	.23
MANUAL METAL ARC WELD	.06	.94	.011	.020	.27	.04	.73	.59	.01
BASE PLATE	.19	1.12	.011	.016	.23	.15	.57	.48	.20

HEAT TREATMENT PRIOR TO M.M.A. WELD 1 HR/IN @ 1675°-1725°F BRINE QUENCH
HEAT TREATMENT PRIOR TO M.M.A. WELD 1 HR/IN @ 1600°-1650°F BRINE QUENCH
HEAT TREATMENT PRIOR TO M.M.A. WELD 1 HR/IN @ 1175°-1200°F LIQUID QUENCH
FINAL STRESS RELIEF 18 HRS @ 1100°-1150°F FURNACE COOL
(AFTER WELDING)

PQ 1309B
WELDED IN VERTICAL POSITION
DATE 7-8-66

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

CONTRACT NO. A.S.M.E.
SPECIFICATION NO.

OF PROCEDURE AND/OR OPERATOR QUALIFICATION TEST-QC 2E4-122

NAVSHIPS 250-1500-1	ASME SECTION 3	ASME SECTION 1 & 8	OTHER	PLATE	PIPE	SINGLE PASS	MULTIPLE
		X		X		X	

WELDING PROCESS	QUALIFICATION POSITION	METAL THICKNESS	SINGLE LAYER	MULTIPLE
Double Electroslag	Vertical	6¼ IN.	N.R.	N.A.

MATERIAL SPECIFICATION	SINGLE ARC	MULTIPLE
P-3 (SA-302-B) and electroslag weld metal (Mn-Mo base material plus Mn-Mo filler metal	X	2

HEAT TREATMENT	MACRO. EXAM.	MICRO. EX
See reverse side	N.R.	N.R.

FLUX NAME OR COMPOSITION	PREHEAT TEMPERATURE	INTERPASS TEMPERATURE	WELDER SYMBOL CLOCK NO.		
Linde #124	NONE °F MIN.	NONE °F MAX.	Cissna 1071	McFarland 1072	

TYPE OF BACKUP (STRIP OR GAS) AND COMPOSITION	FILLER METAL GROUP NO.	SHIELDING GAS	CUP SIZE	TORCH GAS FLOW RATE
N.A.	RACO - Hi-Mn-Mo	N.A.	N.A.	N.A.

AMPS, VOLTS, CURRENT, POLARITY
Alternating current - 48-52 Volts 590-600 Amps

SIZE OF ELECTRODE, IN. DIA. / SIZE OF FILLER WIRE, IN. DIA.	ELECTRODE EXT. BEYOND CUP IN.	TRAVEL SPEED IPM	WIRE FEED IPM	OSCILLATION	DWELL TIME
1/8	N.A.	N.A.	N.A.	48 ipm	sec

LIQUID PENETRANT	MAGNETIC PARTICLE	RADIOGRAPH	ULTRASONIC TEST
N.A.	Acceptable	Acceptable	Acceptable

REMARKS: Procedure Qualification for welding P-3 material in the vertical position by the electroslag process using 1/8" dia. (RACO) Hi-Mn-Mo filler wire with Linde #124 flux. See reverse side for groove configuration.

CHEMICAL ANALYSIS - S E NO. 59703

LOCATION	C	MN	P	S	SI	CR	NI	MO	FE	CU	CB	CO	TA	TI
	.19	1.41	.019	.015	.07	.06	.25	.57		.20				

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS, INCHES WIDTH	DIMENSIONS, INCHES THICKNESS	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULTIMATE TENSILE STRENGTH PSI	FRACTURE LOCA
PQ-1667	.995	2.465	2.453	221,000	90,100	Weld
PQ-1667	1.000	2.342	2.342	208,500	89,020	Weld
PQ-1667	.995	2.590	2.577	228,000	88,470	Weld
PQ-1667	1.000	2.660	2.660	233,000	87,600	Weld

BEND TEST

Four side bends - Acceptable (No defects)

ALL WELD METAL TENSILE

SPECIMEN NO.	DIAMETER, IN.	AREA SQ. IN.	YIELD POINT PSI	TENSILE STR. PSI	ELONG % IN 2"	REC AREA %
			N.R.			

TYPE CHARPY V-NOTCH IMPACT TEST AT +10 °F 240 FT. LBS. ENERGY LOAD

ASE METAL	57,	69,	77	FT.LBS.			FT.
LD METAL	47,	39,	27	FT.LBS.			FT.
EAT AFFECTED ZONE	44,	44,	35	FT.LBS.			FT.

WE CERTIFY THAT TO THE BEST OF OUR KNOWLEDGE THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED, AND TESTED IN ACCORDANCE WITH THE APPLICABLE SPECIFICATIONS.

N.R. = NOT REQUIRED N.A. = NOT APPLICA

MTV-9
PQ 1667

WITNESSED

A-11

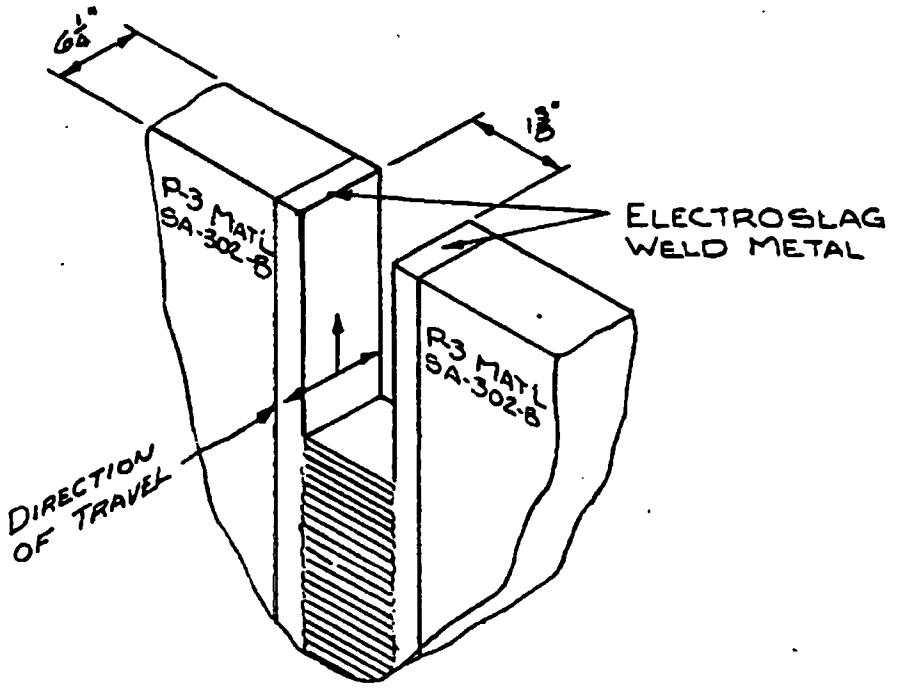
BY Paul E Campbell

DATE Sept. 22, 1967

BABCOCK & WILCOX COMPANY

241 235

DOUBLE ELECTROSLAG (A.C.)



⅛" DIA (RACO) HI-MN-MO FILLER WIRE

LINDE *124 FLUX

48-52 VOLTS 590-600 AMPS

48 IPM OSCILLATION 5 SEC. DWELL TIME

HEAT TREATMENT AFTER WELDING

6½ HRS @ 1675°-1725°F - BRINE QUENCH

6½ HRS @ 1600°-1650°F - BRINE QUENCH

6½ HRS @ 1180°-1200°F - WATER QUENCH

30 HRS @ 1100°-1150°F - FURNACE COOL

PQ 1667

MTV-9

WELDED IN VERTICAL POSITION

DATE 10-18-67

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

CONTRACT NO. 847-008136-02
SPECIFICATION NO. WS-40

501-4

CORD OF PROCEDURE AND/OR OPERATOR QUALIFICATION TEST-QC 2E4-122

/SHIPS)-1500-1	ASME SECTION 3	ASME SECTION 8	OTHER	PLATE	PIPE	SINGLE PASS	MULTIPLE PAS
		X		X		X	

DING PROCESS	QUALIFICATION POSITION	METAL THICKNESS	SINGLE LAYER	MULTIPLE LAY
Electroslag	Vertical	6-3/8 IN.	NA	NA

TERIAL SPECIFICATION	SINGLE ARC	MULTIPLE ARC
P-3 (SA-302-B)		* 2

AT TREATMENT	MACRO. EXAM.	MICRO. EXAM.
See reverse side	**	NR

UX NAME OR COMPOSITION	PREHEAT TEMPERATURE	INTERPASS TEMPERATURE	WELDER SYMBOL CLOCK NO.		
Linde 124	60 °F MIN.	NA °F MAX.	Pierson 5702	Miller 5701	

PE OF BACKUP (STRIP OR GAS) AND COMPOSITION	FILLER METAL GROUP NO.	SHIELDING GAS	CUP SIZE	TORCH GAS FLOW RATE
None	A-2	NA	NA	NA C H

PS, VOLTS, CURRENT, POLARITY: Alternating current 46-48 volts, 550-600 amps

ZE OF ELECTRODE, IN. DIA. / ZE OF FILLER WIRE, IN. DIA.	ELECTRODE EXT. BEYOND CUP IN.	TRAVEL SPEED IPM	WIRE FEED IPM	OSITION IPM	DWELL TIME SEC.
1/8	NA	NA	NA	37-38 IPM 4-5 CY/PM	

QUID PENETRANT	MAGNETIC PARTICLE	RADIOGRAPH	ULTRASONIC TEST
NA	Acceptable	Acceptable	Acceptable

MARKS: Procedure qualification for welding P-3 material in the vertical position by the electroslag process using 1/8" dia. (RACO) Hi-Mn-Mo fillerwire with Linde 124 flux. See reverse for additional information & groove configuration.

CHEMICAL ANALYSIS - S E NO. 65179

OCATION	C	MN	P	S	SI	CR	NI	MO	FE	CU	CB	CO	TA	TI	
Weld	.19	1.40	.015	.015	.14	.09	.27	.54		.23					
Base	.24	1.26	.016	.019	.23	.14	.69	.51		.16					

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS, INCHES		AREA SQ. IN.	ULTIMATE LOAD LBS.	ULTIMATE TENSILE STRENGTH PSI	FRACTURE LOCATI N
	WIDTH	THICKNESS				
PQ-1822	.993	2.895	2.875	255,000	88,690	Weld
PQ-1822	.993	2.802	2.782	249,000	89,510	Weld

BEND TEST

Four side bends (split into 20) - Acceptable (No defects)

ALL WELD METAL TENSILE

SPECIMEN NO.	DIAMETER, IN.	AREA SQ. IN.	YIELD POINT PSI	TENSILE STR. PSI	ELONG % IN 2"	RED AREA %
Q-1822 (¼T)	.504		66,000	88,000	25.0	64.6
Q-1822 (¼T)	.504		66,000	85,500	26.5	64.1
Q-1822 (¼T)	.505		65,000	85,500	27.0	67.0
Q-1822 (¼T)	.505		63,750	85,500	29.0	67.9

TYPE CHARPY — IMPACT TEST AT °F — FT. LBS. ENERGY LOAD

SE METAL	FT.LBS.		FT.LBS
LD METAL	See Reverse Side FT.LBS.		FT.LBS
AT AFFECTED ZONE	FT.LBS.		FT.LBS

WE CERTIFY THAT TO THE BEST OF OUR KNOWLEDGE THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED, WELDED AND TESTED IN ACCORDANCE WITH THE APPLICABLE SPECIFICATIONS.

N.R. = NOT REQUIRED N.A. = NOT APPLICABLE

* Electrode spacing 4"

** One transverse & one longitudinal macro - Acceptable

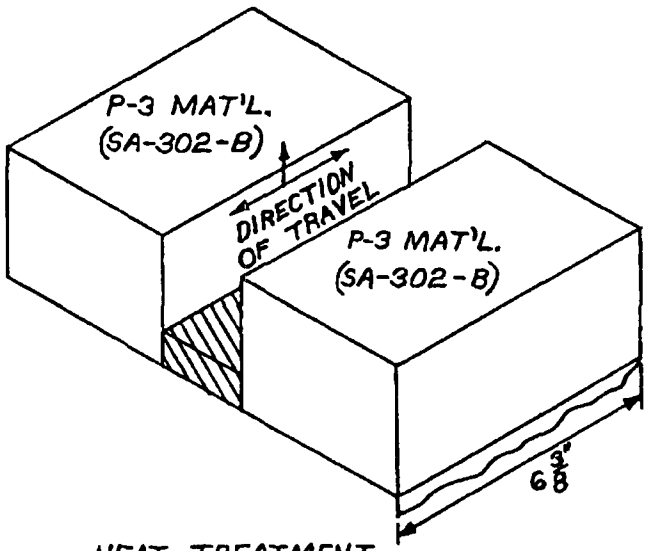
PQ 1822

WITNESSED

A-13

DATE July 30, 1968

BY F J Muffet
BABCOCK & WILCOX COMPANY



HEAT TREATMENT

6½ HRS. @ 1675°–1725°F — BRINE QUENCH
6½ HRS. @ 1600°–1650°F — BRINE QUENCH
6½ HRS. @ 1175°–1225°F — LIQUID QUENCH
30 HRS. @ 1100°–1150°F — FURANCE COOL

DROP WEIGHTS

TEMP.	WELD	BASE	HEAT AFFECTED ZONE
+50°	NF NF		
+40°	NF NF		
+30°	NF F F		NF NF
+20°	F	NF NF	F NF
-10°		NF NF	
-20°		NF F	
-30°		F	
-40°		F	

CHARPY V-NOTCH IMPACTS — ¼T

TEMP.	WELD FT. LBS.	BASE FT. LBS.	HEAT AFFECTED ZONE FT. LBS.
+10	36, 70, 42, 64, 45	56, 56, 56	66, 77, 60
+40	66, 56, 65		
-20	25, 36, 43		
-50	8, 35	32	

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

CONTRACT NO. 610-0127
SPECIFICATION NO. W-57

RECORD OF PROCEDURE AND/OR OPERATOR QUALIFICATION TEST-QC 2E4-122

NAVSHIPS 250-1500-1 ☐	ASME SECTION 3 ☒	ASME SECTION 8 ☒	OTHER ☐	PLATE ☒ PIPE ☐		SINGLE PASS ☒	MULTIPLE PASS ☐
WELDING PROCESS: Electroslag	QUALIFICATION POSITION: Vertical			METAL THICKNESS: 6-3/8 in.		SINGLE LAYER: NA ☐	MULTIPLE LAYER: NA ☐
MATERIAL SPECIFICATION: P-3 (SA-302-B)						SINGLE ARC ☐	MULTIPLE ARC ☒
HEAT TREATMENT: See reverse side						MACRO. EXAM.: 5-Acceptable	MICRO. EXAM.: NR
FLUX NAME OR COMPOSITION: Linde 124	PREHEAT TEMPERATURE: 70 °F MIN.	INTERPASS TEMPERATURE: NA °F MAX.	WELDER SYMBOL: Pierson / Miller	CLOCK NO.: 5702 / 570			
TYPE OF BACKUP (STRIP OR GAS) AND COMPOSITION: None	FILLER METAL GROUP NO.: A-2	SHIELDING GAS: NA	CUP SIZE: NA	TORCH GAS FLOW RATE: NA CFH			
AMPS, VOLTS, CURRENT, POLARITY: Alternating current 48 volts, 550-600 amps							
SIZE OF ELECTRODE, IN. DIA. / SIZE OF FILLER WIRE, IN. DIA.: 1/8	ELECTRODE EXT. BEYOND CUP IN.: NA	TRAVEL SPEED IPM: NA	WIRE FEED IPM: NA	OSCILLATION: 40" /PM	DWELL TIME SEC:		
LIQUID PENETRANT: NA	MAGNETIC PARTICLE: Acceptable *	RADIOGRAPH: Acceptable	ULTRASONIC TEST: Acceptable				

REMARKS: Procedure qualification for welding P-3 material in the vertical position by the electroslag process using 1/8" dia. (Raco) Hi-Mn-Mo filler wire with Linde 124 flux. See reverse side for groove configuration.

CHEMICAL ANALYSIS - S E NO. 65765

LOCATION	C	MN	P	S	SI	CR	NI	MO	FE	CU	CB	CO	TA	TI	AL
Weld	.18	1.49	.014	.011	.15	.06	.36	.49		.18					
Base	.23	1.35	.013	.019	.25	.09	.62	.51		.08					

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS, INCHES: WIDTH	DIMENSIONS, INCHES: THICKNESS	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULTIMATE TENSILE STRENGTH PSI	FRACTURE LOCATION
PQ-1851	.878	2.765	2.428	206,500	85,050	Weld
PQ-1851	.871	3.122	2.719	224,500	82,560	Weld
PQ-1851	1.004	2.995	3.007	251,000	83,460	Weld
PQ-1851	1.006	2.852	2.859	240,000	83,940	Weld

BEND TEST

Four side bends (split into 16) - Acceptable (No defects)

ALL WELD METAL TENSILE

SPECIMEN NO.	DIAMETER, IN.	AREA SQ. IN.	YIELD POINT PSI	TENSILE STR. PSI	ELONG % IN 2"	RED AREA %
PQ-1851	.505		61,750	83,000	30.0	65.6
PQ-1851	.505		63,000	83,500	30.0	69.7
PQ-1851	.505		60,000	82,000	29.0	69.0
PQ-1851	.505		59,500	81,250	29.0	67.9

TYPE CHARPY — IMPACT TEST AT °F — FT. LBS. ENERGY LOAD

BASE METAL	FT.LBS.		FT.LBS
WELD METAL	See reverse side FT.LBS.		FT.LBS
HEAT AFFECTED ZONE	FT.LBS.		FT.LBS

WE CERTIFY THAT TO THE BEST OF OUR KNOWLEDGE THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED, WELDED AND TESTED IN ACCORDANCE WITH THE APPLICABLE SPECIFICATIONS.

N.R. = NOT REQUIRED N.A. = NOT APPLICABLE

* Final surfaces

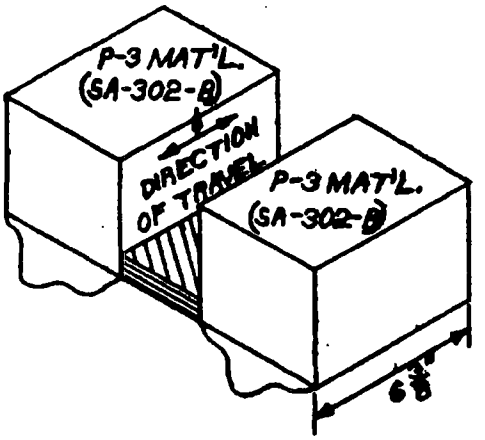
PQ 1851

WITNESSED _____

A-15

DATE Oct. 15, 1968

BY Paul E Campbell
BABCOCK & WILCOX COMPANY CN 23



HEAT TREATMENT AFTER WELDING

6½ HRS. @ 1675°–1725°F —BRINE QUENCH
6½ HRS. @ 1600°–1650°F —BRINE QUENCH
6½ HRS. @ 1175°–1225°F —LIQUID QUENCH
30 HRS. @ 1100°–1150°F —FURNACE COOL

CHARPY V-NOTCH IMPACTS @ 240 FT. LBS.

LOCATION	0°F	+10°F	+40°F	-20°F	-30°F	-40°F
WELD METAL (¼T)	55	84, 71, 57	79, 72, 81, 83	39, 39, 35	44	21
BASE METAL (¼T)		74, 84, 81		55		
HEAT AFFECTED ZONE (¼T)		70, 96, 64		64		

DROP WEIGHTS @ 3 FT./100 LBS.

HEAT AFFECTED ZONE (¼T)	
+20°F	NF
0°F	NF
-20°F	F
-10°F	NF
-10°F	NF
-20°F	F
-20°F	NF
-20°F	NF

WELD METAL (¼T)	
-20°F	F
-10°F	F
0°F	F
+10°F	F
+20°F	NF
+20°F	NF
-10°F	NF
-30°F	F

BASE METAL (¼T)	
0°F	NF
0°F	NF
0°F	NF
0°F	NF
0°F	F
+20°F	NF
+10°F	NF
+10°F	NF

PQ 1851
DATE: 10-15-68

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

CONTRACT NO. ASME
SPECIFICATION NO. P-3, M-1

NPM 901-4

D OF PROCEDURE AND/OR OPERATOR QUALIFICATION TEST-QC 2E4-122

NAVSHIPS 250-1500-1	ASME SECTION 3	ASME SECTION 8	OTHER	PLATE	PIPE	SINGLE PASS	MULTIPLE
	Y	X		X		Y	

WELDING PROCESS	QUALIFICATION POSITION	METAL THICKNESS	SINGLE LAYER	MULTIPLE
Electroslag	Vertical	6-3/8 IN.	NA	NA

MATERIAL SPECIFICATION	SINGLE ARC	MULTIPLE ARC
P-3 (SA-302-B)		2

HEAT TREATMENT	MACRO. EXAM.	MICRO. EXAM.
See Reverse Side	NR	NR

FLUX NAME OR COMPOSITION	PREHEAT TEMPERATURE	INTERPASS TEMPERATURE	WELDER SYMBOL CLOCK NO.
Linde 124	70°F MIN.	NA °F MAX.	Pierson 5702 Miller 5701

TYPE OF BACKUP (STRIP OR GAS) AND COMPOSITION	FILLER METAL GROUP NO.	SHIELDING GAS	CUP SIZE	TORCH GAS FLOW RATE
None	A-2	NA	NA	NA

AMPS, VOLTS, CURRENT, POLARITY: Alternating Current 46-48 Volts 590-600 Amps

SIZE OF ELECTRODE, IN. DIA. / SIZE OF FILLER WIRE, IN. DIA.	ELECTRODE EXT. BEYOND CUP IN.	TRAVEL SPEED IPM	WIRE FEED IPM	OSCILLATION	DWELL TIME SEC.
1/8	NA*	NA	NA	1/8 IN. 28 CYCPM	

LIQUID PENETRANT	MAGNETIC PARTICLE	RADIOGRAPH	ULTRASONIC TEST
NA	Acceptable **	Acceptable	Acceptable

REMARKS: Procedure qualification for welding P-3 mat'l in the vertical position by the electroslag process using 1/8" Dia (Raco) HiMnMo filler wire with Linde 124 flux. See reverse side for groove configuration.

CHEMICAL ANALYSIS - S & E NO. 67501

LOCATION	C	MN	P	S	SI	CR	NI	MO	FE	CU	CB	CO	TA	TI
Weld	.19	1.49	.016	.014	.16	.06	.38	.55		.19				
Base	.22	1.34	.013	.018	.25	.07	.52	.53		.11				

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS, INCHES WIDTH	DIMENSIONS, INCHES THICKNESS	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULTIMATE TENSILE STRENGTH PSI	FRACTURE LOCATION
PQ-1928	.995	3.141	3.125	260,500	83,360	Weld
PQ-1928	.995	3.150	3.134	262,000	83,600	Weld
PQ-1928	.996	2.790	2.779	242,500	87,270	Weld
PQ-1928	1.006	2.697	2.713	235,500	86,800	Weld

BEND TEST

Four side bends (split into 16) - Acceptable (No Defects)

ALL WELD METAL TENSILE

SPECIMEN NO.	DIAMETER, IN.	AREA SQ. IN.	YIELD POINT PSI	TENSILE STR. PSI	ELONG % IN 2"	RED AREA
			NR.			

TYPE CHARPY	IMPACT TEST AT °F	FT. LBS. ENERGY LOAD
BASE METAL	FT.LBS.	FT. LBS.
WELD METAL	See Reverse Side FT.LBS.	FT. LBS.
HEAT AFFECTED ZONE	FT.LBS.	FT. LBS.

WE CERTIFY THAT TO THE BEST OF OUR KNOWLEDGE THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED, WELDED AND TESTED IN ACCORDANCE WITH THE APPLICABLE SPECIFICATIONS.

N.R. = NOT REQUIRED N.A. = NOT APPLICABLE

* 4" Electrode spacing
** Final surface

PQ 1928

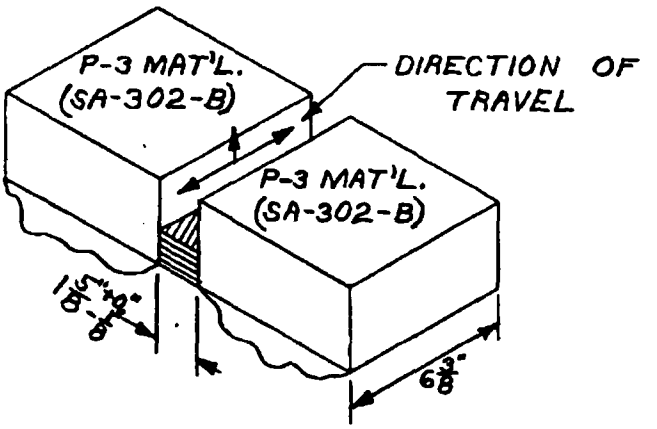
WITNESSED

A-17

DATE Dec. 10, 1968

BY J. J. Muffett
BABCOCK & WILCOX COMPANY

CN 235



HEAT TREATMENT AFTER WELDING

6½ HRS. @ 1675°-1725°F—BRINE QUENCH
6½ HRS. @ 1600°-1650°F—BRINE QUENCH
6½ HRS. @ 1175°-1225°F—LIQUID QUENCH
30 HRS. @ 1100°-1150°F—FURNACE COOL

CHARPY V-NOTCH IMPACTS 240 FT. LBS. ENERGY LOAD

WELD METAL (¼T)	
+10°F	30
+10°F	33
+10°F	33
0°F	18
0°F	26

BASE METAL (¼T)	
-10°F	57
-10°F	39
-10°F	27
-20°F	52
-20°F	30
-20°F	38

HEAT AFFECTED ZONE (¼T)	
+10°F	81
+10°F	81
+10°F	62
-20°F	41
-20°F	58
-20°F	35

DROP WEIGHTS

WELD METAL (¼T)	
+20°F	NF
+20°F	F
+30°F	NF
+30°F	NF
+25°F	F
+25°F	NF
+25°F	F

BASE METAL (¼T)	
+20°F	NF
+20°F	NF
+10°F	NF
+10°F	NF
-10°F	F
0°F	NF
0°F	NF
-10°F	F

HEAT AFFECTED ZONE (¼T)	
+20°F	F
+30°F	NF
+30°F	NF
+25°F	NF
+25°F	F

PQ 1928
DATE: 12-10-68

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

CONTRACT NO. ASME
SPECIFICATION NO. P-3, 1

RDN 501-4

RD OF PROCEDURE AND/OR OPERATOR QUALIFICATION TEST-QC 2E4-122

NAVSHIPS 250-1500-1	ASME SECTION 3	ASME SECTION 8	OTHER	PLATE	PIPE	SINGLE PASS	MULTIP. E
	X	Y		X		X	

WELDING PROCESS	QUALIFICATION POSITION	METAL THICKNESS	SINGLE LAYER	MULTIPLE
Electroslag	Vertical	6-3/8 IN.	NA	NA

MATERIAL SPECIFICATION	SINGLE ARC	MULTIPLE
P-3 (SA-302-B)		2

HEAT TREATMENT	MACRO. EXAM.	MICRO. E
See reverse side	NR	NR

FLUX NAME OR COMPOSITION	PREHEAT TEMPERATURE	INTERPASS TEMPERATURE	WELDER SYMBOL / CLOCK NO.		
Linde 124	70 °F MIN.	NA °F MAX.	Pierson 5702	Miller 5701	

TYPE OF BACKUP (STRIP OR GAS) AND COMPOSITION	FILLER METAL GROUP NO.	SHIELDING GAS	CUP SIZE	TORCH GAS FLOW RATE
NA	A-2	NA	NA	NA

AMPS, VOLTS, CURRENT, POLARITY
Alternating current 48 volts, 600-650 amps

SIZE OF ELECTRODE, IN. DIA. / SIZE OF FILLER WIRE, IN. DIA.	ELECTRODE EXT. BEYOND CUP IN.	TRAVEL SPEED IPM	WIRE FEED IPM	OSCILLATION	DWEL TIME SEC.
1/8	NA*	NA	NA	48" PM	

LIQUID PENETRANT	MAGNETIC PARTICLE	RADIOGRAPH	ULTRASONIC TEST
NA	Acceptable **	Acceptable	Acceptable

REMARKS: Procedure qualification for welding P-3 material in the vertical positi by the electroslag process using 1/8" dia. (Esco) Hi-Mn-Mo fillerwire with Linde 124 flux. See reverse side for groove configuration.

CHEMICAL ANALYSIS - S E NO. C6641

LOCATION	C	MN	P	S	SI	CR	NI	MO	FE	CU	CB	CO	TA	TI
ase	.22	1.37	.013	.014	.27	.11	.51	.49		.09				
Weld	.18	1.50	.016	.013	.17	.03	.30	.43		.20				

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS, INCHES WIDTH	DIMENSIONS, INCHES THICKNESS	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULTIMATE TENSILE STRENGTH PSI	FRACTURE LOCA
PQ-1929	.990	3.155	3.153	274,000	86,900	Weld
PQ-1929	1.015	3.119	3.165	275,000	86,890	Weld
PQ-1929	.995	2.721	2.707	232,500	85,880	Weld
PQ-1929	1.002	2.735	2.741	237,500	86,670	Weld

BEND TEST

Four side bends (Split into 16) - Acceptable (No defects)

ALL WELD METAL TENSILE

SPECIMEN NO.	DIAMETER, IN.	AREA SQ. IN.	YIELD POINT PSI	TENSILE STR. PSI	ELONG % IN 2"	RED AREA

TYPE CHARPY	IMPACT TEST AT °F	FT. LBS. ENERGY LOAD
BASE METAL	FT.LBS.	
WELD METAL	See reverse side FT.LBS.	
HEAT AFFECTED ZONE	FT.LBS.	

WE CERTIFY THAT TO THE BEST OF OUR KNOWLEDGE THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED, WELDED AND TESTED IN ACCORDANCE WITH THE APPLICABLE SPECIFICATIONS.

N.R. = NOT REQUIRED N.A. = NOT APPLIC

* 4" electrode spacing
** Final surface

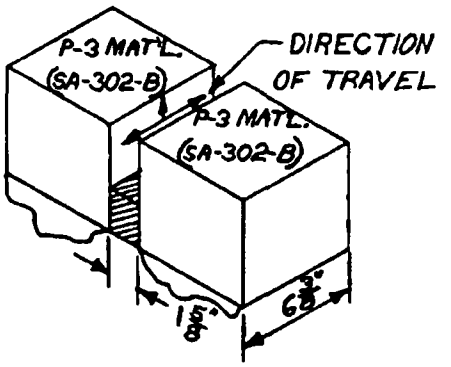
PQ 1929

WITNESSED

DATE Dec. 10, 1968

BY F J Moffet
BABCOCK & WILCOX COMPANY

NN 234



HEAT TREATMENT AFTER WELDING

6½ HRS. @ 1675°–1725°F — BRINE QUENCH
6½ HRS. @ 1600°–1650°F — BRINE QUENCH
6½ HRS. @ 1175°–1225°F — LIQUID QUENCH
30 HRS. @ 1100°–1150°F — FURNACE COOL

CHARPY V-NOTCH IMPACTS @ 240 FT. LBS. ENERGY LOAD

BASE METAL ¼T	
+10 °F	18
+10 °F	21
+10 °F	30
0 °F	24
0 °F	25
0 °F	20

WELD METAL ¼T	
+10 °F	80
+10 °F	40
+10 °F	55

HEAT AFFECTED ZONE ¼T	
+10 °F	33
+10 °F	41
+10 °F	31
0 °F	36
0 °F	13
0 °F	25

DROP WEIGHTS

BASE METAL ¼T	
+20 °F	F
+20 °F	F
+30 °F	F
+40 °F	F
+80 °F	NF
+70 °F	NF
+60 °F	NF
+60 °F	NF

WELD METAL ¼T	
+20 °F	F
+20 °F	F
+30 °F	F
+40 °F	F
+50 °F	F
+70 °F	NF
+70 °F	NF
+60 °F	NF

HEAT AFFECTED ZONE ¼T	
+20 °F	F
+20 °F	F
+30 °F	NF
+30 °F	NF
+25 °F	F
+25 °F	F

PQ 1929
DATE: 12-10-68

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO.

CONTRACT NO. ASME
SPECIFICATION NO. [illegible]

M 601-4

...RD OF PROCEDURE AND/OR OPERATOR QUALIFICATION TEST-QC 2E4-122

NAVSHIPS 250-1500-1	ASME SECTION 3	ASME SECTION 8	OTHER	PLATE	PIPE	SINGLE PASS	MULTIPLE PASS
	X	X		X		X	

WELDING PROCESS	QUALIFICATION POSITION	METAL THICKNESS	SINGLE LAYER	MULTIPLE LAYER
Electroslag	Vertical	6-3/8 IN.	NA	NA

MATERIAL SPECIFICATION	SINGLE ARC	MULTIPLE ARC
P-3 (SA-302-B)		2

HEAT TREATMENT	MACRO. EXAM.	MICRO. EXAM
See reverse side	NR	NR

FLUX NAME OR COMPOSITION	PREHEAT TEMPERATURE	INTERPASS TEMPERATURE	WELDER SYMBOL CLOCK NO.		
Linde 124	70 °F MIN.	NA °F MAX.	Pierson 5702	Miller 5701	

TYPE OF BACKUP (STRIP OR GAS) AND COMPOSITION	FILLER METAL GROUP NO.	SHIELDING GAS	CUP SIZE	TORCH GAS FLOW RATE
NA	A-2	NA	NA	NA CFH

AMPS, VOLTS, CURRENT, POLARITY
Alternating current 50 volts, 590-600 amps

SIZE OF ELECTRODE, IN. DIA. / SIZE OF FILLER WIRE, IN. DIA.	ELECTRODE EXT. BEYOND CUP IN.	TRAVEL SPEED IPM	WIRE FEED IPM	OSCILLATION	DWELL TIME SEC.
1/8	NA*	NA	NA	24.5 IPM	

LIQUID PENETRANT	MAGNETIC PARTICLE	RADIOGRAPH	ULTRASONIC TEST
NA	Acceptable **	Acceptable	Acceptable

REMARKS: Procedure qualification for welding P-3 material in the vertical position by the electroslag process using 1/8" dia. (Raco) Hi-Mn-Mo filler wire with Linde 124 flux. See reverse side for groove configuration.

CHEMICAL ANALYSIS - S C NO. 66581

LOCATION	C	MN	P	S	SI	CR	NI	MO	FE	CU	CB	CO	TA	TI	AL
Base	.19	1.38	.012	.020	.28	.11	.50	.49		.08					
Weld	.16	1.52	.012	.014	.15	.07	.25	.51		.20					

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS, INCHES WIDTH	DIMENSIONS, INCHES THICKNESS	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULTIMATE TENSILE STRENGTH, PSI	FRACTURE LOCATION
PQ-1930	1.000	2.862	2.862	241,000	84,220	Weld
PQ-1930	1.000	3.080	3.080	260,500	84,580	Weld
PQ-1930	1.000	2.462	2.462	210,500	85,500	Weld
PQ-1930	1.000	3.230	3.230	271,000	83,900	Weld

BEND TEST
Four side bends (Split into 16) - Acceptable (No defects)

ALL WELD METAL TENSILE

SPECIMEN NO.	DIAMETER, IN.	AREA SQ. IN.	YIELD POINT PSI	TENSILE STR. PSI	ELONG % IN 2"	RED AREA %
			NR			

TYPE CHARPY	IMPACT TEST AT °F	FT. LBS. ENERGY LOAD
BASE METAL	FT.LBS.	FT.LBS.
WELD METAL	See reverse side FT.LBS.	FT.LBS.
HEAT AFFECTED ZONE	FT.LBS.	FT.LBS.

WE CERTIFY THAT TO THE BEST OF OUR KNOWLEDGE THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED, WELDED AND TESTED IN ACCORDANCE WITH THE APPLICABLE SPECIFICATIONS.

N.R. = NOT REQUIRED N.A. = NOT APPLICABLE

* 2-3/4" electrode spacing
** Final surfaces

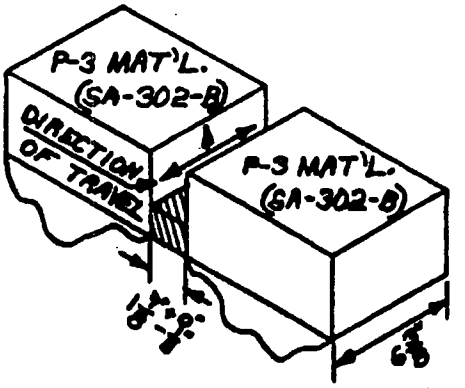
PQ 1930

WITNESSED

DATE [illegible], 1968

BY F J Mifft
BABCOCK & WILCOX COMPANY

CN 23



HEAT TREATMENT AFTER WELDING

6½ HRS. @ 1675°-1725°F — BRINE QUENCH
6½ HRS. @ 1600°-1650°F — BRINE QUENCH
6½ HRS. @ 1175°-1225°F — LIQUID QUENCH
30 HRS. @ 1100°-1150°F — FURNACE COOL

CHARPY-V NOTCH IMPACTS @ 240 FT. LBS.

BASE METAL (¼T)	
+10°F	44
+10°F	52
+10°F	15
+10°F	32
+10°F	50
+10°F	44

WELD METAL (¼T)			
+10°F	10	+20°F	78
+10°F	72	+40°F	62
+10°F	70	+40°F	94
+10°F	75	+30°F	89
+10°F	16	+20°F	72
+10°F	14	+10°F	39
+40°F	90	0°F	45
-20°F	31	-10°F	67

HEAT AFFECTED ZONE (¼T)	
+10°F	65
+10°F	52
+10°F	54
-10°F	10
-10°F	65
-10°F	30

DROP WEIGHTS

BASE METAL (¼T)	
+20°F	F
+20°F	F
+10°F	F
+30°F	NF
+30°F	F
+40°F	NF
+40°F	NF
+35°F	F

WELD METAL (¼T)	
+20°F	F
+20°F	F
+10°F	F
+30°F	F
+40°F	NF
+40°F	NF
+30°F	NF
+30°F	F

HEAT AFFECTED ZONE (¼T)	
+20°F	F
+20°F	F
+10°F	F
+30°F	NF
+30°F	F
+40°F	NF
+40°F	NF
+40°F	NF

PQ 1930
DATE: 10-10-68

BD-30356

RECORD OF TEST RESULTS

THE BABCOCK & WILCOX COMPANY
BARBERTON, OHIO

Base Metal: 6-3/8" thk SA-302-B
Parallel weld groove side walls 1-3/8" ± 1/2 apar

CT

ASME Code Weld Test Plate (Electroslag WS-40)

CUSTOMER: General Electric

CUSTOMER ORDER NO.:

TEST NO.	ASSOCIATED PROCESS QUALIFICATION NO.	B&W CONTRACT NO.
PQ-1931		610-0111

DESCRIPTION OF TEST: Heat treatment after welding: 6-1/2 hrs @ 1675-1725°F - Brine quench; 6-1/2 hrs @ 1600-1650°F - Brine quench; 6-1/2 hrs @ 1175-1225°F - Liquid quench; 30 hrs. @ 1100-1150°F - Furnace cool

WELD CHEMICAL ANALYSIS E-66319

C	Mn	Si	P	S	Cr	Ni	Mo	Cu		
.20	1.52	.12	.015	.021	.05	.38	.59	.19		

BASE METAL CHEMICAL ANALYSIS E-66319

C	Mn	Si	P	S	Cr	Ni	Mo	Cu		
.21	1.32	.18	.015	.034	.04	.60	.55	.10		

BEND TEST: TYPE — NUMBER — RESULTS
Four side bends (split into 16) - Acceptable (No defects)

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMAN NO.	WIDTH	THICKNESS	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULT. TENSILE STRENGTH PSI	LOCATION OF FRACTURE
PQ-1931	1.009	2.769	2.794	236,000	84,470	Weld
PQ-1931	.883	2.854	2.520	211,000	83,740	Weld
PQ-1931	1.000	3.056	3.056	256,500	83,940	Weld
PQ-1931	1.001	2.945	2.947	243,500	82,620	Weld

WELD METAL TENSILE

SPECIMAN NO.	DIAMETER	AREA SQ. IN.	YIELD POINT PSI	TENSILE STRENGTH PSI	E LONG % IN. 2"	RED AREA %
			NR			

CHARPY IMPACT TESTS

TYPE _____ AT _____ °F _____ FT. LBS. ENERGY LOAD.

LOCATION	FT. LBS.	LOCATION	FT. LBS.
	See reverse side		

DROP WEIGHT IMPACT TESTS

LOCATION	HEIGHT	WEIGHT
See reverse side		

TEMPERATURE °F

F = FAILURE NF = NO FAILURE

DATE Nov. 1, 1968 WITNESSED _____ BY Paul E Campbell

235

CHARPY V-NOTCH IMPACTS

)CATION	TEMP. °F.	FT. LBS.
T WELD	+10	47
"	+10	24
"	+10	33
"	+10	57
"	+10	50

LOCATION	TEMP. °F.	FT. LBS.
¼T HAZ	+10	36
" "	+10	30
" "	+10	75
" "	-20	29
" "	-20	24
" "	-20	16

LOCATION	TEMP. °F.	FT. LBS.
¼T BASE	+10	82
" "	+10	56
" "	+10	74
" "	-20	39
" "	-20	30
" "	-20	50

DROP WEIGHTS

LOCATION	TEMP. °F.	RESULTS
¼T WELD	+20	F
" "	+20	F
" "	+30	NF
" "	+30	NF
" "	+20	F

LOCATION	TEMP. °F.	RESULTS
¼T HAZ	+20	F
" "	+20	F
" "	+30	NF
" "	+30	NF
" "	+20	F

LOCATION	TEMP. °F.	RESULTS
¼T BASE	+20	NF
" "	+20	NF
" "	0	NF
" "	-20	F
" "	-10	NF
" "	-10	NF
" "	-20	F
" "	-20	F

PQ 1931

DATE: 11-1-68

WELDERS

PIERSON — 5702

MILLER — 5701

THE BABCOCK & WILCOX COMPANY

MT. VERNON, INDIANA

CONTRACT NO. 610-0122
SPECIFICATION NO. WS-40

71-6

OF PROCEDURE AND/OR OPERATOR QUALIFICATION TEST-QC 2E4-122 Code No. 235*

NAVSHIPS 250-1500-1	ASME SECTION 3	ASME SECTION 1 & 8	OTHER	PLATE	PIPE	SINGLE PASS	MULTIPLE P.
	X	X	X A.S.M.E. Sect. IX*	X		X	

WELDING PROCESS	QUALIFICATION POSITION	METAL THICKNESS	SINGLE LAYER	MULTIPLE L.
Electroslag	Vertical	6½" IN.	N.A.	N.A.

MATERIAL SPECIFICATION	SINGLE ARC	MULTIPLE AR
P-3 (SA-302 Gr. B. Mod.)		2

HEAT TREATMENT	MACRO. EXAM.	MICRO. EXAM
See Reverse Side	N.R.	N.R.

FLUX NAME OR COMPOSITION	PREHEAT TEMPERATURE	INTERPASS TEMPERATURE	WELDER SYMBOL NO.
Linde #124	70 °F MIN.	N.A. °F MAX.	Irvin 1068

TYPE OF BACKUP (STRIP OR GAS) AND COMPOSITION	FILLER METAL GROUP NO.	SHIELDING GAS	CUP SIZE	TORCH GAS FLOW RATE
N.A.	Raco Hi-Mn-Mo(A-2)	N.A.	N.A.	N.A.

AMPS, VOLTS, CURRENT, POLARITY

Alternating Current 48-52 Volts 575-625 Amps

SIZE OF ELECTRODE, IN. DIA. / SIZE OF FILLER WIRE, IN. DIA.	ELECTRODE EXT. BEYOND CUP IN.	TRAVEL SPEED IPM	WIRE FEED IPM	OSCILLATION CY/PM	DWELL SEC.
1/8"	N.A.	N.A.	N.A.	See Reverse Side	

LIQUID PENETRANT	VISUAL INSPECTION
N.A.	Acceptable

MAGNETIC PARTICLE	RADIOGRAPH	ULTRASONIC TEST
Acceptable/No Defects	Acceptable/No Defects	Acceptable/No Defects

REMARKS: Procedure Qualification for welding P-3 material in the vertical position by the Electroslag Process using 1/8" Dia. (RACO) Hi-Mn-Mo Filler Wire with Linde #124 Flux. See Reverse Side for Groove Configurati

CHEMICAL ANALYSIS - % HEAT NO.

LOCATION	C	MN	P	S	SI	CR	NI	MO	FE	CU	CB	TA	TI	V
						N.R.								

REDUCED SECTION TENSILE (TRANSVERSE TO WELD)

SPECIMEN NO.	DIMENSIONS, INCHES WIDTH	DIMENSIONS, INCHES THICKNESS	AREA SQ. IN.	ULTIMATE LOAD LBS.	ULTIMATE TENSILE STRENGTH PSI	FRACTURE LOCA
T1A	.962	2.895	2.785	248,500	89,250	Weld
T1B	.978	3.193	3.123	278,250	89,100	Weld
T10A	.890	3.095	2.755	244,000	88,600	Weld
T10B	.965	2.969	2.865	255,250	89,100	Weld

BEND TEST

(4) Side Bends Split into 16 - Acceptable/No Defects

ALL WELD METAL TENSILE

SPECIMEN NO.	DIAMETER, IN.	AREA SQ. IN.	YIELD POINT PSI	TENSILE STR. PSI	ELONG % IN 2	REDUCTION
			N.R.			

TYPE CHARPY V-Notch IMPACT TEST AT +10 °F @ 240 FT. LBS. ENERGY LOAD

ASE METAL	¼T	79, 84, 89	FT. LBS.		FT.
ELD METAL	Surface	59, 47, 49	FT. LBS.	Weld Metal @¼T =	27, 34, 32 FT.
EAT AFFECTED ZONE	¼T	84, 80, 76	FT. LBS.		FT.

I CERTIFY THAT TO THE BEST OF MY KNOWLEDGE THE STATEMENTS MADE IN THIS RECORD ARE CORRECT AND THAT THE TEST WELDS WERE PREPARED, WELDED AND TESTED IN ACCORDANCE WITH THE APPLICABLE SPECIFICATIONS.

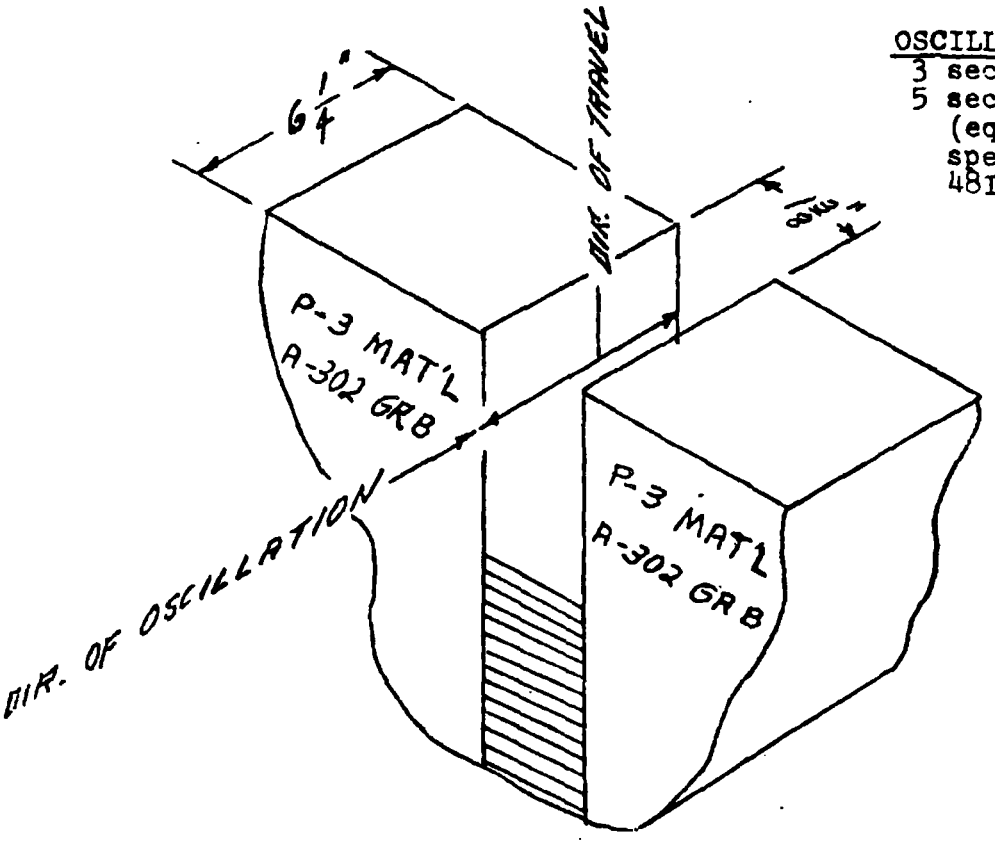
N.R. = NOT REQUIRED N.A. = NOT APPL

*Revised 1/26/71.W.L.W.

235

PQ 2563
MTV-1

WITNESSED Hartford (ASME) DATE 5/22/70 BY D. V. Collins
BABCOCK & WILCOX



OSCILLATION *
3 second traverse
5 second dwell
(equivalent to a trav. speed of approximately 48 I.P.M.)

HEAT TREATMENT

6¼ HRS @ 1675°-1725°F - BRINE QUENCH
6½ HRS @ 1600°-1650°F - BRINE QUENCH
6½ HRS @ 1175°-1225°F - BRINE QUENCH
42 HRS @ 1100°-1150°F - FURNACE COOL

DROP WEIGHT TESTS PER ASTM-E208

BASE METAL ½ T	
-10°F	NF
-20°F	NF, NF
-30°F	NF, F
-40°F	F

WELD METAL ½ T	
+20°F	NF, NF
+10°F	F

HAZ ½ T	
-10°F	NF, NF
-20°F	NF, F
-30°F	F
-40°F	F

N.D.T.T. = WELD +10°F
HAZ -20°F
B.M. -30°F

P.O. 2563
MTV-148
DATE-5/22/70

Revised 1/26/71 W.L.W.