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Babcock & Wilcox  
Evaluation of Weld Preheat and Postheat  
Requirements for Pressure Vessel Materials

610-0255

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# Babcock & Wilcox

## EVALUATION OF WELD PREHEAT AND POSTHEAT REQUIREMENTS FOR PRESSURE VESSEL MATERIALS

POWER GENERATION GROUP  
MT. VERNON, INDIANA

JUNE 26, 1974

**MASTER**

Released for announcement  
ATF. Technical Units to  
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program. Others request from  
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*zb*

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EVALUATION OF WELD PREHEAT AND POSTHEAT  
REQUIREMENTS FOR PRESSURE VESSEL MATERIALS

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June 26, 1974

The Babcock & Wilcox Company  
Power Generation Group  
Mt. Vernon, Indiana

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ABSTRACT

Background

Hydrogen induced cracking can be a serious problem if proper precautions are not taken. Current procedures used by B&W include the use of preheating, low hydrogen welding procedures, and low carbon content weld metals. Several years ago B&W initiated a program to determine if it is necessary to maintain the preheat temperature until the part is given a high temperature postweld heat treatment. This report will document the results of this test work. In addition, the B&W Company now has many years of successful experience in dropping preheat on commercial pressure vessels prior to stress relief treatment.

Summary

Laboratory tests, which included weldments up to 6-3/8-inches thick, showed that the preheat temperature during welding is an important factor in preventing hydrogen induced cracking. The maintenance of the preheat temperature after welding is not required to prevent cracking. This was shown to be true for highly restrained welds even when consumables with high moisture levels were used.

The appendix provides tabulated data on 97 commercial nuclear reactor vessel welds which were made where the preheat was dropped prior to the post-weld stress relief heat treatment. Careful nondestructive examination showed that hydrogen induced cracking did not occur in any of these weldments.

## 1.0 INTRODUCTION

Hydrogen induced cracking in weldments can be a severe problem if proper precautions are not taken by a manufacturer. This type of failure occurs when all of the following three conditions are satisfied:

1. Hydrogen is present.
2. Tensile stresses are acting on the weldment.
3. The heat affected zone (HAZ) microstructure is susceptible.

Hydrogen can be picked up from moisture in fluxes, the atmosphere, or from contaminants and transferred to the HAZ by diffusion. Tensile stresses are inevitable in any weldment. These are caused by shrinkage of the weld metal during cooling. In addition, most ferritic steels that are welded have some portion of the HAZ that may be susceptible to hydrogen cracking. It has been the practice of some reactor vessel manufacturers to maintain a temperature of 200 to 300°F until a high temperature postweld heat treatment (PWHT) has been accomplished after welding. This PWHT tempers the susceptible portion of the HAZ and causes some hydrogen to diffuse out of the weldment prior to reaching ambient temperature.

The current procedures used by B&W to minimize the presence of hydrogen during fabrication are standard throughout industry. The EXX15 and EXX18 classifications of manual electrodes and an automatic submerged arc (ASA) process utilizing a fused flux are used. These are low hydrogen consumables. Both of these processes insure that a minimum amount of hydrogen will be introduced to the weld. Also, the weld metal deposited by the ASA process with Linde 80 flux and 0.15 max. carbon wire is a low carbon deposit. (See weld metal chemistries in appendix.)

Several years ago Babcock & Wilcox initiated a program to determine if it was indeed necessary to maintain the preheat temperature until the part is given a high temperature PWHT. The use of low hydrogen processes and low carbon deposits reduces or eliminates the need for maintaining preheat temperature after welding.

A302 Grade B plate was used for the initial test work. This grade of steel is approximately equivalent in chemistry to A508 Class II but it is not purchased in the quenched and tempered condition. The as-received condition provides a "worse case condition" because the mixed microstructure of A302 Grade B would have a heat affected zone that would be more susceptible to hydrogen cracking than would a quenched and tempered A508 Class II.

It was theorized that since hydrogen diffuses fairly rapidly at 300°F and because it takes such long periods of time to finish our weldments, that the amount of hydrogen remaining after welding might be below the minimum level that would cause cracking. After the completion of this program, maintaining preheat for 8 to 10 hours after welding, and then dropping preheat became a standard manufacturing practice on Babcock & Wilcox Commercial Nuclear Vessels. This practice was also used on several G.E. Commercial Contracts.

Babcock & Wilcox has now had many years of experience in dropping preheat on Commercial Pressure Vessels prior to stress relief. The chemistries of the base metal and weld metal, the carbon equivalents of the base metal, the heat inputs and the processes used in welding, the inspections, and the acceptance criteria are all given in Appendix A. Our shops still call for the maintenance of preheat until a postweld heat treatment is accomplished for pressure boundary welds for Westinghouse components. On November 20, 1973, a presentation of the technical data we have generated to justify dropping preheat was made to Westinghouse personnel. They requested that we publish a report summarizing all of the laboratory data and shop experience to document the experience that justifies this approach. This report is intended to summarize this data.

## 2.0 INITIAL STUDY OF PREHEAT AND POSTHEAT

The initial study on the effect dropping preheat was done using 50 inch by 50 inch by 6-3/8 inch thick A302 Grade B plate. A 16 inch diameter plug was welded into the middle of one plate and 20 inch diameter plugs into the middle of two others using different conditions (see Figure 2.1). It took approximately two days to complete each weld. Figure 2.2 shows one of the actual plates after it had been welded. Table 2.1 shows the welding conditions and results for the three test plates. The nondestructive testing was performed after the welds had been at ambient temperature for two weeks.

Figure 2.3 shows a section through the first plate. The crack was caused by the lack of notch ductility in the base material. The initiation point of this crack was the backing strap and it ran 270° around the welds. It does not appear that the crack is hydrogen related.

Figure 2.4 is a chart of the defects that were found in the second test plate by longitudinal wave ultrasonic examination. Shear wave ultrasonic examination was also used. Table 2.2 shows the length and depth of the defects found.

This plate was sectioned in several places to confirm that the defects charted by ultrasonic examination were in fact hydrogen cracks. Figure 2.5 shows one of these sections; Figure 2.6 is a higher magnification view of the area of the crack and shows that this is a typical toe type hydrogen crack.

Nondestructive examination did not reveal any cracks in the third test plate. The plate was sectioned in several places to confirm this and no cracks were found. These three test plates were welded with our standard welding consumables and procedures. The restraint was much more severe than would be found in normal circle or longitudinal seam welds. The conclusions that were drawn from this data were:

1. The use of 300°F preheat and postheat for eight hours will prevent hydrogen cracking.

2. Ultrasonic examination will detect small cracks if proper preheat and postheat are not used.
3. Maintenance of the preheat temperature until stress relief is not necessary.

TABLE 2.1 WELDING CONDITIONS AND RESULTS OF  
THE THREE TEST PLATES

	<u>Weld I</u>	<u>Weld II</u>	<u>Weld III</u>
Heat Treatment Base Metal	Annealed	Quench and Temper	Quench and Temper
Plug Size	16 inches	20 inches	20 inches
Welding Method	ASA	ASA	ASA
Welding Materials	Linde 80 and Mn-Mo-Ni	Linde 80 and Mn-Mo-Ni	Linde 80 and Mn-Mo-Ni
Heat Input	90,700 joules/inch	100,000-110,000 joules/inch	100,000-110,000 joules/inch
Preheat	300°F	200°F	300°F
Interpass	500°F	250°F	350°F
Postheat	None	200-500°F 48 hours	300-350°F 8 hours
Stress Relief	1100-1150°F 6 hours	None	None
Cracking	270° originated from backing strap not preheat related	Many preheat related cracks	None

All of these plates were nondestructively examined using radiographic examination, ultrasonic examination, and magnetic particle examination.

TABLE 2.2 WELD II DEFECTS

<u>Long Wave</u>			<u>Shear Wave</u>		
<u>Defects</u>	<u>Length, inch</u>	<u>Distance Below Surface of Plate, inch</u>	<u>Defects</u>	<u>Length, inch</u>	<u>Node</u>
A	7/8	3	A	3	3/4
B	3/4	3-1/2	B	5	1/4
C	5/8	3	C	2-3/4	1/2
D	5/8	3	D	5-7/8	1/2
E	5/8	3-1/2	E	1-1/8	1/2
F	2	3	F	1-3/8	3/8
G	5/8	3	G	6	3/8
J	3/4	3	J	4-1/8	3/8
K	3/4	3-1/2	K	1-5/8	3/8
L	3/4	3-1/2	L	2-1/2	1/2
M	3/4	3-1/2			
N	5/8	3-1/2			
O	7/8	1-7/8			
P	5/8	4			
R	1	3			
S	1-3/4	4-1/8			
T	3/4	4-1/8			
U	5/8	3-1/2			
V	5/8	3-1/2			
W	1/2	3-1/4			
X	7/8	2-5/8			
Y	3/4	2-5/8			

CRYSTALS

Long Wave - 2.25 MHZ 3/4 Inch Diameter "2"

Shear Wave - 1.0 MHZ 1 Inch Square Ls

SCOPE

Sperry 721 Reflectoscope

### 3.0 MODIFIED BWRA RESTRAINT TEST

To attempt to gather more laboratory data on hydrogen related cracking, a modified BWRA restraint test was designed (see Figure 3.1) and a series of tests varying preheat and postheat were performed. Table 3.1 outlines the tests that were made and the cracking that was found in these tests. The base material that was used in these tests was quenched and tempered ASTM A302 Grade B. Standard welding consumables were used with no special control of the moisture level (except in one case wet flux was used).

The automatic submerged arc process was used to make these test welds using a 1/8 inch diameter Mn-Mo-Ni filler wire, Linde 80 flux, and 52,000 joules per inch heat input.

TABLE 3.1 MODIFIED BWRA RESTRAINT TEST,  
TEST VARIABLES AND RESULTS

<u>Test Plate No.</u>	<u>Preheat</u>	<u>Postheat</u>	<u>Extent of Cracking</u>
1	70°	None	Extensive-270° ID-HAZ Intergranular
1A	70°	None 300-8 hours	Extensive ID-HAZ-Cracks
8	200°	None	Cracks Present
6	200° (Wet Flux)	300-8 hours	Cracks
4	200°	200-8 hours	None
2	300°	300-8 hours	None
3	300°	300°-Maintained to Furnace	None

Figures 3.2 through 3.5 show sections through the different tests and the cracking that was found. Extensive fractographic work was done on these cracks and hydrogen cracking was confirmed. Figure 3.6 shows scanning electron fractographs of one of the fracture surfaces from this series of tests. These were typical and show intergranular cracking in the heat affected zone and plastic fracture in the weld metal.

The data from this program again show that 300 to 350°F preheat and 300 to 350°F postheat will prevent hydrogen cracking even in the presence of severe stress risers.

#### 4.0 RESTRAINED CIRCULAR GROOVE WELDS

This program was initiated to attempt to statistically correlate preheat, interpass, postheat, and welding consumable moisture levels with cracking. The plate material used was A533 Grade B (see Table 4.2).

The test plate configuration is shown in Figure 4.1. To insure that the interpass temperature on each test piece did not get out of control, the special water jacket shown in Figure 4.2 was used to cool the specimen during welding. The temperature was reduced to  $\pm 10^{\circ}\text{F}$  of the specified preheat temperature prior to the start of each pass. Three processes were used in this program, automatic submerged arc at 85,000 joules per inch heat input, 7/64 inch diameter flux core at 400 amperes, and 5/32 inch diameter manual metal arc at 150 amperes. Moisture was introduced into the welding consumables by storing them in a humidity chamber as shown in Figure 4.3. Three moisture levels were tested with each welding process.

The "wet" condition is defined as the amount of moisture in the materials after two to three weeks in the humidity box. The "dry" condition was defined as materials that had been taken from shipping containers and baked at  $400^{\circ}\text{F}$  for four hours. The "medium" moisture condition was defined as the amount of moisture left in the wet materials after baking at  $250^{\circ}\text{F}$  for one hour.

The moisture levels shown for dry consumables are typical of production.

TABLE 4.1 MOISTURE LEVELS OF CONSUMABLES

<u>Process</u>	<u>Wet, %</u>	<u>Medium, %</u>	<u>Dry, %</u>
MMA	1.06	0.43	0.14
FC	0.30	0.33	0.15
ASA Flux	0.04	0.05	0.02

TABLE 4.2 STATISTICAL DESIGN FOR THIRD STUDY

<u>Test</u>	<u>Process</u>	<u>Moisture Level</u>	<u>Preheat and Interpass, °F</u>
M-M-2-1	MMA	Medium	200
M-D-1	MMA	Dry	100
M-W-1	MMA	Wet	100
M-D-3	MMA	Dry	300
M-W-3	MMA	Wet	300
M-M-2-2	MMA	Medium	200
S-M-2-1	SAW	Medium	200
S-D-1	SAW	Dry	100
S-W-1	SAW	Wet	100
S-D-3	SAW	Dry	300
S-W-3	SAW	Wet	300
S-M-2-2	SAW	Medium	200
F-M-2-1	FCW	Medium	200
F-D-1	FCW	Dry	100
F-W-1	FCW	Wet	100
F-D-3	FCW	Dry	300
F-W-3	FCW	Wet	300
F-M-2-2	FCW	Medium	200

After welding all plates were allowed to cool to room temperature and at least two weeks elapsed prior to radiography. The results are shown in Table 4.3.

There was no UT on these tests because the test blocks were too small to allow a meaningful UT to be performed.

TABLE 4.3 RESULTS OF CIRCULAR GROOVE WELD TESTS

<u>Moisture Level</u>	<u>Identification No.</u>	<u>Preheat and Interpass, °F</u>	<u>Amount of Cracking</u>	<u>Process</u>
Dry	M-D-1	100	Crack 360°	MMA
Wet	M-W-1	100	Crack 360°	MMA
Dry	S-D-1	100	Crack 360°	SAW
Wet	S-W-1	100	Crack 360°	SAW
Dry	F-D-1	100	Crack 180°	FCW
Wet	F-W-1	100	Crack 270°	FCW
Medium	M-M-2-1	200	Slight Crack	MMA
Medium	M-M-2-2	200	Crack 360°	MMA
Medium	S-M-2-1	200	2 Radial Cracks	SAW
Medium	S-M-2-2	200	None	SAW
Medium	F-M-2-2	200	One 2 inch Crack	FCW
Medium	F-M-2-2	200	None	FCW
Dry	M-D-3	300	None	MMA
Wet	M-W-3	300	None	MMA
Dry	S-D-3	300	None	SAW
Wet	S-W-3	300	None	SAW
Dry	F-W-3	300	None	FCW
Wet	F-W-3	300	None	FCW

Figure 4.1 shows a typical crack from this study.

The results from this series of tests verify the results from the first two series of tests. With highly restrained test specimen and normal welding consumables, no cracking can be produced with a 300°F preheat. This is true even with extremely moist flux. In addition, these tests show that with this test configuration all welds cracked at 100°F preheat and that 200°F preheat is marginal.

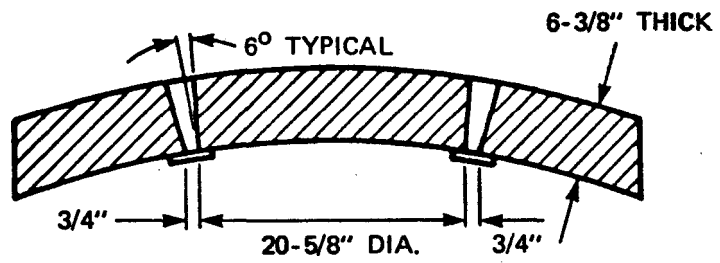
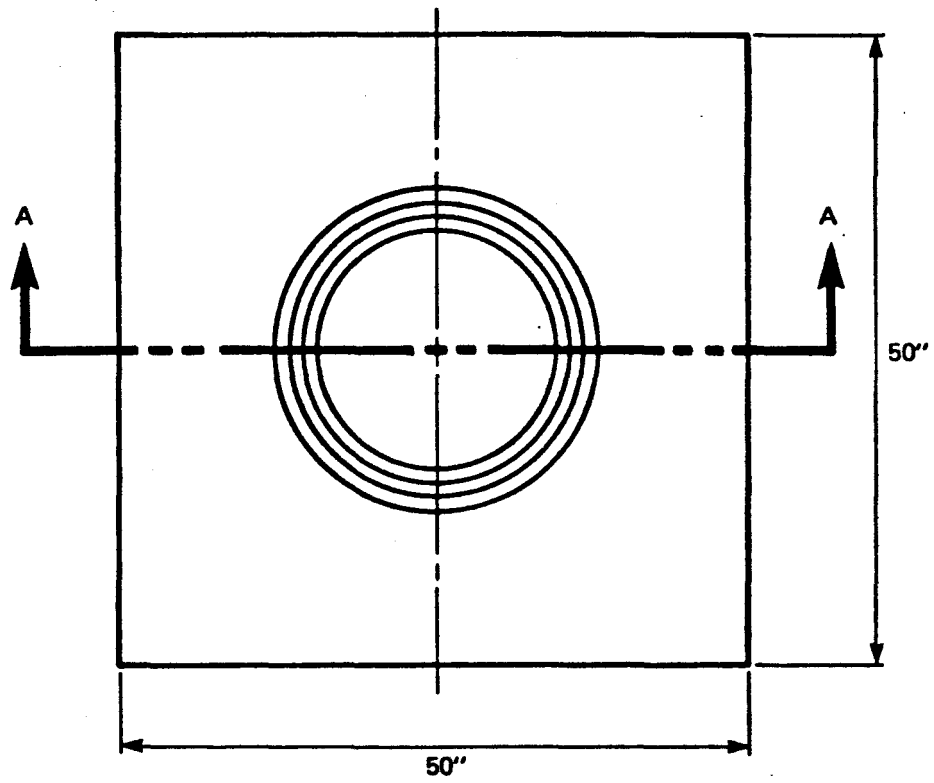


FIGURE 2.1 CIRCULAR PATCH SPECIMEN

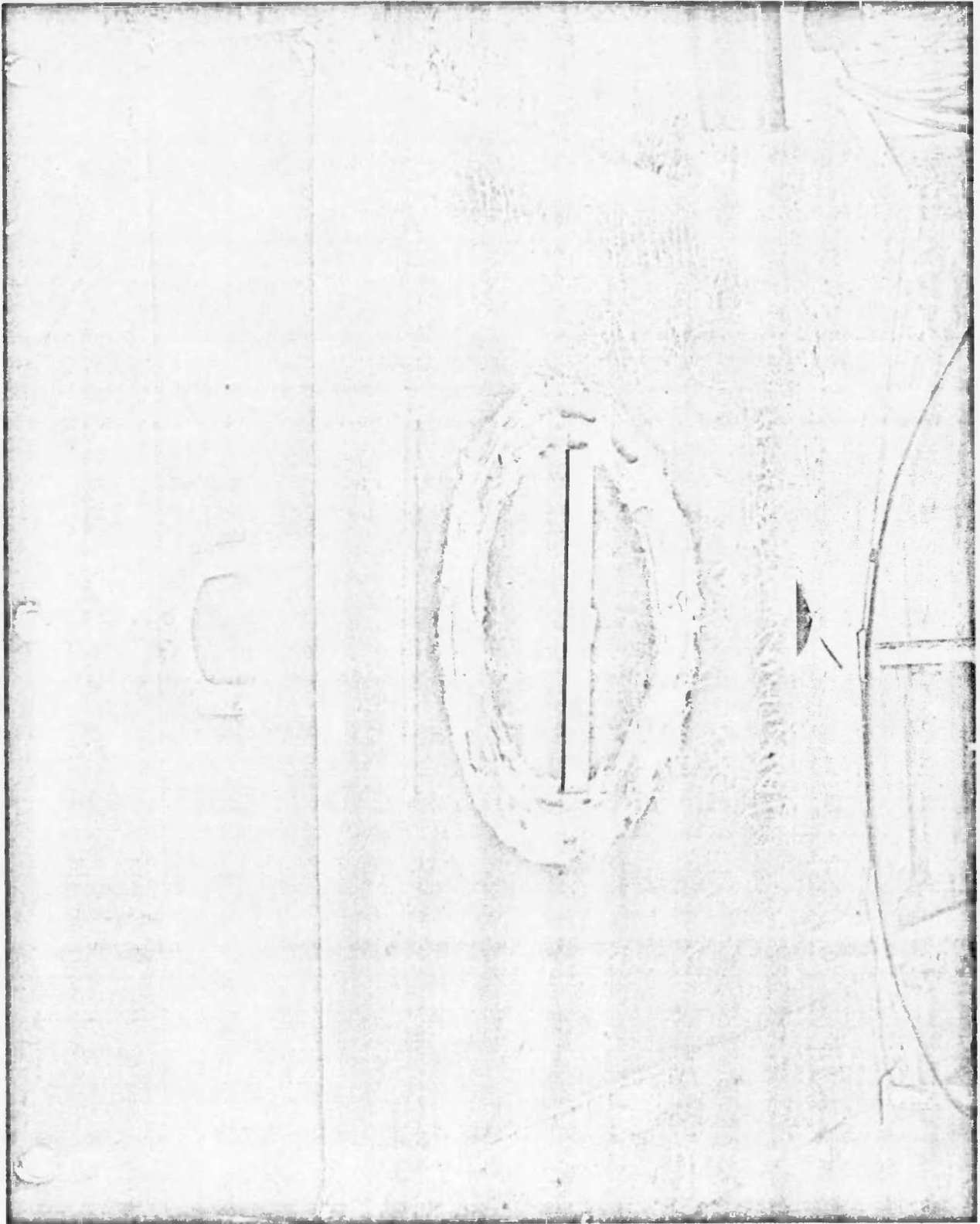
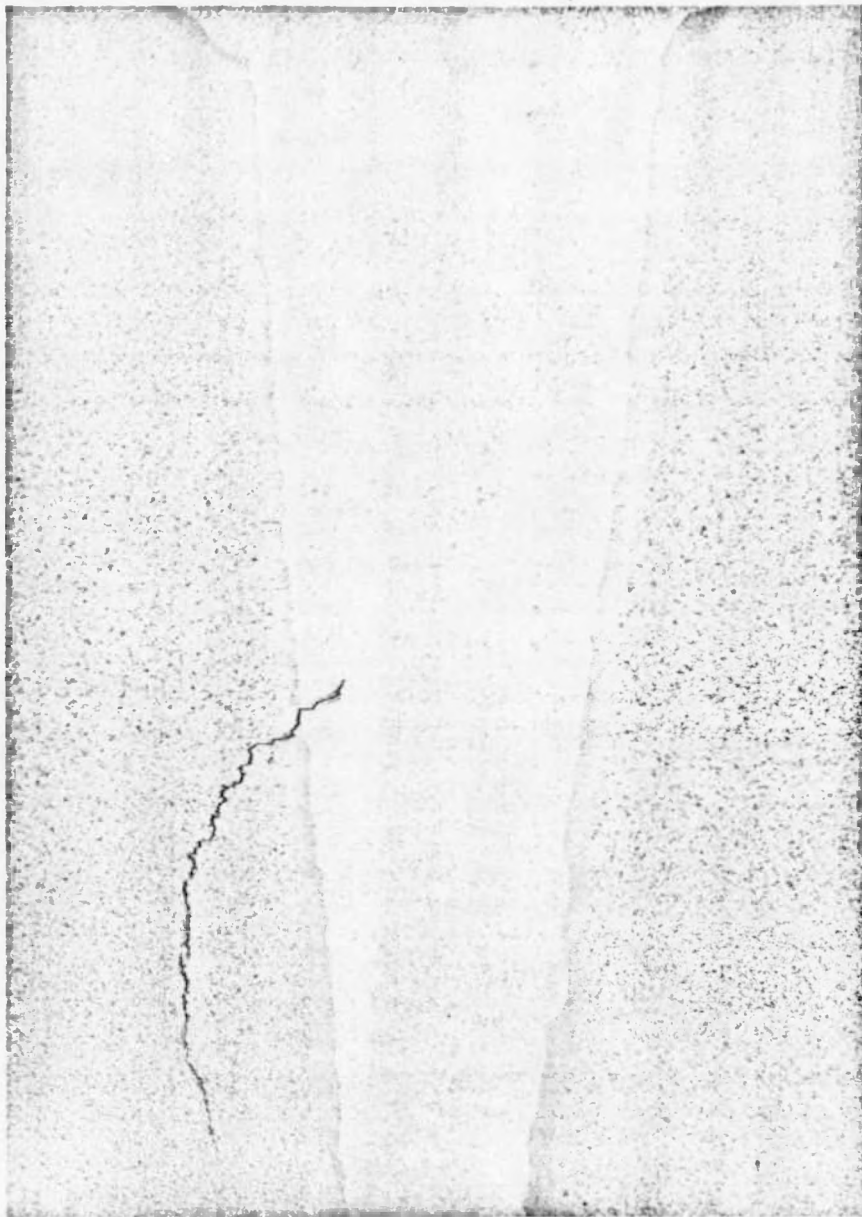


FIGURE 2.2 COMPLETED CIRCULAR PATCH SPECIMEN



**FIGURE 2.3 SECTION FROM CIRCULAR PATCH TEST WELD I**

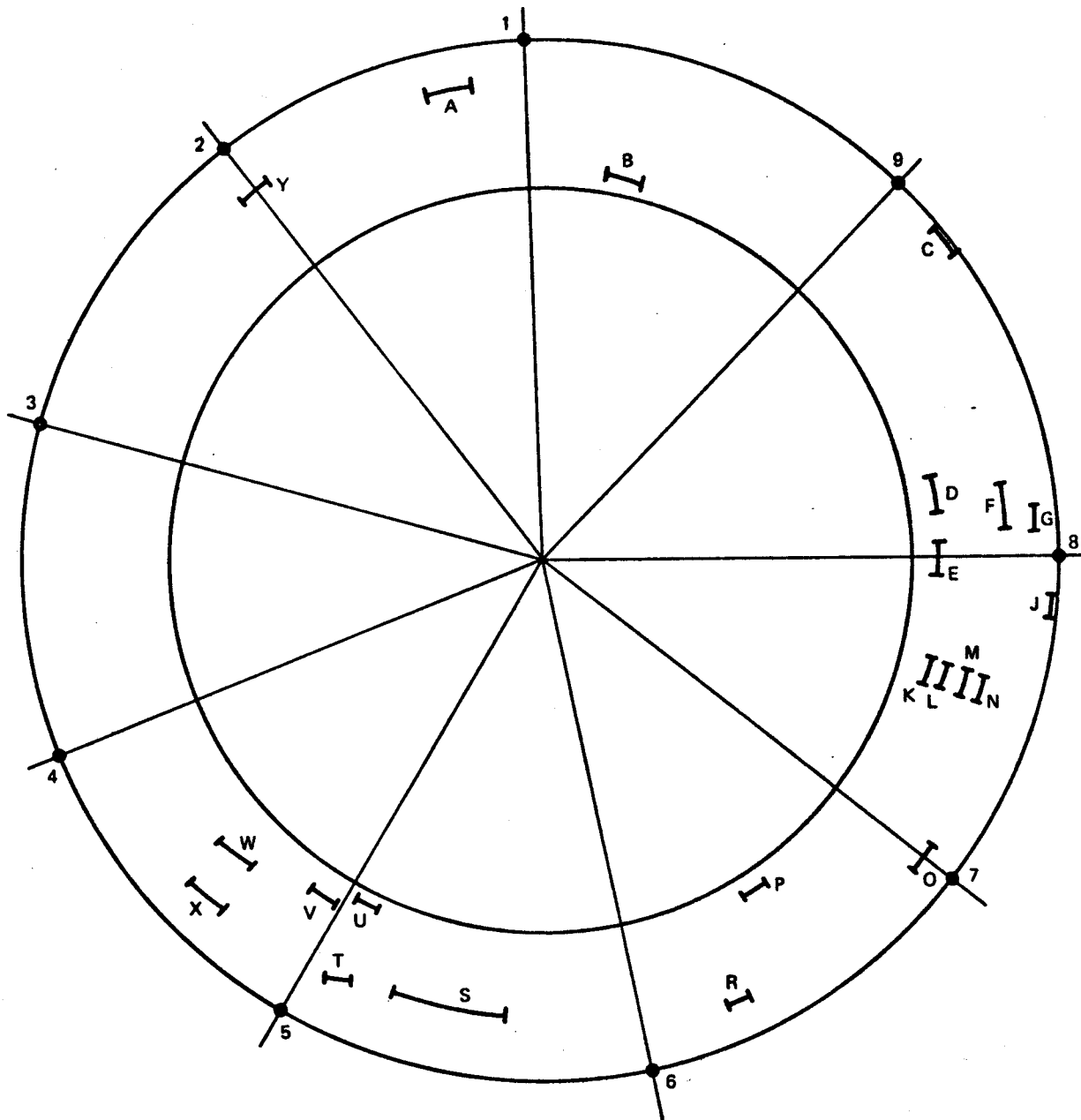


FIGURE 24 CIRCULAR PATCH TEST WELD II LONGITUDINAL WAVE EXAMINATION

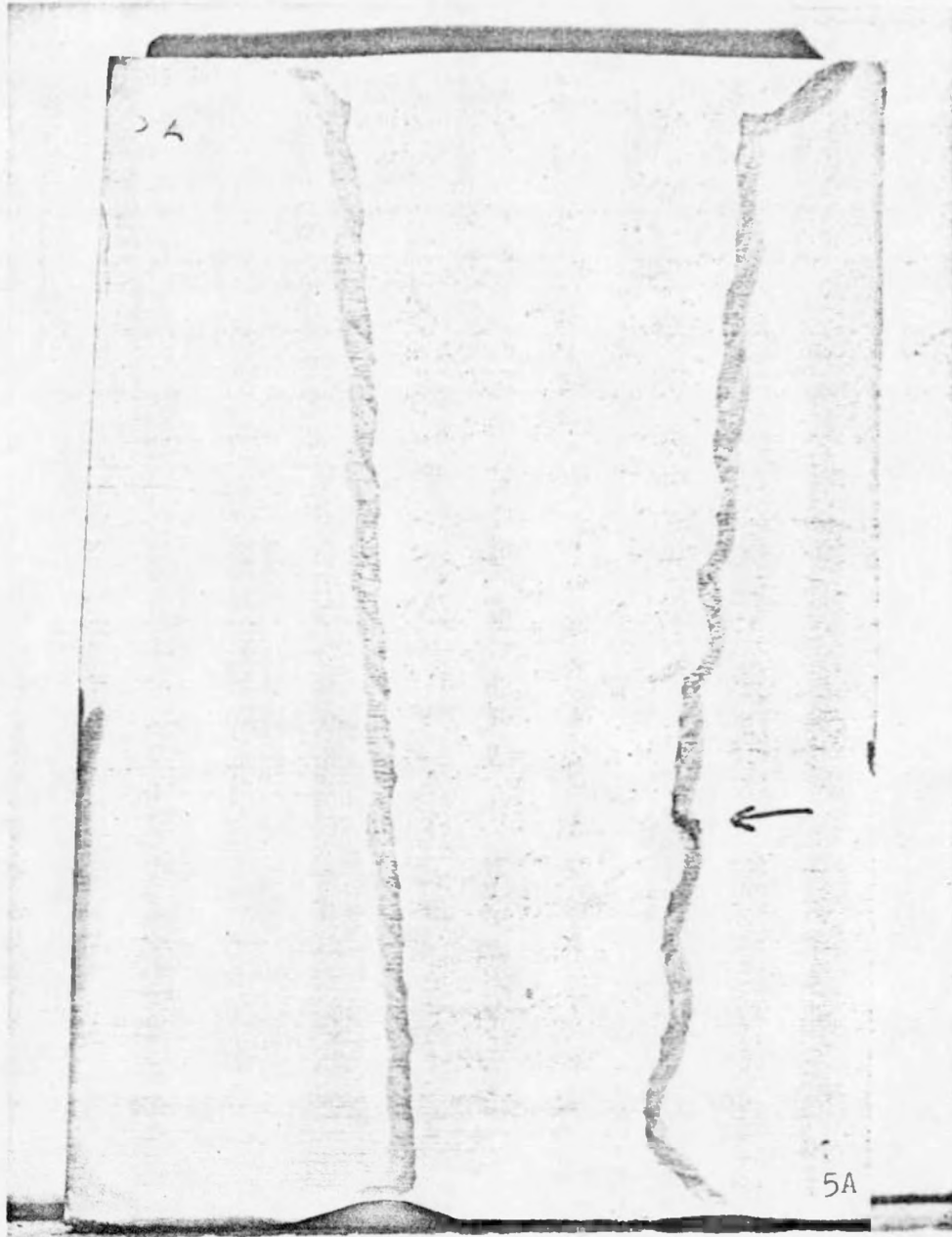


FIGURE 2.5 SECTION FROM CIRCULAR PATCH TEST WELD II



FIGURE 2.6 SECTION FROM CIRCULAR PATCH TEST WELD II

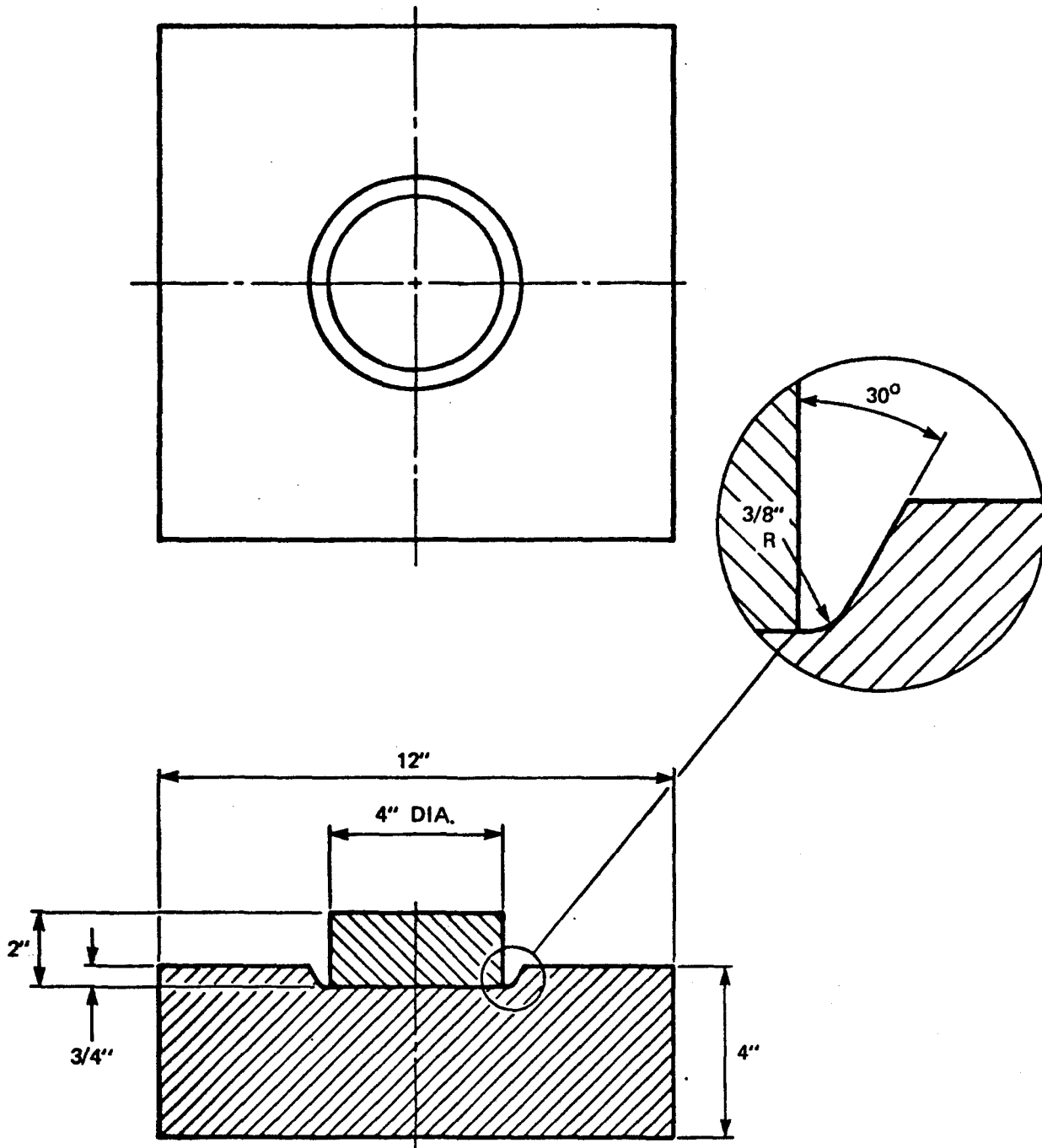
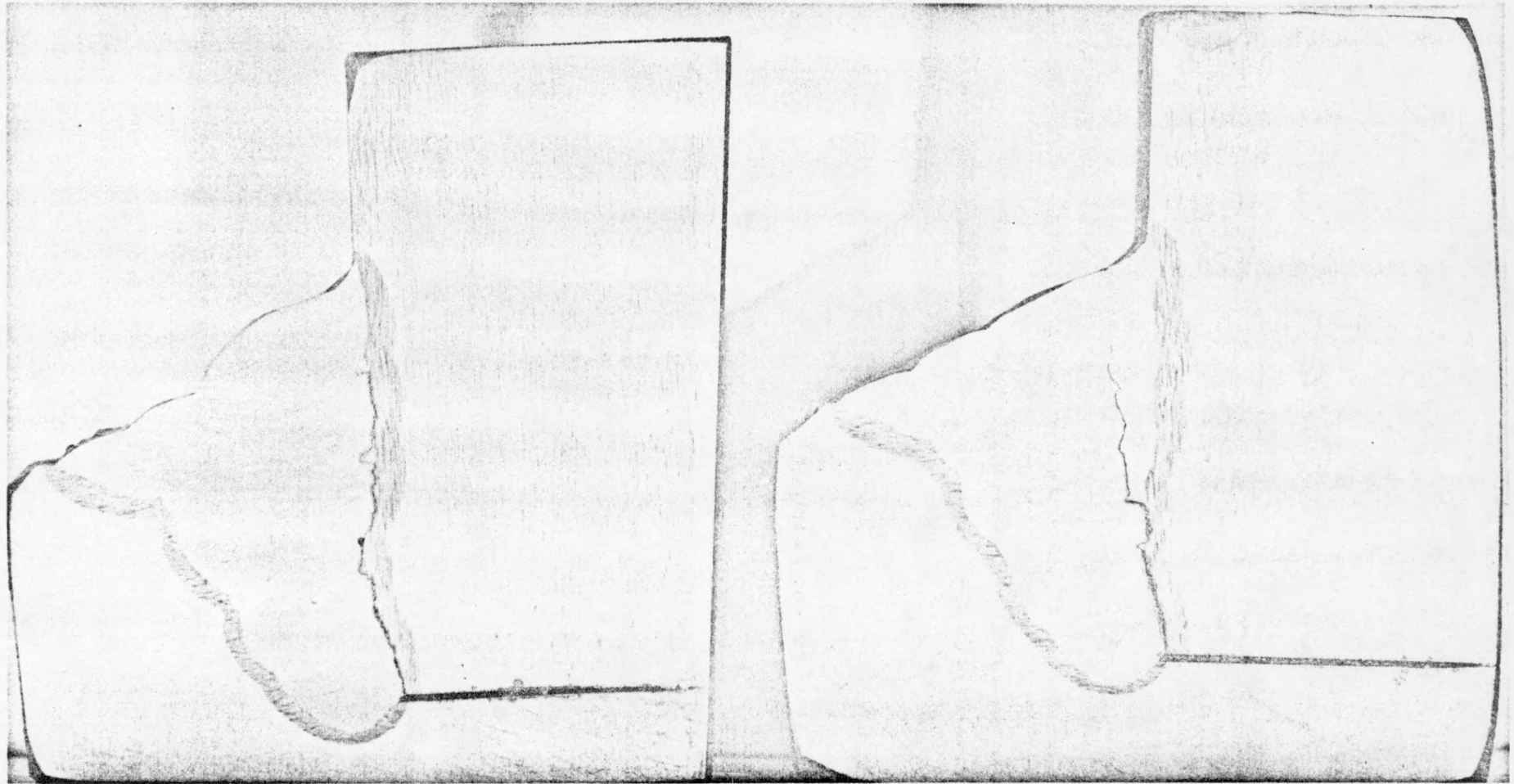


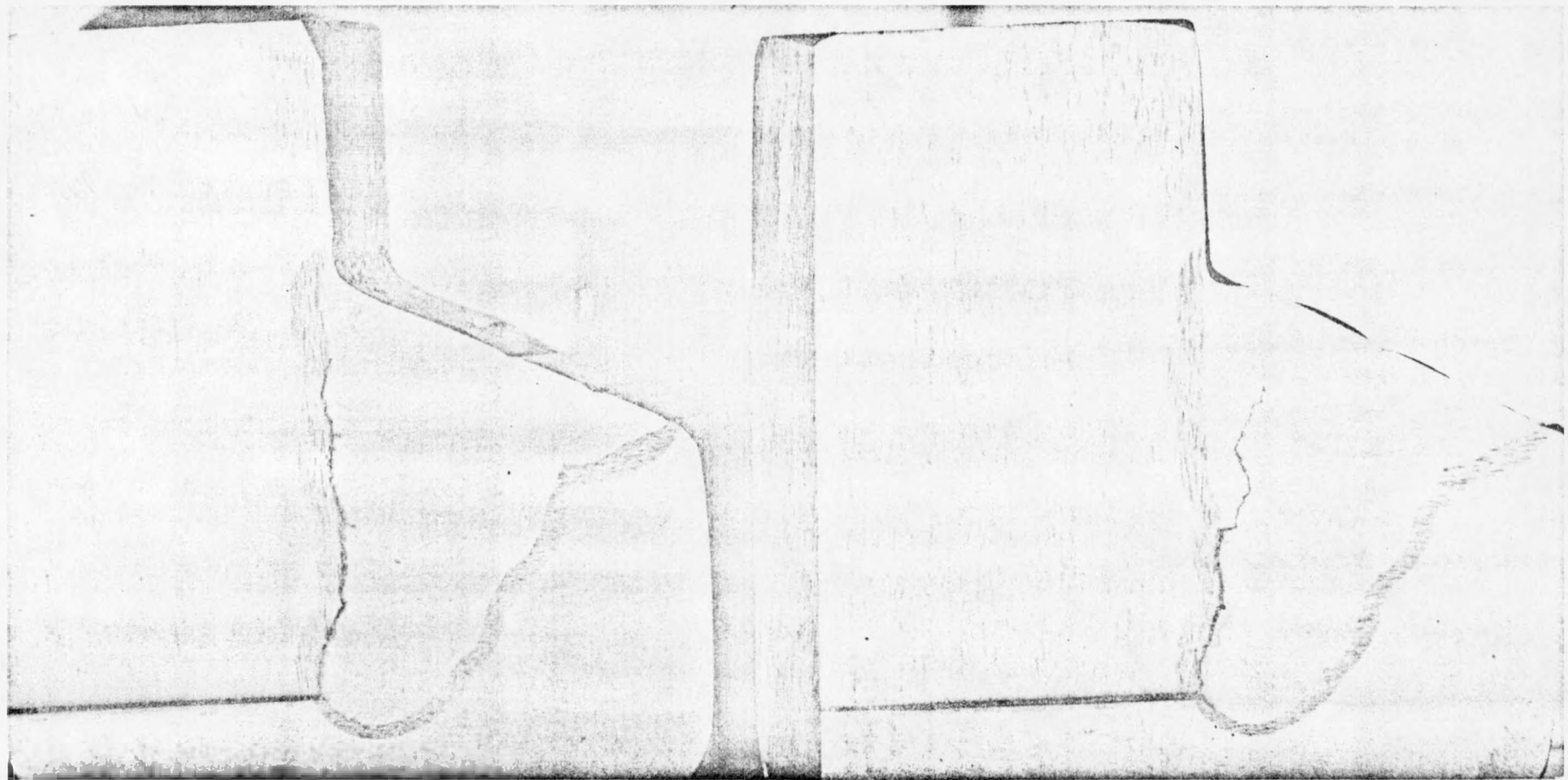
FIGURE 3.1 MODIFIED BWRA RESTRAINT TEST



#1 SEC 3

#1 SEC 4

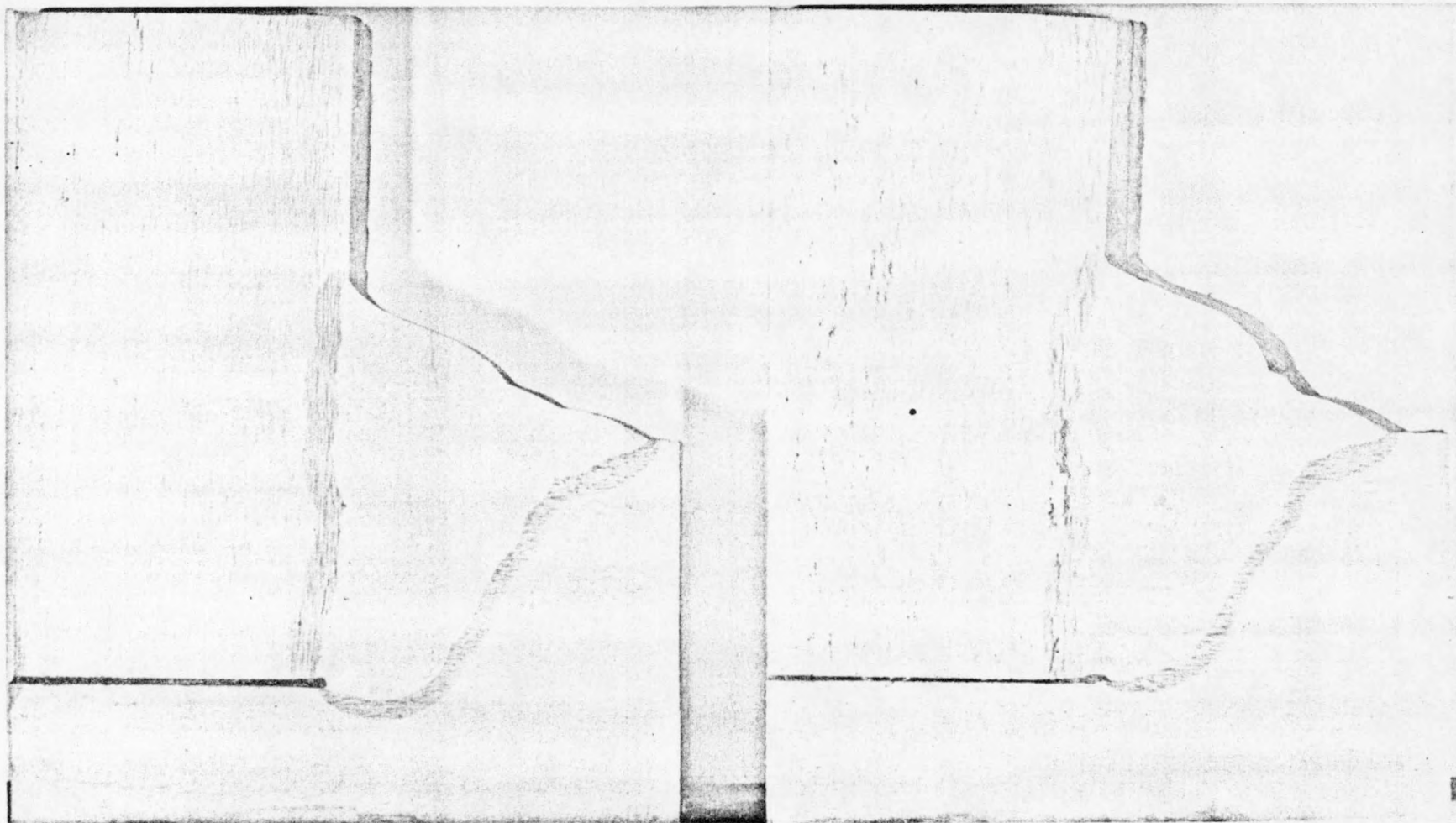
FIGURE 3.2 MODIFIED RESTRAINT TEST CROSS SECTIONS



#1 SEC 1

#1 SEC 5

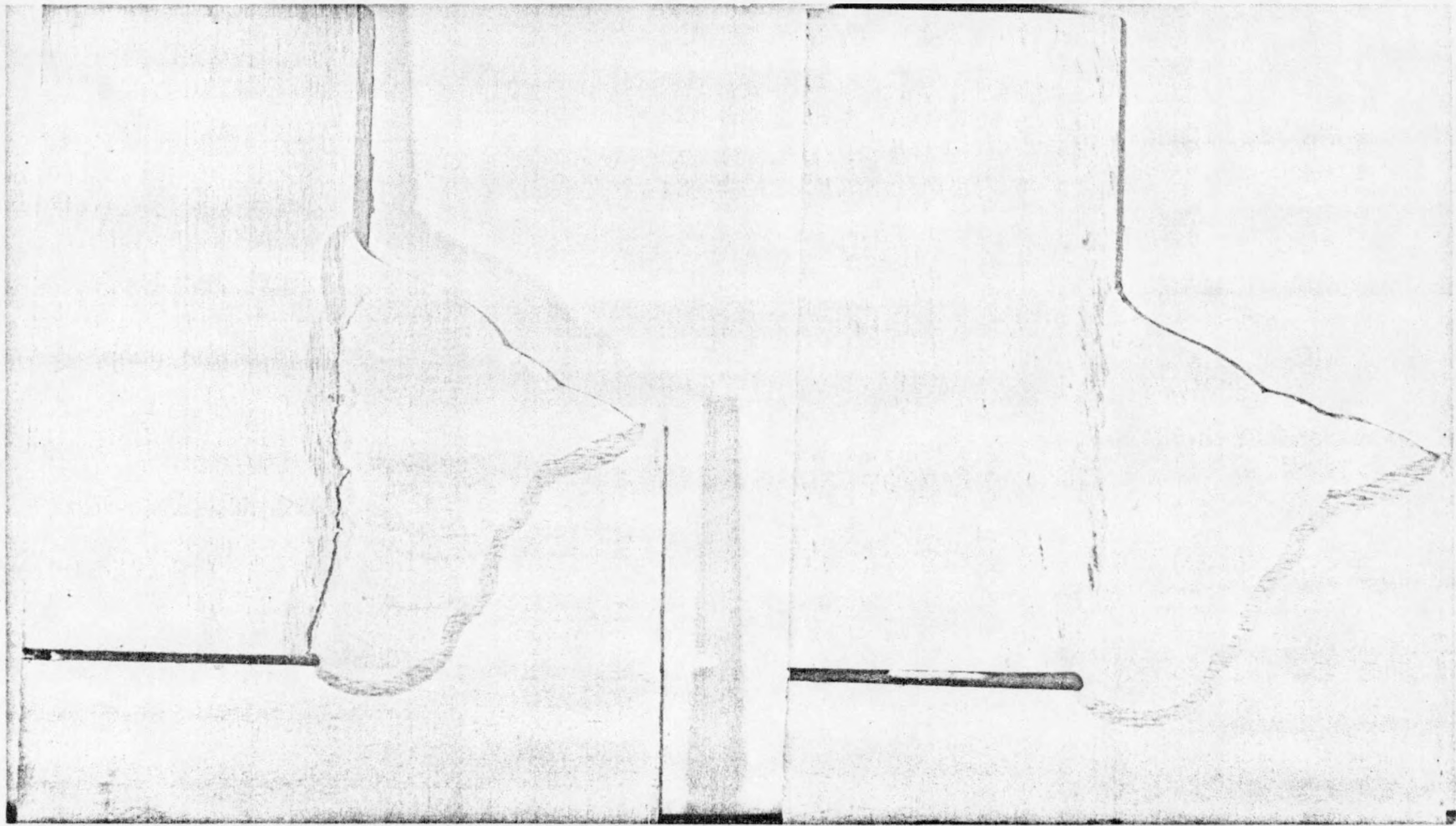
FIGURE 3.3 MODIFIED RESTRAINT TEST CROSS SECTIONS



#1a SEC 3

#1a SEC 4

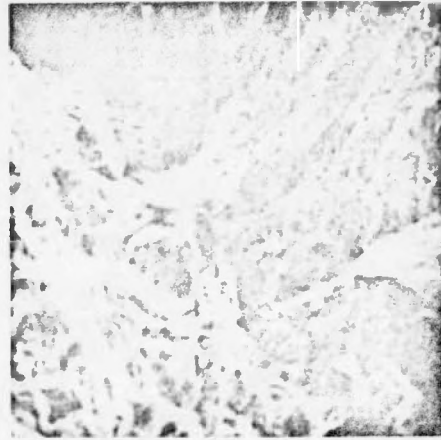
FIGURE 3.4 MODIFIED RESTRAINT TEST CROSS SECTIONS



#1a SEC 1

#1a SEC 2

FIGURE 3.5 MODIFIED RESTRAINT TEST CROSS SECTIONS



STEREO-PAIR X100  
PLASTIC FRACTURE IN WELD METAL



X100



X100

FIGURE 3.6 FRACTOGRAPHS FROM MODIFIED WELD RESTRAINT TEST SPECIMEN #1

SCANNING ELECTRON MICROSCOPE FRACTOGRAPHS OF FRACTURE SURFACES

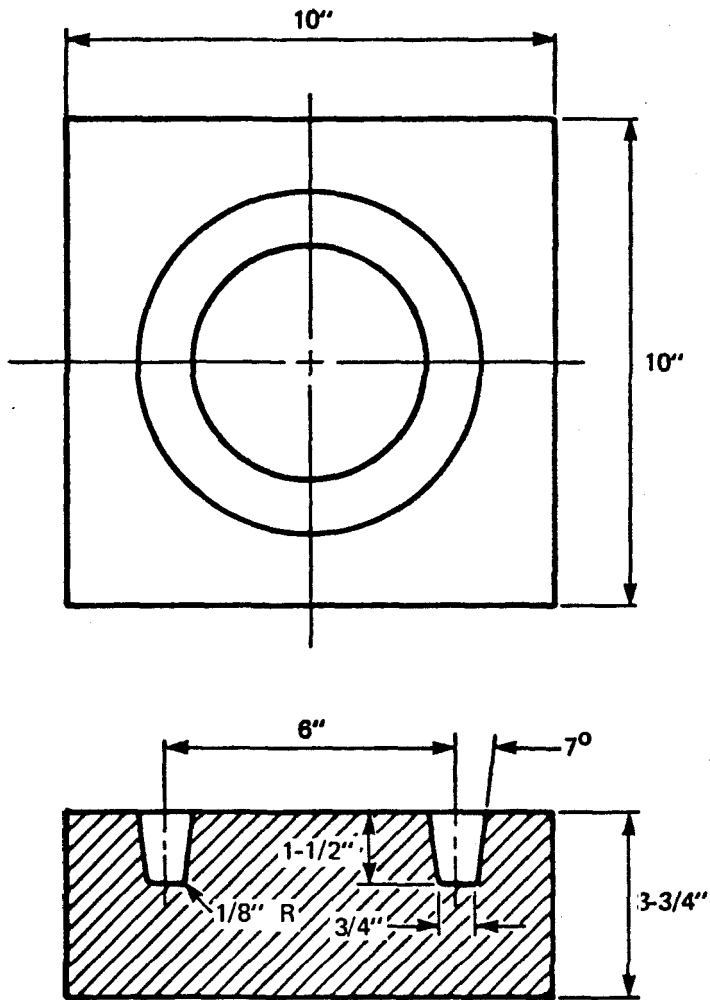


FIGURE 4.1 CIRCULAR "U" GROOVE TEST



**FIGURE 4.2 CIRCULAR "U" GROOVE TEST ARRANGEMENT**

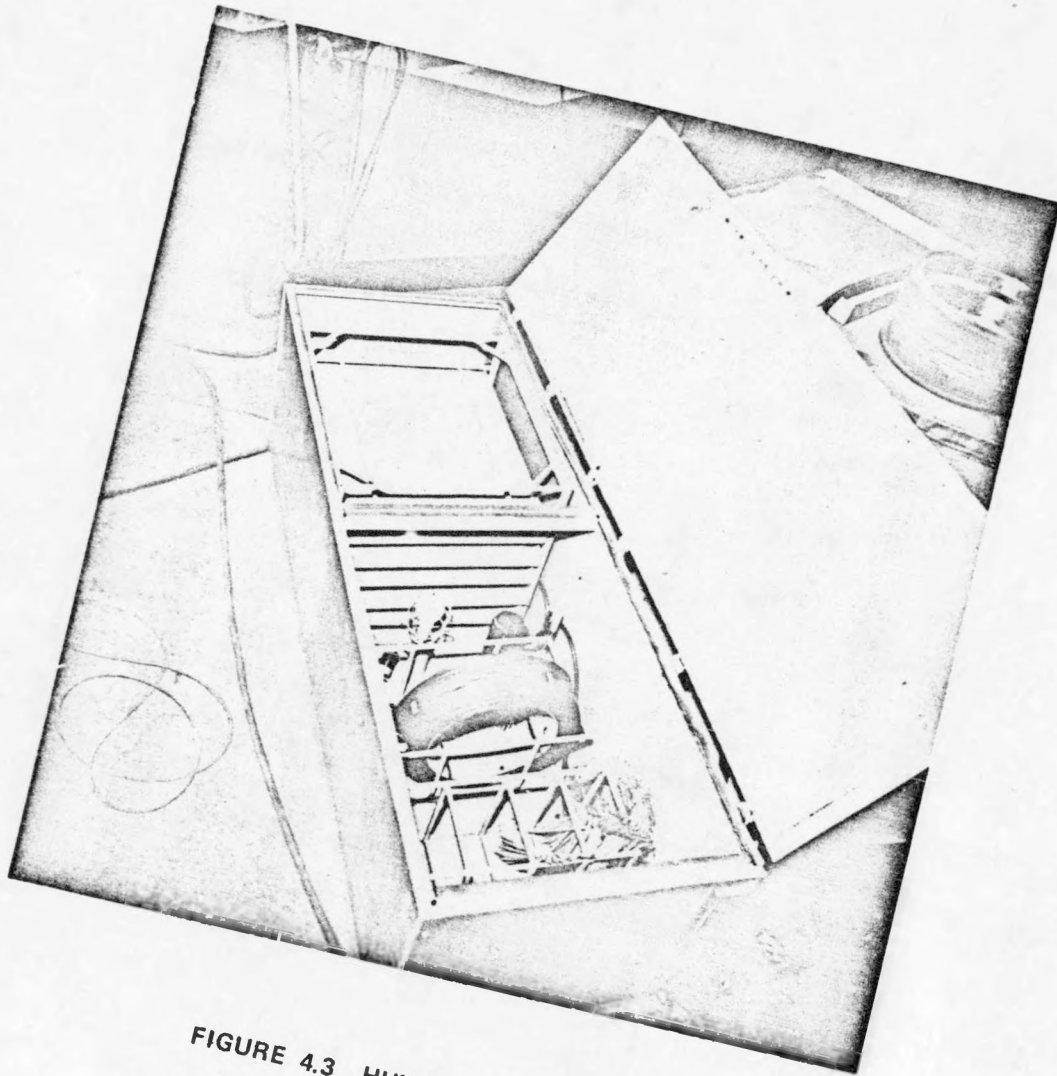


FIGURE 4.3 HUMIDITY CHAMBER

APPENDIX A  
DATA ON B&W COMMERCIAL COMPONENTS

This appendix contains a short summary of the special precautions B&W takes to insure that minimum preheat is not violated and to insure that a minimum amount of hydrogen is introduced to the weld. There is also a short section on the NDT that has been performed on our production welds and a tabulation of production weld metal and weld metal chemistries, the carbon equivalent of the base metals and the heat input used for welding. The carbon equivalent was calculated using the Welding Institute formula:

$$\text{C.E.} = \text{C} + \frac{\text{Mn}}{6} + \frac{\text{Cr} + \text{Mo} + \text{V}}{5} + \frac{\text{Ni} + \text{Cu}}{15}$$

#### A-1 PREHEAT PRECAUTIONS

To insure that the minimum preheat is maintained in production welding, the Welding Surveillance Section of the Welding Technology Department at Mt. Vernon checks each component that is being welded at the beginning and middle of each shift. This is done with temperature indicating crayons and the minimum temperature is recorded on a weld control card.

#### A-2 MINIMUM HYDROGEN PRECAUTIONS

To insure that a minimum amount of hydrogen is introduced to the weld metal the following standard procedures are followed. Care of manual metal arc electrodes that are issued to a welder is such that they will be used in a maximum of four hours. If by chance the welder has any electrodes remaining at the end of four hours, he returns these to the oven and is issued new electrodes.

The submerged arc flux that is used for circle and long seam welding is preheated in the flux hoppers to 500°F.

#### A-3 NONDESTRUCTIVE TESTING

Following is a description of the NDT inspection methods and acceptance standards used for each different method.

Radiography - 100% of all full penetration pressure boundary welds are radiographed after intermediate stress relief.

The following acceptance standards apply:

1. Any type of crack or zone of incomplete fusion or penetration is unacceptable.
2. Any other elongated indication which has a length greater than:
  - a.  $1/4$  inch for  $t$  up to  $3/4$  inch inclusive
  - b.  $1/3t$  for  $t$  from  $3/4$  inch to  $2-1/4$  inch inclusive
  - c.  $3/4$  inch for  $t$  over  $2-1/4$  inch

$t$  is the thickness of the thinner portion of the weld.

3. Any group of indications in a line that have an aggregate length greater than  $t$  in a length of  $12t$  except where the distance between the successive indications exceed  $6L$ , where  $L$  is the longest indication in the group.

In addition, all penetration welds on reactor vessels commencing with 620-0006 and up have been ultrasonic inspected to the following acceptance standards:

1. Discontinuities are unacceptable, if the amplitude exceeds the reference level and discontinuities have lengths which exceed:
  - a.  $1/4$  inch for  $t$  up to  $3/4$  inch inclusive
  - b.  $1/3t$  for  $t$  from  $3/4$  inch to  $2-1/4$  inch inclusive
  - c.  $3/4$  inch for  $t$  over  $2-1/4$  inch

$t$  is the thickness of the weld being examined.

2. Where discontinuities are interpreted to be cracks or incomplete penetration, they are unacceptable regardless of discontinuity or signal amplitude.

In addition, all welds will be either liquid penetrant inspected or magnetic particle inspected, both after an intermediate stress relief and a shop hydrostatic test.

The following are unacceptable:

1. Any cracks and linear indications.
2. Rounded indications with dimensions greater than 3/16 inch.
3. Four or more rounded indications in a line separated by 1/16 inch or less edge to edge.
4. Ten or more rounded indications in any 6 square inches of surface with the major dimension of this area not to exceed 6 inches, with the area taken in the most unfavorable location relative to the indications being evaluated.

The radiography acceptance standards apply before intermediate stress relief on contracts built to the 1968 ASME Section III Code. On all contracts built to the 1971 ASME Section III Code, the NDT inspection must be performed after an intermediate stress relief if one is required.

#### A-4 PRODUCTION WELDS

The data shown in Tables I through XXVI are for 97 welds made on commercial nuclear reactor vessels. In each case the vessels were permitted to cool to ambient temperature before the stress relief heat treatment. No hydrogen induced cracks have been produced.

TABLE I. 0004 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.230	0.64	0.008	0.018	0.28	0.73	0.37	0.61	0.04	0.014	--	0.56	90,000-100,000
Welded with ASA	0.085	1.36	0.019	0.014	0.42	0.54	0.06	0.37	--	--	0.18	--	
To													
Nozzle Belt	0.250	0.79	0.005	0.012	0.27	0.69	0.30	0.59	0.04	0.020	--	0.61	90,000-100,000
Welded with ASA	0.080	1.24	0.015	0.013	0.47	0.50	0.06	0.54	--	--	0.17	--	
To													
Upper Shell	0.250	0.65	0.006	0.009	0.23	0.76	0.36	0.64	0.04	0.010	--	0.62	90,000-100,000
Welded with ASA	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	0.290	--	--	
To													
Intermediate	0.240	0.63	0.006	0.012	0.25	0.75	0.36	0.62	0.02	0.010	0.04	0.60	90,000-100,000
Shell Welded	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.22	--	
With ASA													
To													
Lower Shell	0.240	0.64	0.010	0.010	0.23	0.80	0.39	0.58	0.01	0.010	--	0.60	90,000-100,000
Welded with ASA	0.085	1.36	0.019	0.014	0.42	0.54	0.06	0.37	--	--	1.80	--	
To													
Dutchman Welded	0.200	0.63	0.010	0.011	0.23	0.72	0.38	0.57	0.02	0.008	--	0.55	90,000-100,000
With ASA	0.072	1.50	0.015	0.021	0.45	0.59	--	0.30	--	--	0.20	--	
To													
Lower Head	0.210	1.31	0.013	0.017	0.24	0.59	--	0.48	--	0.015	--	0.56	90,000-100,000

t-4

TABLE II. 0004 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head Dome Welded With MMA To Dutchman Welded With ASA To Head Flange	0.22	1.36	0.014	0.012	0.17	0.54	--	0.55	--	0.015	0.09	0.60	90,000-100,000
	0.25	0.62	0.007	0.017	0.24	0.76	0.34	0.66	0.03	0.010	--	0.60	90,000-100,000
	0.08	1.35	0.016	0.011	0.43	0.51	0.06	0.35	--	--	0.25	--	
	0.25	0.72	0.010	0.010	0.25	0.73	0.39	0.58	0.02	0.014	--	--	90,000-100,000

TABLE III. 0005 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.190	0.64	0.012	0.015	0.25	0.73	0.33	0.54	0.03	0.011	--	0.52	90,000-100,000
Welded with ASA	0.070	1.48	0.020	0.011	0.47	0.62	0.16	0.37	--	--	0.21	--	
To													
Nozzle Belt	0.200	0.60	0.004	0.009	0.21	0.70	0.34	0.58	0.04	0.010	--	0.54	90,000-100,000
Welded with ASA	0.060	1.56	0.021	0.012	0.43	0.57	0.17	0.43	--	--	0.20	--	
To													
Upper Shell	0.260	0.63	0.006	0.008	0.28	0.72	0.34	0.64	0.04	0.010	0.08	0.62	90,000-100,000
Welded with ASA	0.080	1.34	0.014	0.013	0.49	0.52	0.05	0.45	--	--	0.22	--	
To													
Intermediate	0.240	1.36	0.010	0.017	0.23	0.57	--	0.51	--	0.015	--	0.61	90,000-100,000
Shell Welded	0.080	1.24	0.015	0.013	0.47	0.50	0.06	0.54	--	--	0.17	--	
With ASA													
To													
Intermediate	0.240	1.36	0.010	0.017	0.23	0.57	--	0.51	--	0.015	--	0.61	90,000-100,000
Shell Welded	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	--	0.29	--	
With ASA													
To													
Lower Shell	0.230	1.41	0.012	0.013	0.21	0.50	--	0.47	--	--	--	0.59	90,000-100,000
Welded with ASA	0.064	1.49	0.014	0.017	0.54	0.57	0.02	0.41	--	--	0.27	--	
To													
Dutchman	0.210	0.64	0.008	0.010	0.27	0.69	0.36	0.60	0.01	0.012	--	0.56	90,000-100,000
Welded with ASA	0.070	1.60	0.014	0.011	0.40	0.46	--	0.46	--	--	0.27	--	
To													
Lower Head	0.210	1.29	0.005	0.016	0.17	0.44	--	0.49	--	0.015	--	0.55	90,000-100,000

9-6

TABLE IV. 0005 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Head Flange	0.21	0.67	0.009	0.011	0.26	0.68	0.33	0.60	0.01	0.010	--	0.54	90,000-100,000
Welded with ASA	0.08	1.43	0.017	0.015	0.43	0.60	0.12	0.42	--	--	0.16	--	
To													
Closure Head	0.22	1.35	0.009	0.018	0.22	0.61	--	0.49	--	0.005	--	0.57	90,000-100,000
Dome													

TABLE V. 0006 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.270	0.63	0.016	0.017	0.22	0.76	0.35	0.65	0.040	0.010	0.100	0.62	90,000-100,000
Welded with ASA	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	--	0.290	--	
To													
Nozzle Belt	0.240	0.65	0.009	0.010	0.27	0.67	0.32	0.55	0.040	0.020	--	0.48	90,000-100,000
Welded with ASA	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	--	0.290	--	
To													
Upper Shell	0.230	0.66	0.005	0.010	0.45	0.71	0.11	0.58	0.050	0.020	--	0.58	90,000-100,000
Welded with ASA	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	--	0.290	--	
To													
Inter Shell	0.220	1.42	0.010	0.015	0.19	0.50	--	0.47	--	0.026	--	0.57	90,000-100,000
Welded with ASA	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
To													
Inter Shell	0.220	1.45	0.010	0.015	0.19	0.55	--	0.47	--	0.013	--	0.59	90,000-100,000
Welded with ASA	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
To													
Lower Shell	0.220	1.35	0.010	0.015	0.23	0.50	--	0.47	--	0.025	--	0.58	90,000-100,000
Welded with ASA	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
To													
Lower Shell	0.220	1.45	0.010	0.015	0.19	0.55	--	0.47	--	--	--	0.58	90,000-100,000
Welded with ASA	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
To													
Dutchman	0.020	0.68	0.009	0.010	0.25	0.76	0.36	0.59	0.010	0.010	--	0.58	90,000-100,000
Welded with ASA	0.070	1.60	0.014	0.011	0.48	0.46	--	0.40	--	--	0.270	--	
To													
Lower Head	0.220	1.36	0.014	0.012	0.17	0.54	--	0.55	0.015	--	0.090	0.62	90,000-100,000

8-V

TABLE VI. 0006 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head Dome Welded with ASA To	0.220	1.37	0.009	0.010	0.18	0.50	--	0.46	--	0.008	--	0.56	90,000-100,000
Closure Head Dutchman Welded with ASA To	0.075	1.50	0.024	0.066	0.60	0.58	--	0.51	--	--	0.221	--	
Head Flange	0.250	0.72	0.010	0.025	0.22	0.78	0.38	0.64	0.02	0.010	--	0.50	90,000-100,000
	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
	0.210	0.66	0.012	0.008	0.25	0.68	0.32	0.58	0.01	0.010	--	0.54	90,000-100,000

TABLE VII. 0007 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.260	0.72	0.013	0.017	0.24	0.84	0.34	0.70	0.04	0.020	--	0.64	90,000-100,000
Welded with ASA	0.080	1.52	0.018	0.015	0.12	0.64	0.06	0.39	--	--	0.25	--	
To													
Nozzle Belt	0.220	0.57	0.008	0.006	0.35	0.70	0.32	0.58	0.04	0.040	--	0.53	90,000-100,000
Welded with ASA	0.080	1.52	0.018	0.015	0.12	0.64	0.06	0.39	--	--	0.25	--	
To													
Upper Shell	0.260	0.65	0.007	0.016	0.24	0.72	0.34	0.62	0.04	0.020	--	0.60	90,000-100,000
Welded with ASA	0.080	1.52	0.018	0.015	0.12	0.64	0.06	0.39	--	--	0.25	--	
To													
Inter Shell	0.230	1.30	0.008	0.016	0.22	0.54	--	0.55	--	0.013	0.20	0.59	90,000-100,000
Welded with ASA	0.070	1.60	0.014	0.011	0.48	0.46	--	0.40	--	--	0.27	--	
To													
Inter Shell	0.230	1.30	0.008	0.016	0.22	0.54	--	0.55	--	0.013	0.20	0.59	90,000-100,000
Welded with ASA	0.070	1.60	0.014	0.011	0.48	0.46	--	0.40	--	--	0.27	--	
To													
Lower Shell	0.220	1.32	0.013	0.015	0.24	0.58	--	0.55	--	0.020	0.12	0.59	90,000-100,000
Welded with ASA	0.080	1.35	0.016	0.011	0.43	0.51	0.06	0.35	--	--	0.25	--	
To													
Dutchman	0.220	0.60	0.010	0.012	0.24	0.76	0.32	0.59	0.01	0.010	0.08	0.55	90,000-100,000
Welded with ASA	0.072	1.50	0.015	0.012	0.45	0.59	--	0.30	--	--	0.20	--	
To													
Lower Head	0.230	1.37	0.008	0.014	0.26	0.55	--	0.56	--	0.013	0.13	0.60	90,000-100,000

01-V

TABLE VIII. 0007 REACTOR VESSEL

<u>Part</u>	<u>S</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head Dome Welded with ASA	0.220	1.35	0.009	0.014	0.25	0.60	--	0.55	--	0.013	0.17	0.60	90,000-100,000
To	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	--	0.29	--	
Head Flange	0.210	0.62	0.011	0.010	0.23	0.71	0.36	0.59	0.01	0.010	--	0.54	90,000-100,000

TABLE IX. 0008 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.270	0.68	0.009	0.017	0.22	0.74	0.39	0.61	0.05	0.010	0.170	0.65	90,000-100,000
Welded with ASA	0.064	1.49	0.014	0.017	0.54	0.57	0.02	0.41	--	--	0.270	--	
To													
Nozzle Belt	0.220	0.64	0.018	0.026	0.22	0.74	0.35	0.65	0.04	0.020	--	0.52	90,000-100,000
Welded with ASA	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	--	0.290	--	
To													
Upper Shell	0.220	0.56	0.013	0.017	0.16	0.72	0.31	0.60	0.02	0.010	--	0.55	90,000-100,000
Welded with ASA	0.079	1.55	0.017	0.010	0.42	0.27	--	0.33	--	--	0.160	--	
To													
Inter Shell	0.220	1.41	0.014	0.013	0.18	0.55	--	0.53	--	--	0.170	0.59	90,000-100,000
Welded with ASA	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
To													
Inter Shell	0.210	1.32	0.010	0.016	0.20	0.52	--	0.57	--	0.012	0.150	0.58	90,000-100,000
Welded with ASA	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
To													
Lower Shell	0.022	1.41	0.014	0.013	0.18	0.55	--	0.53	--	0.012	0.170	0.59	90,000-100,000
Welded with ASA	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	0.290	--	--	
To													
Lower Shell	0.210	1.41	0.014	0.013	0.18	0.55	--	0.53	--	0.012	0.150	0.59	90,000-100,000
Welded with ASA	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	0.290	--	--	
To													
Dutchman	0.240	0.66	0.011	0.009	0.27	0.76	0.34	0.62	0.01	0.017	--	0.69	90,000-100,000
Welded with ASA	0.080	1.43	0.017	0.012	0.42	0.47	0.06	0.40	--	--	0.290	--	
To													
Lower Head	0.220	1.32	0.010	0.016	0.19	0.53	--	0.55	--	0.015	0.150	0.59	90,000-100,000

A-12

TABLE X. 0008 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head	0.210	1.25	0.008	0.016	0.22	0.60	--	0.46	--	0.015	0.12	0.54	90,000-100,000
Dome													
Welded with ASA	0.070	1.60	0.014	0.011	0.48	0.46	--	0.40	--	--	0.27	--	
To													
Head Flange	0.210	0.62	0.005	0.011	0.21	0.69	0.33	0.58	0.01	0.010	--	0.53	90,000-100,000

TABLE XI. 0009 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.020	0.066	0.011	0.012	0.027	0.085	0.043	0.059	--	0.019	--	0.56	90,000-100,000
Welded with ASA	0.088	1.500	0.019	0.010	0.450	0.710	0.110	0.330	--	--	0.29	--	
To													
Nozzle Belt	0.220	0.630	0.011	0.008	0.250	0.880	0.370	0.600	0.02	0.021	--	0.53	90,000-100,000
Welded with ASA	0.088	1.500	0.019	0.010	0.450	0.710	0.110	0.330	--	--	0.29	--	
To													
Upper Shell	0.210	0.620	0.012	0.009	0.260	0.840	0.360	0.600	0.02	0.019	--	0.52	90,000-100,000
Welded with ASA	0.088	1.500	0.019	0.010	0.450	0.710	0.110	0.330	--	--	0.29	--	
To													
Inter Shell	0.240	0.720	0.014	0.012	0.210	0.760	0.340	0.620	0.01	0.020	--	0.60	90,000-100,000
Welded with ASA	0.088	1.500	0.019	0.010	0.450	0.710	0.110	0.330	--	--	0.29	--	
To													
Lower Head	0.240	0.720	0.014	0.012	0.210	0.760	0.340	0.620	0.01	0.020	--	0.60	90,000-100,000
Welded with ASA	0.064	1.490	0.014	0.017	0.540	0.570	0.020	0.410	--	--	0.41	--	
To													
Dutchman	0.020	0.066	0.011	0.012	0.027	0.085	0.043	0.059	--	0.019	--	0.57	90,000-100,000
Welded with ASA	0.064	1.490	0.014	0.017	0.540	0.570	0.020	0.410	--	--	0.41	--	
To													
Lower Head	0.190	1.300	0.010	0.015	0.180	0.500	--	0.470	--	0.014	0.15	0.53	90,000-100,000

A-14

TABLE XII. 0009 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head	0.210	1.380	0.010	0.014	0.180	0.480	--	0.470	--	0.016	0.12	0.57	90,000-100,000
Dome Welded with ASA	0.088	1.500	0.019	0.010	0.450	0.710	0.11	0.330	--	--	0.29	--	
To													
Closure Head	0.250	0.620	0.007	0.017	0.240	0.760	0.34	0.660	0.03	0.010	--	0.55	90,000-100,000
Welded with ASA	0.088	1.500	0.019	0.010	0.450	0.710	0.11	0.330	--	--	0.29	--	
To													
Head Flange	0.210	0.068	0.010	0.010	0.030	0.089	--	0.063	--	0.016	--	0.49	90,000-100,000

TABLE XIII. 0011 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.200	0.68	0.009	0.008	0.26	0.66	0.38	0.57	0.02	0.008	0.140	0.55	90,000-100,000
Welded with ASA	0.088	1.50	0.019	0.010	0.45	0.71	0.11	0.33	--	--	0.290	--	
To													
Nozzle Belt	0.200	0.69	0.001	0.007	0.21	0.69	0.39	0.55	0.02	0.008	0.100	0.51	90,000-100,000
Welded with ASA	0.070	1.60	0.014	0.011	0.48	0.46	--	0.40	--	--	0.270	--	
To													
Upper Shell	0.180	0.70	0.009	0.005	0.25	0.68	0.44	0.60	0.01	0.008	0.150	0.55	90,000-100,000
Welded with ASA	0.070	1.60	0.014	0.011	0.48	0.46	--	0.40	--	--	0.270	--	
To													
Inter Shell	0.200	1.26	0.013	0.017	0.15	0.60	--	0.55	--	0.007	0.120	0.56	90,000-100,000
Welded with ASA	0.072	1.50	0.015	0.021	0.45	0.59	--	0.30	--	--	0.200	--	
To													
Inter Shell	0.200	1.26	0.013	0.017	0.15	0.60	--	0.55	--	0.007	0.120	0.56	90,000-100,000
Welded with ASA	0.072	1.50	0.015	0.021	0.45	0.59	--	0.30	--	--	0.200	--	
To													
Lower Shell	0.200	1.33	0.010	0.015	0.19	0.58	--	0.52	--	0.019	0.100	0.51	90,000-100,000
Welded with ASA	0.072	1.50	0.015	0.021	0.45	0.59	--	0.30	--	--	0.200	--	
To													
Lower Shell	0.200	1.33	0.010	0.015	0.19	0.58	--	0.52	--	0.019	0.100	0.51	90,000-100,000
Welded with ASA	0.072	1.50	0.015	0.021	0.45	0.59	--	0.30	--	--	0.200	--	
To													
Dutchman	0.220	0.66	0.009	0.009	0.24	0.70	0.34	0.60	0.01	0.004	--	0.56	90,000-100,000
Welded with ASA	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
To													
Lower Head	0.210	1.38	0.010	0.014	0.18	0.48	--	0.47	--	0.016	0.120	0.57	90,000-100,000

A-16

TABLE XIV. 0011 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>V</u>	<u>Co</u>	<u>Cu</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head Dome Welded with ASA To Head Flange	0.220	1.30	0.014	0.014	0.19	0.57	--	0.56	--	0.019	0.150	0.58	90,000-100,000
	0.075	1.50	0.024	0.006	0.60	0.58	--	0.51	--	--	0.221	--	
	0.210	0.79	0.012	0.007	0.26	0.68	0.41	0.62	0.01	0.008	0.120	0.59	90,000-100,000

TABLE XV. 620-0012 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.240	0.66	0.014	0.010	0.26	0.80	0.43	0.62	0.13	0.05	0.010	0.63	90,000-100,000
Welded with ASA	0.072	1.50	0.015	0.021	0.45	0.59	--	0.30	0.20	--	--	--	
To													
Nozzle Belt	0.190	0.64	0.012	0.013	0.24	0.82	0.36	0.60	--	0.02	0.010	0.53	90,000-100,000
Welded with ASA	0.072	1.50	0.015	0.021	0.45	0.59	--	0.30	0.20	--	--	--	
To													
Upper Shell	0.240	0.56	0.006	0.007	0.24	0.73	0.32	0.61	--	0.03	0.020	0.56	90,000-100,000
Welded with ASA	0.072	1.50	0.015	0.021	0.45	0.59	--	0.30	0.20	--	--	--	
To													
Intermediate	0.200	0.66	0.008	0.011	0.19	0.74	0.42	0.60	0.02	0.01	0.010	0.55	90,000-100,000
Shell Welded													
with ASA	0.070	1.60	0.014	0.011	0.48	0.46	--	0.40	0.27	--	--	--	
To													
Lower Shell	0.200	0.60	0.010	0.015	0.19	0.76	0.33	0.61	0.02	0.01	0.010	0.54	90,000-100,000
Welded with ASA	0.070	1.60	0.014	0.011	0.48	0.46	--	0.40	0.27	--	--	--	
To													
Dutchman	0.200	1.28	0.014	0.016	0.17	0.50	--	0.47	0.15	--	0.022	0.54	90,000-100,000
Welded with ASA	0.080	1.43	0.017	0.012	0.42	0.47	0.06	0.40	0.29	--	--	--	
To													
Lower Head	0.210	0.56	0.011	0.013	0.23	0.70	0.29	0.56	0.01	0.01	0.010	0.51	90,000-100,000

A-18

TABLE XVI. 620-0012 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head Dome Welded	0.150	0.57	0.008	0.009	0.24	0.72	0.33	0.55	0.02	0.01	0.020	0.45	90,000-100,000
with ASA	0.071	1.60	0.014	0.015	0.30	0.59	--	0.42	--	--	0.180	--	
To													
Head Flange	0.210	1.34	0.010	0.013	0.21	0.67	--	0.56	0.17	--	0.021	0.59	90,000-100,000

TABLE XVII. 620-0013 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.250	0.67	0.017	0.008	0.23	0.92	0.40	0.63	0.130	0.050	0.010	0.64	90,000-100,000
Welded with ASA	0.120	1.20	0.004	0.016	0.32	0.46	0.09	0.30	0.031	0.031	--	--	
To													
Nozzle Belt	0.210	0.67	0.005	0.009	0.28	0.75	0.38	0.61	0.010	0.030	0.010	0.59	90,000-100,000
Welded with ASA	0.120	1.20	0.004	0.016	0.32	0.46	0.09	0.30	0.031	0.031	--	--	
To													
Upper Shell	0.180	0.61	0.016	0.010	0.25	0.75	0.32	0.52	0.030	0.010	0.010	0.50	90,000-100,000
Welded with ASA	0.088	1.60	0.005	0.015	0.45	0.56	0.03	--	0.150	0.029	--	--	
To													
Lower Shell	0.220	0.65	0.012	0.016	0.30	0.74	0.33	0.55	0.010	0.010	0.010	0.54	90,000-100,000
Welded with ASA	0.088	1.60	0.005	0.015	0.45	0.56	0.03	--	0.150	0.029	--	--	
To													
Dutchman	0.200	1.38	0.018	0.011	0.23	0.49	--	0.49	0.170	--	0.014	0.60	90,000-100,000
Welded with ASA	0.088	1.60	0.005	0.015	0.45	0.56	0.03	--	0.150	0.029	--	--	
To													
Lower Head	0.230	0.61	0.006	0.008	0.23	0.70	0.34	0.60	0.040	0.030	0.020	0.54	90,000-100,000

A-20

TABLE XVIII. 620-0013 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head	0.19	0.66	0.008	0.012	0.24	0.71	0.34	0.03	--	0.010	0.030	0.41	90,000-100,000
Dome Welded with ASA	0.12	1.20	0.004	0.016	0.32	0.46	0.09	0.30	0.031	0.031	--	--	
To													
Head Flange	0.20	1.32	0.014	0.016	0.26	0.49	--	0.51	0.120	--	0.008	0.56	90,000-100,000

TABLE XIX. 620-0015 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.210	0.60	0.009	0.015	0.26	0.74	0.35	0.61	0.040	--	0.010	0.55	90,000-100,000
Welded with ASA	0.120	1.50	0.009	0.002	0.33	0.52	0.15	0.39	0.240	--	--	--	
To													
Nozzle Belt	0.210	0.74	0.007	0.007	0.25	0.72	0.36	0.55	0.080	0.01	0.020	0.56	90,000-100,000
Welded with ASA	0.120	1.50	0.009	0.002	0.33	0.52	0.15	0.39	0.240	--	--	--	
To													
Upper Shell	0.210	0.67	0.012	0.010	0.28	0.73	0.35	0.55	0.050	0.03	0.010	0.54	90,000-100,000
Welded with ASA	0.073	1.50	0.006	0.007	0.49	0.48	--	0.30	0.022	--	--	--	
To													
Lower Shell	0.220	0.61	0.012	0.008	0.24	0.68	0.35	0.56	0.100	0.03	0.020	0.55	90,000-100,000
Welded with ASA	0.073	1.50	0.006	0.007	0.49	0.48	--	0.30	0.022	--	--	--	
To													
Dutchman	0.220	1.24	0.010	0.018	0.27	0.53	--	0.48	0.180	--	0.012	0.55	90,000-100,000
Welded with ASA	0.120	1.50	0.009	0.002	0.33	0.52	0.15	0.39	0.240	--	--	--	
To													
Lower Head	0.220	0.67	0.021	0.021	0.26	0.75	0.28	0.56	0.130	0.04	0.020	0.55	90,000-100,000

A-22

TABLE XX. 620-0015 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head Dome	0.180	0.52	0.013	0.009	0.23	0.63	0.37	0.57	--	0.03	0.020	0.49	90,000-100,000
Welded with ASA To	0.071	1.59	0.011	0.013	0.46	0.58	--	0.32	0.23	--	--	--	
Head Flange	0.220	1.33	0.007	0.015	0.23	0.51	--	0.53	0.14	--	0.019	0.58	90,000-100,000

TABLE XXI. 620-0016 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.200	0.61	0.010	0.011	0.25	0.76	0.380	0.56	0.040	0.02	0.010	0.54	90,000-100,000
Welded with ASA	0.120	1.50	0.009	0.002	0.33	0.52	0.150	0.39	0.240	--	--	--	
To													
Nozzle Belt	0.200	0.60	0.013	0.012	0.20	0.73	0.350	0.56	0.050	0.02	0.010	0.53	90,000-100,000
Welded with ASA	0.085	1.30	0.012	0.010	0.45	0.66	0.008	0.32	0.260	--	--	--	
To													
Upper Shell	0.210	0.67	0.009	0.009	0.21	0.72	0.330	0.60	0.040	0.01	0.010	0.55	90,000-100,000
Welded with ASA	0.075	1.45	0.005	0.009	0.52	0.51	--	0.31	0.028	--	--	--	
To													
Lower Shell	0.220	0.66	0.011	0.010	0.23	0.70	0.350	0.61	0.030	0.01	0.010	0.56	90,000-100,000
Welded with ASA	0.075	1.45	0.005	0.009	0.52	0.51	--	0.31	0.028	--	--	--	
To													
Dutchman	0.210	1.30	0.013	0.020	0.26	0.54	--	0.50	0.090	--	0.009	0.56	90,000-100,000
Welded with ASA	0.120	1.50	0.009	0.002	0.33	0.52	0.150	0.39	0.240	--	--	--	
To													
Lower Head	0.240	0.72	0.022	0.010	0.26	0.76	0.350	0.57	0.120	0.04	0.010	0.60	90,000-100,000

A-24

TABLE XXII. 620-0016 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head Dome Welded with ASA	0.220	1.27	0.008	0.019	0.24	0.61	--	0.57	0.18	--	0.011	0.58	90,000-100,000
To	0.060	1.50	0.012	0.012	0.37	0.57	--	0.33	0.25	--	--	--	
Head Flange	0.230	0.65	0.009	0.250	0.71	0.35	0.60	--	0.03	0.01	0.560	0.48	90,000-100,000

TABLE XXIII. 620-0017 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.210	0.61	0.014	0.015	0.33	0.73	0.37	0.59	0.070	0.04	0.020	0.56	90,000-100,000
Welded with ASA	0.120	1.50	0.009	0.002	0.33	0.52	0.15	0.39	0.240	--	--	--	
To													
Nozzle Belt	0.220	0.64	0.010	0.013	0.24	0.69	0.35	0.60	--	0.01	0.010	0.55	90,000-100,000
Welded with ASA	0.120	1.50	0.009	0.002	0.33	0.52	0.15	0.39	0.240	--	--	--	
To													
Upper Shell	0.230	0.63	0.010	0.010	0.30	0.74	0.36	0.60	--	0.01	0.010	0.56	90,000-100,000
Welded with ASA	0.075	1.45	0.005	0.009	0.52	0.51	--	0.31	0.028	--	--	--	
To													
Lower Shell	0.220	0.65	0.009	0.009	0.21	0.71	0.37	0.60	--	--	0.020	0.55	90,000-100,000
Welded with ASA	0.075	1.45	0.005	0.009	0.52	0.51	--	0.31	0.028	--	--	--	
To													
Dutchman	0.210	1.38	0.012	0.018	0.23	0.54	--	0.50	0.160	--	0.013	0.58	90,000-100,000
Welded with ASA	0.054	1.60	0.019	0.015	0.40	0.66	--	0.34	0.210	--	--	--	
To													
Lower Head	0.230	0.75	0.008	0.007	0.35	0.81	0.33	0.62	0.030	0.01	0.010	0.59	90,000-100,000

A-26

TABLE XXIV. 620-0017 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head	0.230	0.56	0.008	0.008	0.15	0.74	0.33	0.61	0.10	0.03	0.013	0.56	90,000-100,000
Dome Welded with ASA	0.071	1.59	0.011	0.013	0.46	0.58	--	0.32	0.23	--	--	--	
To													
Head Flange	0.220	1.34	0.012	0.016	0.22	0.59	--	0.56	0.13	--	0.013	0.59	90,000-100,000

TABLE XXV. 620-0018 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Vessel Flange	0.210	0.69	0.008	0.009	0.25	0.89	0.37	0.56	0.100	0.020	0.010	0.57	90,000-100,000
Welded with ASA	0.071	1.59	0.011	0.013	0.46	0.58	--	0.32	0.230	--	--	--	
To													
Nozzle Belt	0.210	0.64	0.009	0.013	0.27	0.70	0.35	0.59	--	0.010	0.020	0.54	90,000-100,000
Welded with ASA	0.071	1.59	0.011	0.013	0.46	0.58	--	0.32	0.230	--	--	--	
To													
Upper Shell	0.210	0.65	0.009	0.010	0.26	0.71	0.36	0.59	--	0.010	0.020	0.54	90,000-100,000
Welded with ASA	0.120	1.20	0.004	0.016	0.32	0.46	0.09	0.30	0.031	0.031	--	--	
To													
Lower Shell	0.210	0.62	0.012	0.009	0.28	0.71	0.35	0.60	--	0.010	0.020	0.54	90,000-100,000
Welded with ASA	0.120	1.20	0.004	0.016	0.32	0.46	0.09	0.30	0.031	0.031	--	--	
To													
Dutchman	0.20	1.22	0.013	0.015	0.26	0.52	--	0.50	0.140	--	0.013	0.53	90,000-100,000
Welded with ASA	0.071	1.59	0.011	0.013	0.46	0.58	--	0.32	0.230	--	--	--	
To													
Lower Head	0.220	0.70	0.010	0.014	0.26	0.79	0.34	0.66	0.140	0.030	0.010	0.59	90,000-100,000

A-28

TABLE XXVI. 620-0018 REACTOR VESSEL

<u>Part</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Ni</u>	<u>Cr</u>	<u>Mo</u>	<u>Cu</u>	<u>V</u>	<u>Co</u>	<u>C.E.</u>	<u>Heat Input</u>
Closure Head	0.210	0.62	0.012	0.014	0.24	0.79	0.37	0.59	0.08	0.05	0.020	0.56	90,000-100,000
Welded with ASA	0.071	1.59	0.011	0.013	0.46	0.58	--	0.32	0.23	--	--	--	
To													
Head Flange	0.220	1.33	0.010	0.019	0.26	0.49	--	0.51	0.15	--	0.009	0.58	90,000-100,000