DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 12-26-79 CH. TSC DATE 12-26-79

F. P. 90026-06

Rev. No.	Date	Items Revised
7 Issue E	12-26-79	Paragraph 6.4 revised and Figure 10 added to include submerged arc flux trade names. Figure 9 put on new format. WE R L Davis 12/26/79 QA D L Miller 1/3/80 ANI [illegible] 1-3-80

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 3-14-75 CH. GRE DATE 3-19-75

F. P. 90026-06

REV. NO.	DATE	ITEMS REVISED
1	4-01-75	RECEIVED U. E. & C.
2	5-28-75	
3	8-14-75	MAR 1 8 1980
4	10-13-75	
5	11-06-75	SEABROOK STATION
6	12-01-75	
7	5-15-78	Complete Rewrite
Issue A	10-17-78	Paragraphs 12.3.6, 12.3.6.1, and 12.3.6.2 revised. Figure 5 revised. WE [signature] 10-17-78 QA _____ ANI [signature] 10-17-7
Errata	10-17-78	Figure 6 revised. WE [signature] 10-17-78 QA _____ ANI [signature] 10-17-78
Issue B	11-13-78	Paragraph 4.3 added. Figure 9 added. Paragraph 6.3.1.2 revised. Figure 2 revised. WE [signature] QA [signature] 11-20-78 ANI [signature] 11-20-78
Issue C	4-11-79	Paragraph 4.1.1 added (transferred from WPS'). Paragraphs 4.2.1, 4.2.2 and 12.3.4 added or revised to be consistent with the new ASME definitions of backing and retainers. WE [signature] QA [signature] ANI [signature] 4-11-79
Issue D	4-26-79	Provide for option to delete purge for GTAW when not required by customer specification. WE [signature] QA [signature] ANI [signature] 4-26-79

-NOTE-

When revisions to essential variables are made to a WPS referencing this procedure, a new revision number will be assigned to the WPS and that revision will be submitted to applicable clients for approval.

When editorial corrections, changes in nonessential variables or additional information for clarification are made to a WPS referencing this procedure, an "issue" letter will be assigned to the WPS, distribution made to the shop for use, and that procedure will be submitted to applicable clients for information.

WPS revisions and issues shall be approved by Dravo C.A. and reviewed by the authorized inspector (A.I./A.N.I.) prior to use in fabrication.

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 3-14-75 CH. GDE DATE 3-19-75

Rev. 7

F.P. 90026-06

1.0 SCOPE

1.1 This specification contains parameters for those essential and nonessential variables applicable to welding performed in accordance with the ASME Boiler and Pressure Vessel Code, which are shop standards and, therefore, not variables for welding at Dravo Pipe Fabrication Division. This specification is incorporated into Welding Procedure Specifications (WPS's) by reference in each WPS. Some parameters that vary only by process or weldment material are listed here and referenced in the WPS in sufficient detail to comply with Code requirements.

1.2 The parameters for nonessential variables contained in this specification may be modified to meet special customer requirements by the generation of contract addenda to this specification.

1.3 The parameters for essential variables contained in this specification are qualified by the PQR(s) referenced in each WPS.

1.4 This procedure does not control the inspection requirements or the acceptance criteria for welds. Inspection and acceptance levels shall be as shown in Dravo Standard Shop Procedures.

1.5 This revision complies with the requirements of the ASME IX (and addenda) applicable on the date of issue of this procedure. This procedure shall be reviewed for compliance with later editions and addenda, and revised only as required.

2.0 QUALIFICATIONS

2.1 WPS's, welders, and welding operators shall be qualified per the ASME Boiler and Pressure Vessel Code, Sections III and IX, unless otherwise specified.

2.2 (n) WPS's must be used exactly as written, with the exception of purge requirements (See 10.2). Any desired changes should be referred to Dravo Welding Engineering. Changes may require revision of a WPS, qualification of a new WPS, or selection of a different WPS.

3.0 WELDING PROCESSES

3.1 The welding process(es) (including type-manual, semiautomatic or machine) shall be as specified in the applicable WPS.

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION F.P. 90026-06	DR. RLD DATE 3-14-75 CH. GDE DATE 3-19-75

3.2 Processes shall be referred to by standard American Welding Society (AWS) abbreviations. See Figure 4.

3.3 All root processes are one pass.

4.0 JOINTS

4.1 Joint designs shall be as shown on the WPS or by reference in the WPS to the group(s) shown in Figure 8 of this procedure or other Dravo drawings or standards.

4.1.1 Group A, D, E & F joints may be welded from both sides (double welded).

4.2 Backing rings, when used, shall be as specified in the WPS.

4.2.1 Metallic backing ring composition shall be similar to the base material being joined, unless otherwise specified in the WPS.

4.2.2 Non-metallic backing rings may be used.

4.3 Standard root opening tolerances are given in Figure 9 for uniaxial, single welded, pipe-to-pipe, full penetration butt welds. Weld joints which cannot be machine beveled (e.g., laterals) may not meet the above tolerances. In these cases, the backside of the root will be visually inspected; ground, backgouged and backwelded as necessary, to provide for full penetration.

5.0 BASE METALS

5.1 Base metals to be joined shall be specified in the WPS by ASME IX "P" numbers, when available, or by material description.

5.2 WPS's designated for use for impact tested fabrication shall also show the "P" number group(s) and thickness range to which the WPS is applicable.

5.3 Base metal thickness ranges qualified shall be as specified in the WPS.

5.4 The maximum bead thickness shall not exceed 1/2".

6.0 FILLER MATERIALS

6.1 Filler materials specified in each WPS are selected with consideration of the compatibility of the base and filler metals from the standpoint of metallurgical properties, postweld heat treatment design and service requirements, and mechanical properties.

6.2 Consumable inserts, when used, shall be specified in the WPS and shall be similar in composition to the filler material to be used for the balance of the weld, unless otherwise specified.

6.3 Dravo 521 filler material and Dravo 521 insert material are purchased to the following requirements:

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 3-14-75 CH. GDE DATE 3-19-75

F. P. 90026-06

6.3.1 Manufacture and package in accordance with:

6.3.1.1 SFA 5.18, Class E70S-GB for GTAW and GMAW.

6.3.1.2 SFA 5.20, Class E70T-G for FCAW.

6.3.2 Chemistry to be in accordance with:

6.3.2.1 SFA 5.23, Class B3 for FCAW.

6.3.2.2 SFA 5.23, Class EB3-B3 with the silicon range modified to 0.40 to 0.75 and the carbon modified to 0.14 maximum for GTAW and GMAW.

6.3.3 Proprietary electrodes may be used and certified provided all requirements of Dravo 521 are met.

6.4 Welding flux for submerged arc welding shall be as specified in the WPS (by class, when applicable--otherwise, by trade name). See Figure 10 for flux trade names used by Dravo (unless otherwise specified in WPS).

6.5 For submerged arc welding, the alloy content of the weld is not largely dependent upon the composition of the flux.

6.6 The SMAW process shall not utilize electrodes larger than 1/4" diameter.

6.7 Supplemental filler metal, when used, shall be as specified in the WPS.

6.8 SFA and AWS specifications may be used interchangeably on WPS's and PQR's for those SFA specifications which contain a statement that they are identical to the AWS specification.

7.0 POSITIONS

7.1 The welding position shall be as specified in the WPS.

7.2 Definition of TOP QUARTER - with the pipe in the 5G position, welding is from the three and nine o'clock positions upward to twelve o'clock; or from twelve o'clock downward to three or nine o'clock. The pipe is then rotated 180 degrees and the same sequence is repeated.

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. KLS DATE 3-14-75 CH. GDE DATE 3-19-75

F.P. 90026-06

8.0 PREHEAT AND INTERPASS

8.1 Preheat temperatures for welding shall be as shown in Figure 1, attached, unless otherwise specified in the WPS.

8.2 Interpass temperature control shall be as shown in Figure 1, attached, unless otherwise specified in the WPS.

8.3 When welding is interrupted with loss of preheat, it may be resumed only after the weld surface has been cleaned and preheat has been reinstated. A 3/8" thickness of weld deposit (or for P-4 and P-5 material 25 per cent of the welding groove depth, whichever is greater) must be attained prior to the interruption of welding, with loss of preheat.

8.4 For P-4 and P-5 material, when the preheat is not maintained until stress relief or welding is interrupted, the weldment shall be wrapped with insulating material and permitted to cool until it has reached 150°F. Insulation wrapping may then be removed.

8.5 For P-1 material, preheat will not be maintained to PWHT.

9.0 POSTWELD HEAT TREATMENT (PWHT)

9.1 Postweld heat treatment shall be performed in accordance with one (1) of the following conditions as shown in the WPS:

Condition A: No postweld heat treatment is used;
Condition B: Postweld heat treatment is used (which is defined as below the critical range);
Condition C: Heat treatment of the weldment is applied above the critical range without additional postweld heat treatment;
Condition D: Heat treatment of the weldment is applied above the critical range with additional postweld heat treatment;
Condition E: Solution heat treatment is used.

9.2 Specific postweld heat treatment requirements (time, temperature, heating rate, and cooling rate) shall be as shown in the Shop Procedure. ASME IX, P-1 weld procedures and materials are qualified for 10 hours of PWHT time at temperature for ASME Section III

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION F. P. 90026-06	DR. RLD DATE 3-14-75 CH. GDE DATE 3-19-75

9.2 (Continued)
fabrications unless specified otherwise on the WPS. When the WPS is qualified for optional PWHT conditions, the PWHT used shall be recorded on other shop fabrication records which shall be included in the fabrication data package when required.

9.3 The PWHT conditions to be used may be designated in the WPS in either of the following ways:

9.3.1 By reference to the standard PWHT conditions given in Paragraph 9.1 above; or

9.3.2 By specifying typical PWHT temperature and/or time values which imply which PWHT condition is applicable. Note, as given in Paragraph 9.2 above, that specific PWHT requirements shall be as shown in the Shop Procedure (e.g., in a WPS for ASME IX, P-1 material, where PWHT is designated as 1100-1250°F for 1 hour per inch of thickness, the numbers given in the WPS mean nothing other than that the WPS is good for Condition B--PWHT below the critical range).

9.3.2.1 Note that QW-407 of ASME IX does not require WPS's to show PWHT parameters; but rather, this paragraph requires that the WPS show which PWHT conditions are qualified.

9.4 For information, Figure 7 attached shows a listing of lower critical temperatures for some typical piping materials.

10.0 GAS

10.1 The type of shielding gas(es) and the shop standard flow rates shall be as shown in Figure 2, unless otherwise specified in the WPS.

10.2 (D) GTAW root welds shall be performed with gas purge (backing) for at least the first 3/16 inch of joint thickness or the first two weld passes, except purge may be deleted where not required by customer specifications.

10.2.1 (D) When purge is not required, GWS-1 shall supercede the purge requirement in the WPS.

10.3 The type of purge gas and the shop standard flow rates shall be as shown in Figure 2, unless otherwise specified in the WPS. The purge gas flow rate represents a continuous flow rate after either an initial high rate purge of at least six (6) internal volumes or verifying that purge gas oxygen content does not exceed 1%, as determined by the use of an Oxygen Indicator.

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 3-14-75 CH. GDE DATE 3-19-75

F. P. 90026-06

10.4 Gas purge shall not be used for GMAW, unless indicated on the applicable WPS.

10.5 Trailing shields shall not be used.

11.0 ELECTRICAL CHARACTERISTICS

11.1 Welding current shall be direct current, unless otherwise specified in the WPS.

11.2 Reverse polarity (electrode positive) shall be used for direct current welding, except for the GTAW process.

11.3 Straight polarity (electrode negative) shall be used for the GTAW process.

11.4 Permissible current ranges for tungsten electrodes for GTAW are as shown in Figure 3, attached.

11.5 A 2% thoriated tungsten electrode (AWS 5.12, EWTh-2) is to be used for all GTAW processes, unless otherwise specified in the WPS.

11.6 The short-circuiting arc transfer mode shall be used for GMAW, unless otherwise specified in the WPS. However, FCAW shall not be the short-circuiting arc transfer mode.

12.0 TECHNIQUE

12.1 Cleaning:

12.1.1 The edges or surfaces of the parts to be welded shall be prepared by machining, chipping, grinding, flame cutting, plasma arc cutting, or air-carbon arc cutting. When surfaces are contaminated with oil, grease, paint, oxides, or other foreign materials, they shall be cleaned for a distance of at least one (1) inch on each side of the joint by grinding, blasting, or solvent. Thermal cutting methods shall be followed by grinding or machining to bright metal.

12.1.2 Interbead cleaning shall be accomplished using power wire brushing, pneumatic deslagging guns, grinding, or hand tools as necessary to remove oxidation, slag, and flux. On double welded joints, back gouging to sound metal by machining, grinding, air-carbon arc gouging, chipping, or filing shall be performed prior to welding from the second side.

PE-50

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLW DATE 3-14-75 CH. GDE DATE 3-19-75

F. P. 90026-06

12.1.3 Only aluminum oxide grinding wheels and austenitic stainless steel brushes, which have never been used on any ferritic material, shall be used on stainless steel base material. Cleaning of stainless steel base materials and consumable inserts for welding shall be performed with acetone.

12.2 Tack Welding:

12.2.1 Consumable insert tacks shall be made without consuming the insert.

12.2.2 Acceptable tack welds made by qualified welders need not be removed before welding, but shall be fused into the root pass.

12.2.3 Tack welds made by an unqualified welder must be removed.

12.3 Miscellaneous:

12.3.1 All processes used for root pass welding utilize the stringer bead technique. Arc manipulation may be performed to insure fusion to both sides of a groove and/or full consumption of an insert. Manual processes may use either string or weave technique following the root pass. The electrode weave for covered electrodes shall be limited to four (4) times the electrode core diameter for impact tested welding procedures and for welding procedures that limit heat input. The SAW process utilizes stringer beads, except for the cover pass which may be mechanically oscillated. Mechanical oscillation parameters shall be as shown in Figure 5. For impact tested procedures, SAW oscillation is prohibited.

12.3.2 Single pass or multipass welding per side may be used, except single pass welding per side is prohibited for impact tested procedures for SAW, GTAW, and GMAW processes.

12.3.3 All processes use a single electrode only.

12.3.4 Nonmetallic and nonfusing metal retainers shall not be used.

12.3.5 For impact tested procedures, minimum travel speeds, as shown in the WPS, have been calculated for specific amperage and voltage ranges to insure heat input does not exceed that qualified.

pg. 80

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 3-1--75 CH. GDE DATE 3-19-75

F.P. 90026-06

12.3.6 Magnetic or mechanical arc oscillation may be used with GTAW-ME.

12.3.6.1 Amplitude, oscillation frequency and dwell times shall be controlled by the weld operator as needed to insure full weld bead fusion and adequate weld bead contour, as determined by the weld appearance. Oscillation parameters shall be as shown in Figure 5 for nonimpact tested fabrication.

12.3.6.2 Amplitude, oscillation frequency and dwell times for impact tested fabrication shall be as shown on the applicable WPS.

12.3.7 No peening of welds is permitted.

12.3.8 Welding progression, when applicable (e.g., 3G, 5G, 6G and Top Quarter), shall be in accordance with Figure 6, unless otherwise specified in the WPS.

Written By _____ and J. S. Pribisko 5/18/78
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Lead Welding Engineer
J. S. Pribisko
Welding Engineer

Checked By _____
P. P. Norris
Chief Metallurgist

Q.A. Approved D. S. Gilchrist 5/18/78
D. S. Gilchrist
Quality Assurance Engineer

Reviewed by _____
W. Smith
(AI/ANI)

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. KLD DATE 3-14-75 CH. GDE DATE 3-19-75

Rev. 7

FIGURE 1

PREHEAT AND INTERPASS REQUIREMENTS (°F)

MATERIAL*	THICKNESS (INCHES)	MINIMUM PREHEAT TEMPERATURE	MAXIMUM INTERPASS TEMPERATURE
P-1	≤ 3/4	50°F	Not Controlled
P-1 Impact Tested	≤ 3/4	50°F	400°F
P-1	> 3/4	200°F	Not Controlled
P-1 Impact Tested	> 3/4	200°F	400°F
P-4	≤ 3/4	300°F	Not Controlled
P-4	> 3/4	400°F	Not Controlled
P-5	All	400°F	Not Controlled
P-8	All	40°F	350°F

*P-Numbers are those found in ASME IX, QW-422.

NOTE: Preheat requirements for materials not listed shall be shown on the WPS.

When welding dissimilar materials, the minimum preheat temperature required shall be the higher of the temperatures of the individual materials.

F.P. 90026-06

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO | GWS-1

DRAVO CORPORATION
GENERAL WELDING SPECIFICATION

DR. RLD
DATE 3-14-75
CH. GDE
DATE 3-19-75

F.P. 90026-06

FIGURE 2

STANDARD PARAMETERS FOR DRAVO WELDING

PROCESS	CONTACT TUBE-TO-WORK DISTANCE	SHIELDING GAS	SHIELDING GAS FLOW RATE	ARGON PURGE FLOW RATE	CUP SIZE
SAW	3/4" - 2"	---	---	---	---
GTAW-ME	---	100% Ar 75% Ar-25% He*	25-50 CFH	5 CFH min.	8-12
GTAW-MA	---	100% Ar	10-30 CFH	5 CFH min.	4-8
GMAW	1/4" - 3/4"	75% Ar-25% CO_2	25-45 CFH	---	---
FCAW-ME	3/8" - 1"	100% CO_2	40-60 CFH	---	---
FCAW-SA	3/8" - 1"	100% CO_2	40-60 CFH	---	---
GTAW-HW**	---	100% Ar	0-10 CFH	---	6-10

* GTAW-ME uses 75% Ar-25% He for welding stainless steel (P-3).
** The "HW" of GTAW-HW indicates hot wire.

FIGURE 3

MAXIMUM PERMISSIBLE CURRENT (AMPERES)
FOR 2% THORIATED TUNGSTEN ELECTRODES

ELECTRODE DIAMETER (INCHES)	DC STRAIGHT POLARITY[1] (MAXIMUM AMPERES)
1/16	100
3/32	200
1/8	300
5/32	400
3/16	500

[1] A 2% thoriated tungsten electrode (AWS 5.12, EWTh-2) is to be used with 100% Argon or 75% Argon-25% Helium shielding gas.

DRAVO CORPORATION · PIPE FABRICATION DIVISION · MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. [illegible] DATE 3-14-75 CH. [illegible] DATE 3-19-75

Rev. 7

FIGURE 4

STANDARD AMERICAN WELDING SOCIETY ABBREVIATIONS
FOR WELDING PROCESSES IN USE AT DRAVO

FCAW - Flux Cored Arc Welding

GMAW - Gas Metal Arc Welding (MIG)

GTAW - Gas Tungsten Arc Welding (TIG)

PAW - Plasma Arc Welding

SAW - Submerged Arc Welding

SMAW - Shielded Metal Arc Welding (Manual Stick)

SW - Stud Welding

The following suffixes may be used to indicate the method of applying the above processes:

ME - Machine Welding

MA - Manual Welding

SA - Semiautomatic Welding

Examples:

GMAW-SA Gas Metal Arc Welding - Semiautomatic (MIG)

SMAW-MA Shielded Metal Arc Welding - Manual (Stick)

F.P. 90026-06

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. [illegible] DATE 3-1-79 CH. [illegible] DATE 3-12-79

FIGURE 5

MACHINE WELD OSCILLATION SHOP STANDARDS

	MAXIMUMS
PROCESS	WIDTH/FREQUENCY/DWELL RATIO
GTAW-ME	1/2"/25cps/100:1 (Magnetic) 2"/800cpm/2 sec. (Mechanical)
SAW-ME	4"/60CPM/0

FIGURE 6

WELD PROGRESSION SHOP STANDARDS	
E6010/E7010 SMAW	Uphill
All Other SMAW	Uphill
GMAW Short Circuiting Arc	Downhill
GMAW All Other	Uphill
FCAW	Uphill
GTAW	Uphill

F. P. 90026-06

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 3-14-75 CH. GDE DATE 3-19-75 Rev. 7

FIGURE 7

TYPICAL LOWER CRITICAL TEMPERATURES*

MATERIAL DESIGNATION	ASME IX P-NUMBER	LOWER CRITICAL TEMPERATURE
SA-106B	P-1	1335°F
SA-335, P-11	P-4	1430°F
SA-335, P-22	P-5	1430°F
All	P-8	Does Not Apply, Always Austenitic

* Transformation temperatures (AC1) at which austenite begins to form on heating.

F. P. 90026-06

PF-50

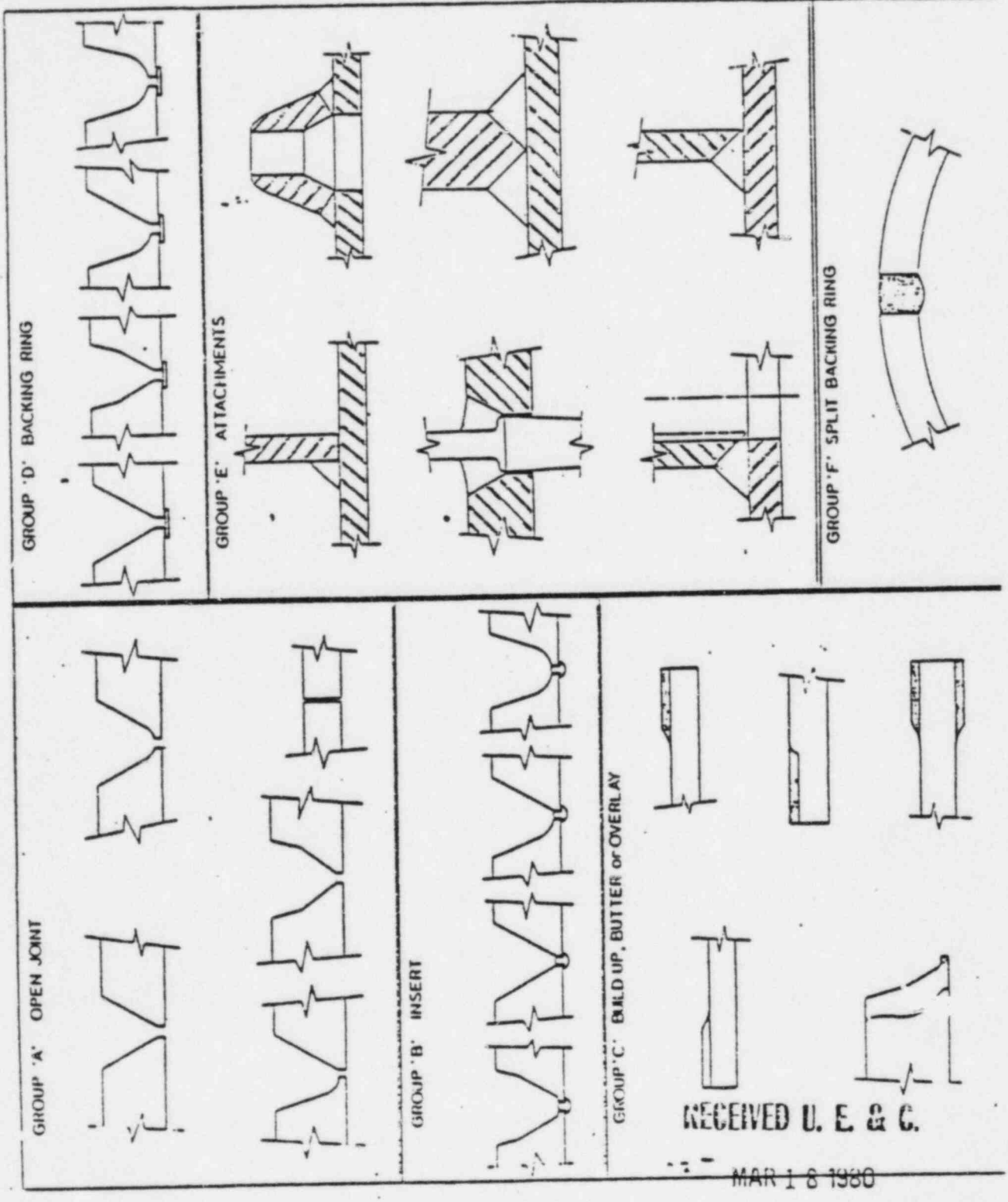
DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO | GWS-1

DRAVO CORPORATION
GENERAL WELDING SPECIFICATION

DR. RLL
DATE 3-14-75
CH. GDE
DATE 3-19-75

F.P. 90026 -06

FIGURE 8 - DRAVO STANDARD JOINT DESIGNS Rev. 7



PF-50

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 12-26-79 CH. [illegible] DATE 12-26-79

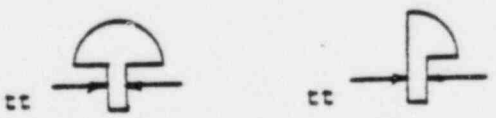
F.P. 90026 -06

Rev. 7

FIGURE 9

STANDARD ROOT OPENING TOLERANCES		
ROOT PROCESS	JOINT GROUP*	DIMENSIONS
GTAW-SA	A,E	3/16" ± 1/16"
GTAW-MA	A,E B	1/8" ± 1/16" tt + 1/32
GTAW-ME 1G	A,E B	0 + 1/32" tt + 1/32"
GTAW-ME 5G	A,E B	.045"-.093" tt + 1/32"
SMAW-MA	A,E,F	1/8" ± 1/16"
ALL APPLICABLE	D	1/8" Minimum

*See Figure 8



Consumable Inserts

PF-50

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	GWS-1
DRAVO CORPORATION GENERAL WELDING SPECIFICATION	DR. RLD DATE 12-26-79 CH. JSP DATE 12-26-79

FIGURE 10

SUBMERGED ARC FLUX TRADES NAMES	
MATERIAL USED	FLUX TRADE NAME
P-1	Linde 231 with SFA 5.17, EL-12 wire -or- Linde 709-5 with SFA 5.23, EA2 wire
P-4 & P-5	Linde 80

F. P. 90026-06

DRAVO CORPORATION - PIPE FABRICATION DIVISION	E2936 E2937 E2938 E2939	GWS-1

ADDENDA TO GENERAL WELDING SPECIFICATION GWS-1	PR	R. ABELE	Date	8-16-76
	CE	[signature]	Date	8-17-76
	QA	[signature]	Date	8/17/76
	ANI		Date	

F.P. 90026-06

PUBLIC SERVICE OF NEW HAMPSHIRE

SEABROOK STATION UNITS 1 & 2

ADDENDA TO GENERAL WELDING SPECIFICATION GWS-1

Rev.	Revised By	Date	Checked By	Date	Qual. Ass.	Date	ANI	Date	Sheet No. Revised

PE-50

DRAVO CORPORATION - PIPE FABRICATION DIVISION - MARIETTA, OHIO	E2936 E2937 E2938 E2939 GWS-1
ADDENDA TO GENERAL WELDING SPECIFICATION GWS-1	DR. BABELE DATE 6-16-78 CH. DATE

1. ADD TO PARAGRAPH 12.1.1:

   Thermal cutting of austenitic stainless steel must be followed by an additional 1/8" of material removal by mechanical means.

2. ADD TO PARAGRAPH 12.1.2:

   Thermal gouging of austentic stainless steel must be followed by an additional 1/8" of material removal by mechanical means.

3. CHANGE PARAGRAPH 12.3.1 TO READ:

   Electrode weave width shall be limited to 3 times the electrode core diameter for austenitic stainless steel and 5 times the electrode core diameter for carbon steel or low alloy steels.

F.P. 90026-06

Sam

back up

for case File

Memo 61-66