TVA 64 (OS-9-65)

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

ESB '840817 203

TO : Those listed

FROM : R. W. Cantrell, Acting Manager of Engineering Design, W11A9 C-K

DATE : August 16, 1984

SUBJECT: GENERAL CONSTRUCTION SPECIFICATION DISTRIBUTION - G-29C (R8) - ADVANCE REVISIONS

Attached are the following advance revisions for filing in your copy of General Construction Specification G-29C (R8):

Detail Weld Procedure SM-SW-P-4, Rev. 3. Remove and destroy SM-SW-P-4, Rev. 2. Mark this change in ink on the Table of Contents.

Detail Weld Procedure GM-SD-P-2, Rev. 3. Remove and destroy GM-SD-P-2, Rev. 2. Mark this change in ink on the Table of Contents.

These advance revisions will be included in the next general revision to G-29C.

E. R. Armstrong

for R. W. Cantrell

TO: See list on page 2

Principally Prepared By: Clara Lay, extension 2411

8505020082 850429
PDR ADOCK 05000390
A PDR

I14230.01

GENERAL CONSTRUCTION SPECIFICATION DISTRIBUTION - G-29C (R8) - ADVANCE REVISIONS

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G. L. Buchanan, W3C126 C-K (3)______
F. W. Chandler, W8C126 C-K______
C. A. Chandley, W7C126 C-K (2)______
R. M. Hodges, 1117 IBM-K (6)______
J. E. Holladay, W2D224 C-K (7)______
R. M. Parker, W4C126 C-K (2)______
J. A. Raulston, W10C126 C-K (15)______
J. C. Standifer, 204 GB-K (3)______
F. A. Stone, M100 MIB-K______
O. P. Thornton, 102 SPT-K______
J. P. Vineyard, W3D224 C-K (3)______

ERA:SDH:NJB
Attachment
cc (Attachment):
J. W. Anderson, 255 SPB-K______
J. W. Angel, 323 CBB-C (2)______
E. J. Barnett, PBN CONST______
C. H. Bowden, 1570 CST2-C (16)______
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D. T. Jones, 501 CEB-M______
G. W. Killian, 401 UBB-C______
D. W. Mack, E5B60 C-K______
O. T. Massey, 520 EB-C______
R. Moore, 606 EB-C______
C. C. Motley, 305 SPT-K______
Resource Center, 219 MPB-M______
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R. H. Sunderland, 805 CUBB-C______
Supervisor, DCU, HTN CONST (4)______
MEDS, W5B63 C-K

Power Plant Superintendents

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Bull Run Steam Plant (2)______
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Johnsonville Steam Plant (2)______
Kingston Steam Plant______
Paradise Steam Plant (2)______
Shawnee Steam Plant (2)______
Widows Creek Steam Plant (2)______

cc: C. C. Schonhoff, 716 EB-C

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C. E. Roberts, Supervisor, Codes, Standards, and Materials,
W11C114 C-K

DATE: 7/12/84

ADVANCE COPIES OF SPECIFICATION(~~s~~) TO G-29 C

Attached for your use is an advance copy of:

Detail Weld Procedure; add to Section/Volume SM
SM-SW-P-4, Rev3 ; add to Section/Volume ____
____ ; add to Section/Volume ____
____ ; add to Section/Volume ____

The above specification(~~s~~) will be included in the next revision to G-29 C .

The specification(~~s~~) should be phased in on a no-construction delay basis, and no later than 30 days after the approval date of the specification(~~s~~). The specification(~~s~~) can be used for rework and future work; however, it (~~they~~) is (~~are~~) not applicable to work completed prior to this approval date unless so specified.

C. E. Roberts
C. E. Roberts

x R. W. Olson, Sequoyah CONST
x G. Wadewitz, Watts Bar Nuclear CONST
x QC&RU, Bellefonte CONST
x W. E. Roper, 127 PSC-M

Note: It is the responsibility of each of the above site representatives to copy and distribute this advance copy to all of its manual holders.

DJE:
Attachment(s)
cc: X D. W. Mack, E5B51 C-K
x S. P. Stagnolia, E6B63 C-K
x W. H. Childress, SME-K
x L. J. Cooney, W6D224 C-K--Please distribute a copy of the attached specification(~~s~~) to all General Construction Specification Distribution for G-29 C , except for those marked above.

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C. E. Roberts, W11C114 C-K.

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Initials ____ Date ____ DE06:SPECS 7/84

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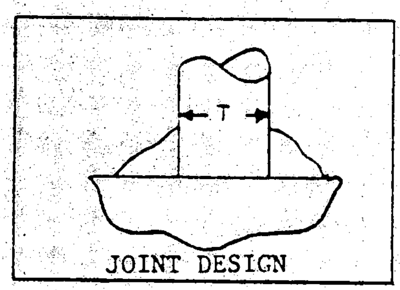
TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-SW-P-4 Rev.: 3 Date: July 11, 1984

Joint Design: Per Sketch



JOINT DESIGN

Base Metal: ASTM Specifications

Type I	A193 Gr B8 (304) or B8M (316) A240 or A666 - TP304, 304L, 316, or 316L	
to	A108 Gr 1010 to 1020	
Type II	A36	A516
	A53 Gr B	A529
	A106 Gr B	A570
	A242	A572 Gr 42, 45, & 50
	A441	A588
	A500 Gr A&B	A606 TP 2 or TP 4
	A501	A607 Gr 45, 50, & 55

Welding Conditions:

Increment	-	-	-
Current	50-80	70-115	100-145
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type	E309-15 or 16	E309-15 or 16	E309-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	60°F min.		
Interpass Temperature	350°F max.		
Post Weld Heat Treatment	None		
Welding Position	F, H, V, OH		
Other			

Weld thickness shall not exceed 3/4-inch.
Tack weld stud to hold in position during welding.
Minimum fillet weld size shall be the larger of 3/16" or T/2.

Reference documents: P.S.1.C.1.2, PQR SM18-B-1

Prepared by: 7/11/84 Reviewed by: 7/11/84

Approved by: C.E. Roberts 7/11/84

E44193.02

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C. E. Roberts, Supervisor, Codes, Standards, and Materials,
W11C114 C-K

DATE: Aug 15 1984

ADVANCE COPIES OF SPECIFICATION(S) TO G-29 C

Attached for your use is an advance copy of:

DWP GM-SD-P-2, R3 ; add to Section/Volume GM-SD
______ ; add to Section/Volume ______
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The above specification(s) will be included in the next revision to G-29 C.

The specification(~~s~~) should be phased in on a no-construction delay basis, and no later than 30 days after the approval date of the specification(~~s~~). The specification(~~s~~) can be used for rework and future work; however, it (the~~y~~) is (~~are~~) not applicable to work completed prior to this approval date unless so specified.

for C. E. Roberts

X R. W. Olson, Sequoyah CONST
X G. Wadewitz, Watts Bar Nuclear CONST
X QC&RU, Bellefonte CONST
X W. E. Roper, 127 PSC-M

Note: It is the responsibility of each of the above site representatives to copy and distribute this advance copy to all of its manual holders.

JWD: ___
Attachment(s)
cc: X D. W. Mack, E5B51 C-K
X S. P. Stagnolia, E6B63 C-K
X W. H. Childress, SME-K
X L. J. Cooney, W6D224 C-K--Please distribute a copy of the attached specification(s) to all General Construction Specification Distribution for G-29 C, except for those marked above.

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Initials ______ Date ______ DE06:SPECS 7/84

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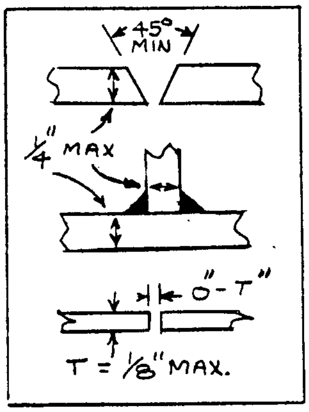
TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-SD-P-2 Rev.: 3 Date: 8/10/84

Joint Design: Per sketch

1. Base metal thickness or fillet weld size shall not exceed 1/4-inch.
2. Groove welds without backing or backgouging are considered partial penetration welds.
3. This procedure is applicable only to miscellaneous nonstructural welds.



Base Metal: ASTM Spec.

A36
A53
A106
A120
A500
A501
A570
A572 Grade 42, 45, & 50
A606 Type 2 or 4
A607 Grade 45, 50, & 55

Welding Conditions:

Increment	-
Current	80-160
Pulse Rate	-
Polarity	DCRP
Arc Voltage	17-22
Transfer Mode	short circuiting
Travel Speed (IPM)	4 min.
Electrode Type	E70S-3
Electrode Size	.035"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	CO_2
Shielding Gas Flow Rate	20-30 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	5/8" max.
Gas Cup to Work Distance	5/8" max.
Contact Tube to Work Dist.	5/8" max.
Preheat	None*
Interpass Temperature	500°F max.
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

*When base metal is below 32°F, preheat to 70°F, and maintain during welding.

Reference documents: P.S.1.C.1.2, PQR WS1133NR-1, GM11-0-6

Prepared by: 8/13/84
Reviewed by: J R Haueter 8/13/84
Approved by: C E Roberts 8/14/84

GMSDP2

TVA 64 (OS-9-65)

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

ECB '84 1123 506

TO : Those listed

FROM : R. W. Cantrell, Manager of Engineering, W11A9 C-K

DATE : November 21, 1984

SUBJECT: GENERAL CONSTRUCTION SPECIFICATION DISTRIBUTION - G-29C (R8) - ADVANCE REVISIONS

File in G-29C:

Table of Contents (R1), dated 9/7/84, 7/3/84, and 6/8/84. Remove and destroy existing Table of Contents.

Addendum No. 1 to Process Specification 0.C.1.1 (R0) (A.K.A. Addendum No. 1 to P.S.0.C.1.1(a)). Pages 20 and 21 (R1) in Process Specification 0.C.1.1 (R0). Remove and destroy pages 20 and 21 of 0.C.1.1 (R0).

Addendum No. 1 to Process Specification 1.C.1.2 (R2).

Detail Weld Procedure SA-P-1, Rev. 0. File in front of SA-U-1. (Reference Table of Contents (R1) 9/7/84.)

Detail Weld Procedure SM-P-4, Rev. 4. Remove and destroy SM-P-4, Rev. 3. File in front of SM-P-5. (Reference Table of Contents (R1) 9/7/84.)

Detail Weld Procedure SM-U-2, Rev. 5. Remove and destroy SM-U-2, Rev. 4. File in front of SM-U-3. (Reference Table of Contents (R1) 9/7/84.)

Detail Weld Procedure SM-SW-P-1, Rev. 5. Remove and destroy SM-SW-P-1, Rev. 4. File in front of SM-SW-P-2. (Reference Table of Contents (R1) 9/7/84.)

Addendum No. 1 to Process Specification 1.C.3.1 (R1).

Addendum No. 1 to Process Specification 3.C.2.1 (R2).

Addendum No. 1 to Process Specification 3.C.5.4 (R1) (A.K.A. Addendum No. 2 to P.S.3.C.5.4(a).).

Addendum No. 2 (R1) to Process Specification 3.C.5.4 (R1).

Addendum No. 3 to Process Specification 3.C.5.4 (R1).

These advance revisions will be included in the next general revision to G-29C.

S T Gordon/c

for R. W. Cantrell

TO: See list on page 2

Principally Prepared By: Clara Lay, extension 2411

I14230.01

Those listed
November 21, 1984

GENERAL CONSTRUCTION SPECIFICATION DISTRIBUTION - G29C (R8) - ADVANCE REVISIONS

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C. A. Chandley, W7C126 C-K (2)
A. T. Dean, W6C126 C-K
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J. C. Standifer, P-104 SB-K (3)
O. P. Thornton, 102 SPT-K
J. P. Vineyard, A8 Sequoyah - ENG (3)

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cal TWR:SDH:PHM
Attachment
cc (Attachment):
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E. J. Barnett, PBN CONST
T. A. Bowles, 10-146 SB-K (14)
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*S. P. Stagnolia, E6B63 C-K (2)
R. H. Sunderland, 805 CUBB-C
Supervisor, DCU, HTN CONST (4)
*G. Wadewitz, WBN CONST
MEDS, W5B63 C-K
Gilbert Associates
Impell

Power Plant Superintendents

Allen Steam Plant
Bull Run Steam Plant (2)
Colbert Steam Plant (2)
Cumberland Steam Plant (2)
Gallatin Steam Plant (2)
John Sevier Steam Plant
Johnsonville Steam Plant (2)
Kingston Steam Plant
Paradise Steam Plant (2)
Shawnee Steam Plant (2)
Widows Creek Steam Plant (2)

cc: C. C. Schonhoff, 716 EB-C
*Memo only

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Procedure Qualification Records

SA-U-2	7-29-80
SA-U-5	6-26-81
SM-P-1	2-24-81
SM-P-6	6-11-76
SM-P-13	4-21-81
SM-U-6	8-15-79 (2 pages)
SM-U-8	5-7-81
SW-5	7-23-74
SM Cadweld Repair	7-29-80 (5 pages)
SM-RB-2	8-7-81 6-23-82
GM-SA-U-1	3-5-81
GM11-0-6	9-1-81

3. Process Specification 1.C.2.2(R1), Welder Performance Qualification, with Addendum 1.

Performance Qualification Tests

- SA-6-U, Rev 0
- SM-4-H, Rev 0
- SM-4-L, Rev 0
- SM-4-4-L, Rev 0
- SM-4-Down, Rev 0
- SM-4-Special-1, Rev 0
- SM-5-H, Rev 2
- SM-5-L, Rev 2
- SM-5-L(a), Rev 1
- SM-5-U, Rev 0
- GM-FC-6-L(1), Rev 1
- GM-FC-6-L(2), Rev 1
- GM-FC-6-L(3), Rev 0
- GM-FC-6-L(4), Rev 0
- GM-FC-6-H(1), Rev 1
- GM-FC-6-H(2), Rev 1
- GM-FC-6-H(3), Rev 0
- GM-FC-6-H(4), Rev 0
- GM-SD-6-L(1), Rev 0
- GM-SD-6-L(2), Rev 0
- GM-SD-6-L(3), Rev 1
- GM-SD-6-L(4), Rev 1
- GM-SD-6-H(1), Rev 0
- GM-SD-6-H(2), Rev 0
- GM-SD-6-H-Pipe, Rev 0
- GM-SD-6-4-L, Rev 0
- GMA-FC-6-H(VERT), Rev 0
- GMA-FC-6-H(HORZ), Rev 0
- GMA-FC-6-H(FLAT), Rev 0

4. Process Specification 1.C.3.1(R1), Peening Procedure, with Addendum 1.

5. Process Specification 1.C.4.1(R1), Peening Performance Qualification Test.

6. Process Specification 2.C.1.1(R0), Post Weld Heat Treatment of AWS Weldments.

7. Process Specification 3.C.1.1(R1), Liquid Penetrant Examination Solvent Removable Method.

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General Construction Specification: G-29C (R8)
Date: 3/11/83
Sheet: 3 of 3

TABLE OF CONTENTS (R1)06/08/84

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Process Specification: 0.C.1.1 (a)
Date: 8/3/83
Sheet: 1 of 1

TENNESSEE VALLEY AUTHORITY

ADDENDUM NO. 1 TO 0.C.1.1 (a)
ADDENDUM NO. 1 TO 0.C.1.1 (R0)

Revise paragraph 8.6.1.6 to read as follows:

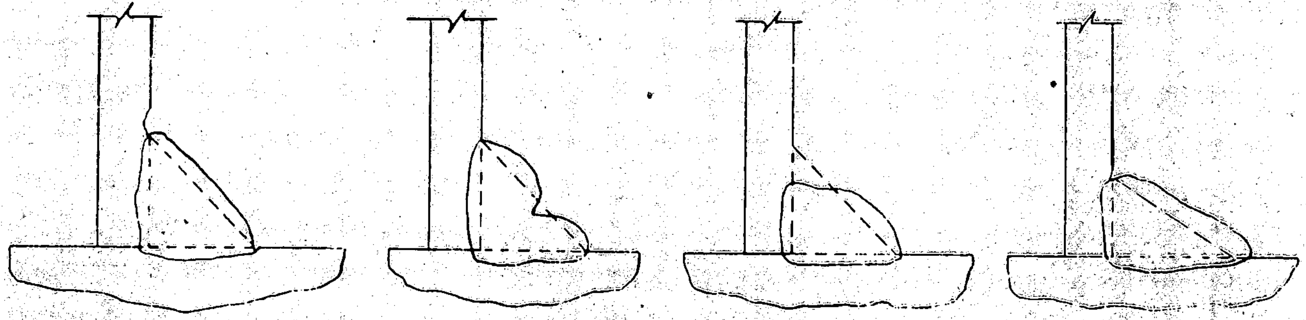
8.6.1.6 The sum of diameters of piping porosity in fillet and partial penetration welds does not exceed 3/8-inch in any linear inch of weld and does not exceed 3/4-inch in any one-foot length of weld.

Prepared by

Reviewed by

Approved by C.E. Roberts

DE06:PS0C11.A



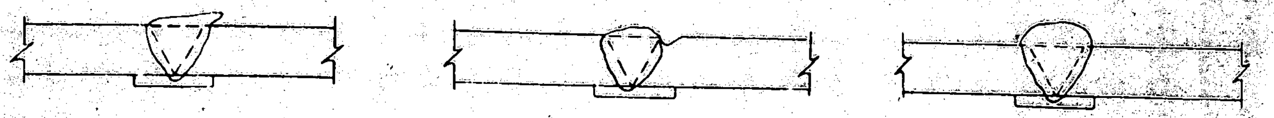
EXCESSIVE UNDERCUT

INSUFFICIENT THROAT

INSUFFICIENT LEG

OVERLAP

Figure 3.6.1 - Unacceptable Fillet Weld Profiles



OVERLAP

EXCESSIVE UNDERCUT

EXCESSIVE REINFORCEMENT

Figure 3.6.2.2 - Unacceptable Butt Weld Profiles

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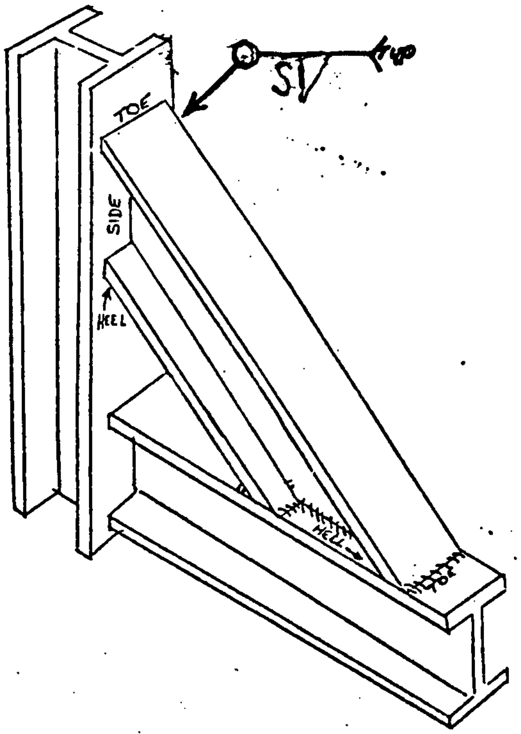
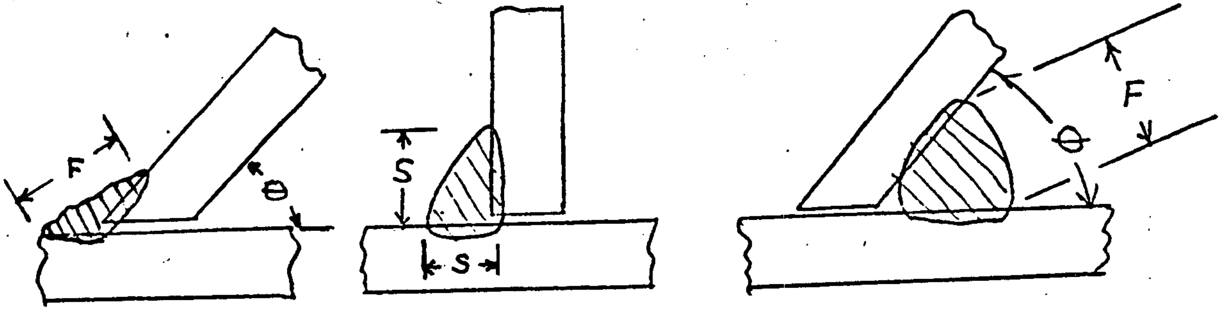
Process Specification: 0.C.1.1 (R0)
Date: 11/30/83
Sheet: 20 of 21
Rev. 1



Fillet Size (S)	Heel Face (F) (inches) 25°-40°	40°-55°	55°-65°
3/16	1/4	1/4	5/16
1/4	1/4	5/16	3/8
5/16	5/16	5/16	7/16
3/8	3/8	3/8	1/2
7/16	3/8	7/16	9/16
1/2	3/8	1/2	5/8
9/16	3/8	9/16	11/16
5/8	7/16	9/16	3/4

Toe Face "F" (in inches) = 2 x "S"



Toe Side Heel

Notes

1. Heel and toe welds to be centered between members to provide approximately equal contact with each.

2. Corners shall provide a smooth transition from the sides to the heel and toe.

Figure 8.3 - Alternate Fillet Weld all Around Connection for Members Meeting at an Angle

Prepared by 11/30/83

Reviewed by

Approved by C.C. Roberts 12/1/83

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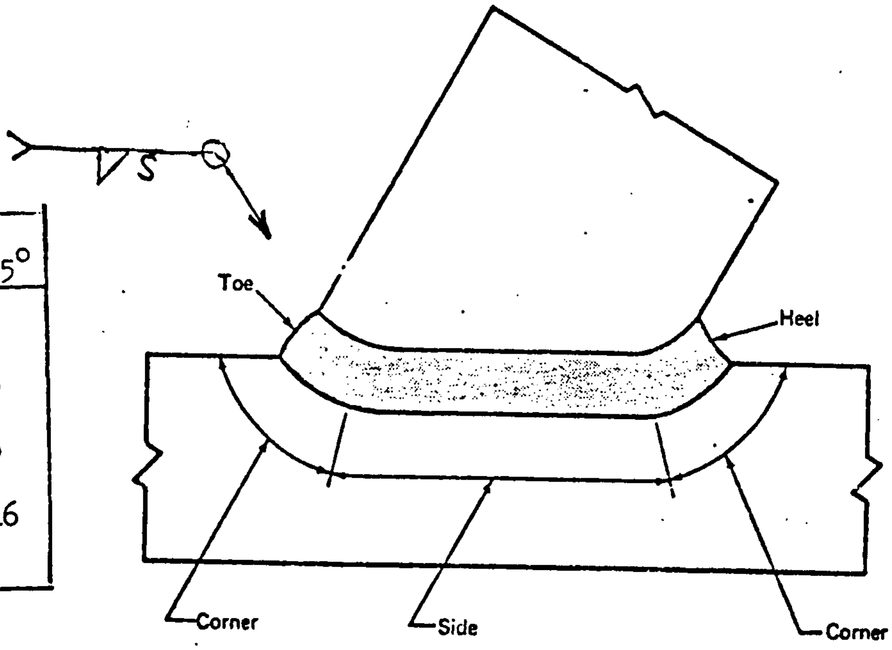
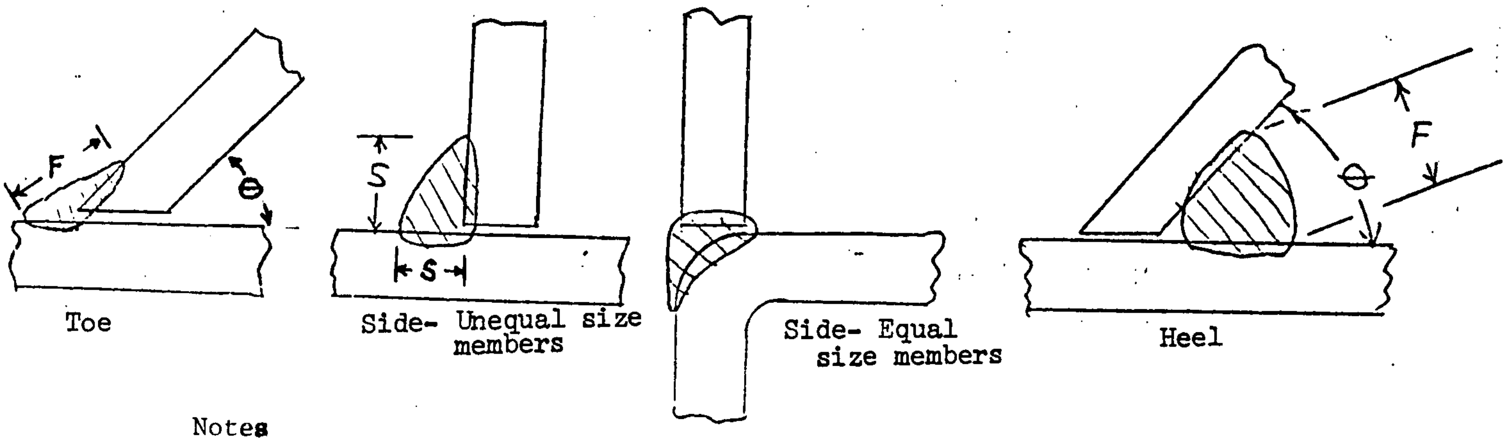


Fillet Size (S)	Heel Face (F) (inches)		
	-25°-40°	40°-55°	55°-65°
3/16	1/4	1/4	5/16
1/4	1/4	5/16	3/8
5/16	5/16	5/16	7/16
3/8	3/8	3/8	1/2
7/16	3/8	7/16	9/16
1/2	3/8	1/2	5/8
9/16	3/8	9/16	11/16
5/8	7/16	9/16	3/4

Toe Face "F" (in inches) = 2 x "S"



Notes

1. Heel and toe welds to be centered between members to provide approximately equal contact with each.
2. Side welds shall be at least flush with the outer surface.
3. Corners shall provide a smooth transition from the sides to the heel and toe.

Figure 9.3 - Alternate Fillet Weld All Around Connection for Members Meeting at an Angle

PSOC11

Prepared by 11/30/83
Approved by C E Roberts 12/1/83
Reviewed W. P. Jost 12/1/83

Process Specification: 1.C.1.2 (R2)
Date: July 3, 1984
Sheet: 1 of 1

ADDENDUM NO. 1 TO P.S.1.C.1.2(R2)

Please add paragraph 8.6.

8.6 Multiple pass tack welds shall have cascaded ends.

Prepared by 7/3/84
Reviewed by J DeWhite 7/3/84
Approved by C E Roberts 7/5/84

DE06:PS1C12.R2

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TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SA-P-1 Rev.: 0 Date: 9/6/84

Joint Design: Per Figure 1

BC-P2-S
B-P3-S
TC-P4-S
TC-P5-S
BC-P6-S
B-P7-S
C-P8-S
T-P8-S
C-P9-S
T-P9-S

Base Metal: Type and Grade

A36
A53, Gr B
A242
A106 Gr B
A441
A500 Gr A&B
A501
A516
A529
A570
A572 Gr 42-50
A588
A606 TP 2 or TP 4
A607 Gr 45, 50, 55

Welding Conditions:

Increment	-	-
Current	275-575A	300-600A
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	28-35V	28-35V
Transfer Mode	-	-
Travel Speed (IPM)	10 ipm min.	10 ipm min.
Electrode Type	EM12K	EM12K
Electrode Size	5/64"	3/32"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	F72EM12K	F72EM12K
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup to Work Distance	-	-
Contact Tube to Work Dist.	-	-
Preheat →		
Interpass Temperature	500°F max	
Post Weld Heat Treatment	None	
Welding Position	Flat	
Other		

Thickness	Min. Preheat
To 3/4"	None*
Over 3/4" - 1-1/2"	70°F
Over 1-1/2" - 2-1/2"	150°F
Over 2-1/2"	225°F

*When base metal temperature is below 32°F, preheat to 70°F min. and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: DEtzler 9/6/84 Reviewed by: Donald Zion 9-6-84

Approved by: C.E. Roberts 9/6/84

E44250.04

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TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-4 Rev.: 4 Date: 6/2/83

Joint Design: Per Figure 1

Base Metal: ASTM Specifications

B-P1a
B-P1b
B-P1c
B-P2
BC-P2
B-P3
B-P4
BTC-P4
BTC-P5
BC-P6
B-P7
BTC-P8
BTC-P9

Type 1: A193 Gr B8 (304)
A240 or A666 - TP304,304L,316, or 316L

to

Type II:

A36	A516
A53 Gr. B	A529
A106 Gr. B	A570
A242	A527 Gr 42, 45 & 50
A441	A588
A500 Gr. A&B	A606 TP 2 of TP 4
A501	A607 Gr 45, 50, 55

Welding Conditions:

Increment	-	-	-
Current	50-100	70-135	100-180
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min	3 min	4 min
Electrode Type	E309-15 or 16	E309-15 or 16	E309-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup Work Distance	-		
Contact Tube to Work Dis	-		
Preheat →			
Interpass Temperature	350° F max		
Post Weld Heat Treatment	None		
Welding Position			
Other			

Thickness (Ty II Mat'l)	Min Temp.
Up to 3/4	None*
Over 3/4 to 1 1/2	50° F
Over 1 1/2 to 2 1/2	150° F
Over 2 1/2	225° F

*When base metal is below 32°F, preheat to 70°F and maintain during welding. Weld thickness shall not exceed 3/4 inch.

Reference documents: P.S.1.C.1.2, PQR SM18-B-1

Prepared by: JWhite 6/7/83 Reviewed by: W. P. 6/8/83

Approved by: C E Roberts 6/8/83 E33157.02

TENNESSEE VALLEY AUTHORITY

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Detail Weld Procedure No.: SM-U-2 Rev.: 5 Date: 1/25/84

Joint Design: Per Figure 2

B-U2a
C-U2
B-U2
C-U2
B-U3a
B-U3b
B-U4a
TC-U4c
B-U4
B-U4a
TC-U4d
TC-U4b
B-U5b
B-U5a
TC-U5b
TC-U5c
TC-U5d
B-U6
C-U6
B-U7
B-U8
TC-U8a
TC-U8b
B-U9
TC-U9a
TC-U9b

Base Metal: ASTM Specifications

A240
A660
A479
A580
**A312
**A182
**A403

TP 304, 304L
316 or 316L

Welding Conditions:

Increment	-	-	-
Current	50-80	70-115	100-145
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type	E308-15 or 16	E308-15-16	E308-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	None*		
Interpass Temperature	350°F max.		
Post Weld Heat Treatment	None		
Welding Position	F, H. V, OH		
Other			

*When base metal is below 32°F, preheat to 70°F and maintain during welding.
**For handrail application only.

Reference documents: P.S.1.C.1.2, PQR GT-SM88-0-2

Prepared by: J White 1/27/84 Reviewed by: 1/27/84

Approved by: C E Roberts 1/27/84

TENNESSEE VALLEY AUTHORITY

etail Weld Procedure No.: SM-SW-P-1 Rev.: 5 Date: 2/15/83

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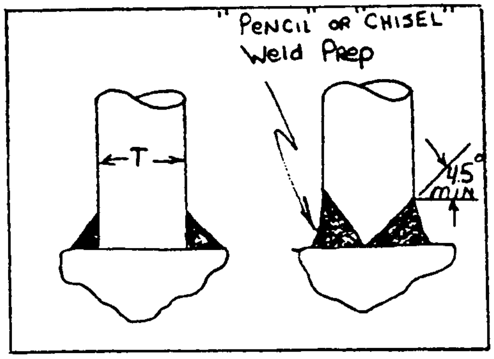
Notes:

1. Tack weld stud to hold in position during welding.
2. Minimum fillet weld size shall be the larger of 3/16" or T/2



Materials

Base

A36
A53 Gr B
A106 Gr B
A242
A441
A500 Gr A&B
A501
A516
A529
A570
A572 Gr 42, 45, 50
A588
A606 TP 2 or TP 4
A607 Gr 45, 50, 55

Stud

A108 Gr
1010
1015
1017
1020
Semi or Fully Killed

Welding Conditions:

Increment	-	-	-	-
Current	75-115	100-145	130-205	170-275
Pulse Rate	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.	7 min.
Electrode Type	E7018	E7018	E7018	E7018
Electrode Size	3/32"**	1/8"**	5/32"	3/16"
Filler Metal Type	-			
Filler Metal Size	-			
Flux Type	-			
Flux Particle Size	-			
Shielding Gas	-			
Shielding Gas Flow Rate	-			
Purging Gas	-			
Purging Gas Flow Rate	-			
Gas Cup Size	-			
Gas Cup to Work Distance	-			
Contact Tube to Work Dist.	-			
Preheat				
Interpass Temperature	400°F max.			
Post Weld Heat Treatment	None			
Welding Position	F, H, V, OH			

Thickness	Min. Preheat
To 3/4"	None*
3/4" to 1-1/2"	70°F
1-1/2" to 2-1/2"	150°F
Over 2-1/2"	225°F

*When base metal temperature is below 32°F, preheat to 70°F and maintain during welding.

**For use only on groove welded studs of all diameters and on fillet welded studs 7/16" or le in diameter or for out of position welds.

Reference documents: P.S.1.C.1.2

Prepared by: 2/15/83 Reviewed by: 2/16/83

Approved by: C.E. Roberts

SMSWP.1

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Process Specification: 1.C.3.1 (R1)
Date: July 3, 1984
Sheet: 1 of 1

ADDENDUM NO. 1 TO P.S.1.C.3.1(R1)

Please revise paragraph 4.1 to read as follows:

4.1 Peening shall not be performed on the first 3/8-inch of weld deposit of groove or fillet welds, the final weld layer, or the base metal at the edges of the weld.

Prepared by 7/3/84

Reviewed by 7/3/84

Approved by C. E. Roberts 7/3/84

DE06:PS1C31.R1

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Process Specification: 3.C.2.1 (R2)
Date: January 17, 1984
Sheet: 1 of 3

ADDENDUM NO. 1 TO 3.C.2.1 (R2)

Please add Appendix D attached.

Prepared by 1/24/84

Reviewed by 1/25/84
SNT-TC-1A, Level III

Approved by C.E. Roberts 1/26/84

APPENDIX D

In lieu of the requirements of 8.2, the following may be used as the acceptance criteria for welds fabricated to the requirements of Section 9, Design of New Bridges, of the Structural Welding Code:

8.2 The following discontinuities are unacceptable:

8.2.1 Cracks

8.2.2 Any porosity or fusion-type discontinuity exceeding the maximum indication size allowable in Table 1.

TABLE 1

Weld Size (1)	Maximum Indication Size Allowable
Less than 3/8 inch	1/16 inch
3/8 inch but less than 3/4 inch	1/8 inch
3/4 inch but less than 1-1/8 inch	1/4 inch
1-1/8 inch but less than 1-1/2 inch	3/8 inch
1-1/2 inch and greater	1/2 inch

(1) The weld size is the leg length of a fillet, the base material thickness for a full penetration weld, the bevel depth for a partial penetration weld, or the bevel depth plus the fillet leg length of a fillet reinforced butt or tee weld.

8.2.3 The distance from any porosity or fusion-type discontinuity described above or another such discontinuity, to an edge, or to any intersecting weld shall not be less than the minimum separation indicated in Table 2 for the size of discontinuity under examination.

TABLE 2

Indication Size	Minimum Separation Required
1/16 inch	9/16 inch
1/8 inch	1-1/8 inch
3/16 inch	1-11/16 inch
1/4 inch	2-1/4 inch
3/8 inch	3-3/8 inch
1/2 inch	4-1/2 inch

Note: Adjacent discontinuities spaced less than the minimum separation required by Table 2 shall be measured as one continuous indication.

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8.2.4 Independent of the requirements of 8.2.2 and 8.2.3, discontinuities having a greatest dimension of less than 1/16 inch shall be unacceptable if the sum of their greatest dimension exceeds 3/8 inch in any linear inch of weld.

PS3C21.R2

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Process Specification: 3.C.5.4(a)
Date: 8/12/83
Sheet: 1 of 1

TENNESSEE VALLEY AUTHORITY

ADDENDUM NO. 2 TO 3.C.5.4(a)
ADDENDUM NO. 1 TO 3.C.5.4(R1)

Revise paragraph 5.2.1 to read as follows:

5.2.1 Welds made prior to November 2, 1981, which are coated with carbo-zinc primer may be visually examined for weld size, undercut, overlap, and arc strikes in accordance with this process specification without removing the primer provided:

(a) The carbo-zinc was sprayed in accordance with the applicable coating application specification.

(b) The carbo-zinc thickness is not greater than 5 mils as documented in coating inspection records and/or log books or as measured adjacent to the weld. Coating thickness measurement techniques shall be in accordance with the specification for coating application.

Prepared by 8-12-83

Reviewed by Robert M [illegible] 8-12-83

Approved by Clarence E Roberts 8/12/83

DE06:PS3C54.A

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Process Specification: 3.C.5.4 (R1)
Date: 1/23/84
Sheet: 1 of 1

ADDENDUM NO. 2 REVISION 1 TO 3.C.5.4 (R1)

Delete paragraph 5.1.

Delete paragraphs 5.2.1 and 5.2.2.

Delete paragraph 6.1.1.

Prepared by 1/24/84

Reviewed by R. M. Jessee 1/25/84
SNT-TC-1A, Level III

Approved by C.E. Roberts

PS3C54.R1

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Process Specification: 3.C.5.4(R1)
Date: June 8, 1984
Sheet: 1 of 1

ADDENDUM NO. 3 TO 3.C.5.4(R1)

Revise paragraph 3.3 to read as follows:

3.3 Final Visual Weld Examination

The examination for weld defects, weld contour, size, weld cleanliness, arc strikes, weld spatter, and drawing requirements.

Prepared by Donald Zion 6-13-84

Reviewed by R. M. Jesse 6/15/84
SNT-TC-1A, Level III

Approved by C.E. Roberts 6/15/84

DE06;PS3C54.R1

TVA 64 (OS-9-65)

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

ESB '830826 201

TO : Those listed

FROM : M. N. Sprouse, Manager of Engineering Design, W11A9 C-K

DATE : August 24, 1983

SUBJECT: GENERAL CONSTRUCTION SPECIFICATION DISTRIBUTION - G-29C R8, G-29E R3, AND BINDER

Attached for your use are General Construction Specifications G-29C R8 and G-29E R3, "Process Specifications for Welding, Heat Treatment, Nondestructive Examination, and Allied Field Fabrication Operations." These revisions have been filed in a single binder labeled G-29C and G-29E. Please destroy your copies of G-29C R7 and G-29E R2, and correct your index in ink to reflect these changes.

Please refer to the revision logs for the changes incorporated into G-29C R8 and G-29E R3.

ER Armstrong

for M. N. Sprouse

TO: See list on page 2

Principally Prepared By: Peggy Baldwin, extension 2411

I13236.02

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TENNESSEE VALLEY AUTHORITY

DIVISION OF ENGINEERING DESIGN

ALL PROJECTS

GENERAL CONSTRUCTION SPECIFICATION

NO. G-29C

FOR PROCESS SPECIFICATIONS FOR WELDING, HEAT TREATMENT, NONDESTRUCTIVE EXAMINATION, AND ALLIED FIELD FABRICATION OPERATIONS

	REVISION 0 *	R6*	R7*	R8	R9	R10
EFFECTIVE DATE	March 10, 1975	4/3/81	12/21/81	9/1/83		
PREPARED		SAC	JDW	maw		
REVIEWED						
SPONSORED	R. M. Jessee	WPJ	CER	CER		
SUBMITTED	R. L. Harris	RMJ	RMJ/tgc	RMJ/rcw		
RECOMMENDED (SPONSOR BR. CHIEF)	D. R. Patterson gfd	JAR/tgc	JAR	JAR		
CONCURRED						
APPROVED (MGR. of CONST)						
APPROVED (MGR. of EN DES)	R. H. Dunham/w	GTD	MNS/Di	MNS		

TVA 10574A (EN DES-1-82) *Original signed by

Title: PROCESS SPECIFICATION FOR WELDING, HEAT TREATMENT NONDESTRUCTIVE EXAMINATION, AND ALLIED FIELD FABRICATION OPERATIONS

REVISION LOG

G-29C

Revision No.	DESCRIPTION OF REVISION	Date Approved
8		9/1/83

1. Replace Table of Contents with March 11, 1983, issue.
2. Replace Process Specification 0.C.1.1(a) with 0.C.1.1(R0).
3. Replace Process Specification 1.C.1.2(b) with 1.C.1.2(R2).
4. In Process Specification 1.C.1.2(R3):
   a. Replace Figure 1, Page 3, Rev 0, with Rev 1.
   b. Replace Figure 1, Page 9, Rev 3, with Rev 6.
   c. Add/Replace Detail Welding Procedures as follows:

Replace	Add
SM-P-1, Rev 8	SM-P-1, Rev 9
SM-U-1, Rev 5	SM-P-14, Rev 0
SM-RB-2, Rev 0	SM-U-1, Rev 6
SM-SW-P-1, Rev 2	SM-RB-2, Rev 1
GM-SD-P-2, Rev 1	SM-SW-P-1, Rev 4
AW-SW-P-5, Rev 0	GM-SD-P-2, Rev 2
	AW-SW-P-5, Rev 1

   d. Add Procedures Qualification Record: GM11-0-6, 9-1-81.

5. Replace Process Specification 1.C.2.2(a) with 1.C.2.2(R1).
6. In Process Specification 1.C.2.2(R1):
   a. Add Performance Qualification Test GM-SD-6-4-L.
   b. Replace Performance Qualification Test GM-SD-6-L(3), Rev 0, with Rev 1.
7. Replace Process Specification 1.C.3.1(a) with 1.C.3.1(R0).
8. Replace Process Specification 1.C.4.1(a) with 1.C.4.1(R1).
9. Replace Process Specification 2.C.1.1(a) with 2.C.1.1(R2).
10. Replace Process Specification 3.C.1.1(a) with 3.C.1.1(R1).
11. Replace Process Specification 3.C.2.1(b) with 3.C.2.1(R1).
12. Replace Process Specification 3.C.3.1(a) with 3.C.3.1(R2).
13. Replace Process Specification 3.C.5.2(b) with 3.C.5.2(R1).
14. Replace Process Specification 3.C.5.3(a) with 3.C.5.3(R1).

TVA

Title: PROCESS SPECIFICATION FOR WELDING, HEAT TREATMENT, NONDESTRUCTIVE EXAMINATION, AND ALLIED FIELD FABRICATION OPERATIONS

REVISION LOG

G-29C

Revision No.	DESCRIPTION OF REVISION	Date Approved
8	15. Add Process Specification 3.C.5.4(R1).	
	16. Replace Process Specification 3.C.7.1(a) with 3.C.7.1(R0).	
	17. Replace Process Specification 3.C.10.1(a) with 3.C.10.1(R1).	
E13083.06		

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TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

Prepared by 4/5/83

Reviewed by 4/1/83

Approved by C.E Roberts 4/6/83

TENNESSEE VALLEY AUTHORITY

SPECIFICATION FOR WELDING OF STRUCTURES FABRICATED IN ACCORDANCE WITH AISC REQUIREMENTS FOR BUILDINGS

1.0 SCOPE

1.1 Application

This specification defines the requirements for welded fabrication of steel structures in accordance with the American Institute of Steel Construction Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings (AISC specification). This specification shall not be interpreted as limiting the responsibilities, rights, or duties of the Engineer in accordance with the AISC specification. This specification does not contain design requirements.

This specification may be used for welding of portions of structures which are not subject to calculated stresses. This specification shall be followed unless EN DES-approved drawings specifically identify features which may be excluded.

1.2 Base Metals

The base metals to be welded in accordance with this specification are those used in the fabrication of structures as specified in EN DES drawings and specifications.

1.3 Welding Processes

1.3.1 Shielded metal arc welding (SMAW), submerged arc welding (SAW), gas metal arc welding (GMAW) (except short circuiting transfer), and flux cored arc welding (FCAW) procedures which conform to the provisions of Sections 2, 3, and 4, in addition to sections 8 and 9, as applicable, may be used without performing procedure qualification tests.

1.3.2 Automatic stud welding may be used provided the procedures conform to the applicable provisions of 4.21 through 4.27 of the AWS Structural Welding Code, using written welding procedures in Process Specification 1.C.1.2.

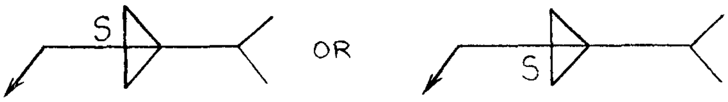
1.3.3 Other welding processes may be used provided they are qualified by applicable tests prescribed by EN DES. These tests shall meet the requirements of 5.2 of this specification.

1.4 Definitions

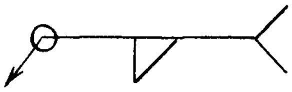
The welding terms in this specification shall be interpreted in accordance with AWS A3.0, Terms and Definitions, and ASME Section IX, QW-490, Definitions. If differences occur, ASME Section IX, QW-490 controls.

1.5 Welding Symbols

Welding symbols shall be those shown in AWS A2.4, Symbols for Welding and Nondestructive Examination, except as modified below:



shall mean two fillet welds of the same size S.



shall be as defined in AWS A2.4 or sections 8 and 9 for connections of tubular sections and structural shapes.

1.6 Safety Precautions

Safety measures should be in accordance with the TVA Occupational Health and Safety Manual.

1.7 Units of Measurement

The values stated in U.S. customary units are to be used. The metric (SI) equivalents of U.S. customary units given in this specification are approximate.

1.8 Where the term "Structural Welding Code" is used, refer to AWS D1.1, Structural Welding Code - Steel.

2.0 WELDED CONNECTIONS

2.1 Drawings

2.1.1 EN DES drawings indicate weld sizes, types, and locations and any special requirements not contained herein.

2.1.2 CONST may prepare any necessary shop, working, or detail drawings to implement EN DES drawings. The drawings should note welding sequences or techniques required to minimize shrinkage stresses and distortion. Where necessary, they shall specify the groove depth necessary to provide the required effective throat.

2.2 Joint Qualification

2.2.1 Joints meeting the following requirements are designated as prequalified.

(1) Conformance with the details specified in 2.3, 2.4, 2.5, 8.3, and 9.3.

(2) Use of one of the following welding processes in accordance with the requirements of sections 3, 4, and 8 or 9 as applicable: shielded metal arc, submerged arc, gas metal arc (except short circuiting transfer), or flux cored arc welding.

2.2.1.1 Joints meeting these requirements may be used without performing the joint welding procedure qualification tests prescribed in 5.2.

2.2.1.2 The joint welding procedure for all joints welded by short circuiting transfer gas metal arc welding shall be qualified by tests prescribed in 5.2.

2.2.2 Joint details may depart from the details described only if approved by EN DES.

2.3 Complete Joint Penetration Groove Welds

2.3.1 Details of complete penetration groove weld butt, corner, and tee joints which may be used without testing per 5.2 shall be as detailed and toleranced in AWS Structural Welding Code figure 2.9.1 (reproduced in Process Specification 1.C.1.2, figure 2).

2.3.2 Weld joints detailed as prequalified for shielded metal arc welding may be considered prequalified for gas metal arc, flux cored arc, and submerged arc welding.

2.3.3 The outside groove preparation of corner joints may be in either or both members unless shown otherwise on the drawing. Adequate edge distance shall be maintained to support the welding operation.

2.4 Partial Joint Penetration Groove Welds

2.4.1 Partial joint penetration groove welds which may be used without testing per 5.2 shall be as detailed and toleranced in AWS Structural Welding Code figure 2.10.1 (reproduced in Process Specification 1.C.1.2, figure 1).

2.4.2 Groove welds without steel backing welded from one side or welded from both sides without back gouging shall be considered partial penetration welds, except submerged arc welds not requiring back gouging per AWS figure 2.9.1 are complete penetration welds.

2.4.3 Groove preparations detailed for prequalified shielded metal arc welding may be considered prequalified for gas metal arc, flux cored arc, or submerged arc welding.

2.4.4 For corner joints, the detailed groove preparation may be in either or both members unless shown otherwise on the drawing. Adequate edge distance shall be maintained to support the welding operation.

2.5 Fillet Welds

Fillet welds shall be as shown on EN DES drawings. Where necessary, the size shall be increased to accommodate variations in fitup as required in 3.3.

3.0 WORKMANSHIP

3.1 General

3.1.1 All applicable paragraphs of this section shall be observed in the production of welded assemblies and structures produced under this specification.

3.1.2 Welding shall not be done when the ambient temperature is lower that 0°F (-18°C) or when surfaces are wet or exposed to rain, snow, or high wind.

3.1.3 The locations, sizes, and lengths of welds shall be no less than those specified by EN DES requirements without approval. The location of welds shall not be changed without approval by EN DES.

3.2 Preparation of Base Metal

3.2.1 Surfaces and edges to be welded shall be smooth, uniform, and free from fins, tears, cracks, and other discontinuities which would adversely affect the quality or strength of the weld. Surfaces to be welded and surfaces adjacent to a weld shall also be free from loose or thick scale, slag, rust, moisture, grease, and other foreign material that would prevent proper welding. Mill scale that can withstand vigorous wire brushing, a thin rust-inhibitive coating, or antispatter compound may remain with the following exception; for girders, all mill scale shall be removed from the surfaces on which flange-to-web welds are to be made by submerged arc welding or by shielded metal arc welding with low hydrogen electrodes.

3.2.2 Repair of Plate Cut Edges

3.2.2.1 In the repair and determination of limits of internal discontinuities discovered on edges, the amount of metal removed should be the minimum necessary to remove the discontinuity or to determine that the permissible limit is not exceeded. All repairs of discontinuities by welding shall conform to the applicable provisions of this specification.

Table 3.2.2
Limits on Acceptability and Repair of Cut Edge Discontinuities of Plate

Description of Discontinuity	Plate Repair Required
Any discontinuity 1 inch in length or less	None, need not be explored.
Any discontinuity over 1 inch in length and 1/8-inch maximum depth	None, but the depth shall be explored.*
Any discontinuity over 1 inch in length with depth over 1/8-inch but not greater than 1/4-inch	Remove, need not weld.
Any discontinuity over 1 inch in length with depth over 1/4-inch but not greater than 1 inch	Completely remove and weld. Aggregate length of welding shall not exceed 20 percent of the length of the plate edge being repaired.
Any discontinuity over 1 inch in length with depth greater than 1 inch	Repairs shall be approved by EN DES.

*A spot check of 10 percent of the discontinuities on the cut edge in question should be explored by grinding to determine depth. If the depth of any one of the discontinuities explored exceeds 1/8-inch, then all of the discontinuities remaining on that edge shall be explored by grinding to determine depth. If none of the discontinuities explored in the 10 percent spot check have a depth exceeding 1/8-inch, then the remainder of the discontinuities on that edge need not be explored.

3.2.2.2 The limits of acceptability and the repair of edge discontinuities shall be in accordance with Table 3.2.2, in which the length of discontinuity is the visible long dimension on the cut edge of the plate and the depth is the distance that the discontinuity extends into the plate from the cut edge.

3.2.3 Reentrant corners, except for the corners of weld access cope holes adjacent to a flange, shall be filleted to a radius of no less than 1/2-inch. The fillet and its adjacent cuts shall meet without offset or cutting past the point of tangency.

3.2.4 Machining, air carbon arc cutting, oxygen cutting, oxygen gouging, chipping, or grinding may be used for the removal of metal, except that oxygen gouging shall not be used on steels that are quenched and tempered or normalized.

3.2.5 Edges of built-up beam and girder webs should be cut to the prescribed camber with suitable allowance for shrinkage due to cutting and welding. However, variation from the specified camber tolerance may be corrected by a carefully supervised application of heat in accordance with 3.7.3.

3.3 Assembly

3.3.1 The parts to be joined by fillet welds shall be brought into as close contact as practicable. The gap between parts should not exceed 3/16-inch (4.8 mm). If, after assembly the gap cannot be closed sufficiently to meet this tolerance, a maximum gap of 5/16-inch (8.0 mm) is acceptable provided a sealing weld or suitable backing material is used to prevent melting-through. If the separation is 1/16-inch (1.6 mm) or greater, the leg of the fillet weld shall be increased by the amount of the separation.

The separation between faying surfaces of lap joints and of welds in butt joints landing on a backing should not exceed 1/16-inch (1.6 mm). The use of fillers is prohibited except as specified on the drawings or as approved by EN DES.

3.3.2 Parts to be joined by groove welded butt joints shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignment, an offset not exceeding 10 percent of the thickness of the thinner part joined, but in no case more than 1/8-inch (3.2 mm), shall be permitted as a departure from the theoretical alignment. In correcting misalignment in such cases, the parts shall not be drawn in to a greater slope than 1/2-inch (12.7 mm) in 12 inches (304 mm). For partial penetration welds, a root opening of 3/16-inch is acceptable.

3.3.3 With the exclusion of electroslag and electrogas welding, and with the exception of 3.3.3.1 for root openings in excess of those permitted in the table below, the dimensions of the cross section of the groove welded joints which vary from those shown on the detail drawings by more than the following tolerances shall be referred to EN DES for approval or correction.

	Root Not Gouged		Root Gouged	
	in.	mm	in.	mm
(1) Root face of joint	±1/16	1.6	Not limited	
(2) Root opening or joints without steel backing	±1/16	1.6	+1/16 -1/8	1.6 3.2
Root opening of joints with steel backing	+1/4 -1/16	6.4 1.6	Not Applicable	
(3) Groove angle of joint	+10° -5°		+10° -5°	

3.3.3.1 Root openings wider than those permitted in 3.3.3 but not greater than twice the thickness of the thinner part or 3/4-inch (19 mm), whichever is less, may be corrected by welding to acceptable dimensions prior to joining the parts by welding. Root openings larger than the above may be corrected by welding only with the approval of EN DES.

3.3.4 Grooves produced by gouging shall be in accordance with groove profile dimensions as specified in 2.3.1 and 2.4.1.

3.3.5 Members to be welded shall be brought into correct alignment and held in position by bolts, clamps, wedges, guy lines, struts, or other suitable devices, or by tack welds until welding has been completed. The use of jigs and fixtures is recommended where necessary. Suitable allowances should be made for warpage and shrinkage.

3.3.6 Tack Welds

3.3.6.1 Tack welds shall be subject to the same quality requirements as the final welds except that:

(1) Preheat is not mandatory for single-pass tack welds which are remelted and incorporated into continuous submerged arc welds.

(2) Discontinuities such as undercut, unfilled craters, and porosity need not be removed before the final submerged arc welding.

3.3.6.2 Tack welds which are incorporated into the final weld shall be made with electrodes meeting the requirements of the final welds and shall be cleaned thoroughly. Multiple-pass tack welds shall have cascaded ends.

3.3.6.3 Tack welds not incorporated into final welds need not be removed unless required by EN DES.

3.4 Control of Distortion and Shrinkage

Control of distortion and shrinkage shall be in accordance with Process Specification 1.C.1.2 including its requirements to prevent lamellar tearing.

3.5 Dimensional Tolerances

Dimensional tolerances of welded structures shall be in accordance with the AISC specification and EN DES drawings and specifications.

3.6 Weld Profiles

As-welded surface profiles are acceptable if they meet the following criteria (unacceptable profiles shall be repaired in accordance with 3.7).

3.6.1 Fillet Welds

The faces of fillet welds may be slightly convex, flat, or slightly concave with none of the unacceptable profiles shown in figure 3.6.1.

3.6.2 Groove Welds

3.6.2.1 Groove welds preferably shall be made with slight or minimum reinforcement. Butt and corner joint reinforcement shall not exceed 1/8-inch in height unless approved by EN DES.

3.6.2.2 Groove welds shall be free of the discontinuities shown for butt joints in figure 3.6.2.2.

3.6.3 Flush Welds

3.6.3.1 Surfaces of butt joints required to be flush shall be finished so as not to reduce the thickness of the thinner base metal or weld metal by more than 1/32-inch or 5 percent of the thickness (which ever is smaller) or to leave more than 1/32-inch reinforcement.

3.6.3.2 Ends of butt joints required to be flush shall be finished so as not to reduce the joined members' width more than 1/8-inch nor to leave more than 1/8-inch of reinforcement on the end of the weld. Ends of welds in butt joints required to be flush shall be faired into adjacent plate or shape edges at a slope not to exceed 1 in 10.

3.6.4 All Welds

All welds shall be free from overlap.

3.6.5 All Welds

The weld profile requirements for ASME Section III, subsection NF may be used in place of 3.6.1 through 3.6.4 above.

3.7 Repairs

3.7.1 The removal of weld metal or portions of the base metal shall be per paragraph 3.2.4. Unacceptable portions of the weld shall be removed without substantial removal of the base metal. Additional weld metal to compensate for any deficiency in size shall be deposited using an electrode preferably smaller than that used for making the original weld, and preferably not more than 5/32-inch (4.0 mm) in diameter. The surfaces shall be cleaned thoroughly before welding.

3.7.2 Unacceptable welds shall be repaired or replaced. The repaired or replaced weld shall be retested by the method originally used, and the same technique and quality acceptance criteria shall be applied. If CONST elects to repair the weld, it shall be corrected as follows:

3.7.2.1 Overlap or Excessive Convexity. Remove excess weld metal.

3.7.2.2 Excessive Concavity of Weld, Crater, Undersize Welds, or Undercutting. Prepare surfaces and deposit additional weld metal.

3.7.2.3 Excessive Weld Porosity, Excessive Slag Inclusions, Incomplete Fusion. Remove unacceptable portions (see 3.7.1) and reweld.

3.7.2.4 Cracks in Weld or Base Metal. Ascertain the extent of the crack by use of acid etching, magnetic particle inspection, or other equally positive means; remove the crack and sound metal 2 inches (50.8 mm) beyond each end of the crack, and reweld.

3.7.2.5 Arc Strikes and Weld Spatter. Remove by grinding or wire brushing.

3.7.3 Members distorted by welding may be straightened by mechanical means or by carefully supervised application of a limited amount of localized heat. The temperature of heated areas shall not exceed 800°F for stainless steel, 1100°F (590°C) for quenched and tempered steel nor 1200°F (650°C) (a dull red color) for other steels. The part to be heated for straightening shall be substantially free of stress and from external forces except those stresses resulting from the mechanical straightening method used in conjunction with the application of heat.

3.7.4 Repairs to base metal other than those permitted by the specification for the base metal or section 3.2, repair of major cracks, or repair of delayed cracks shall be approved by EN DES.

4.0 TECHNIQUE

4.1 General

The technique for welding shall be as required in the welding procedure.

Welding procedures shall meet the requirements of section 4, Technique, of the AWS Structural Welding Code for prequalified welding procedures or they shall be qualified in accordance with section 5 of this specification, except concrete anchor and shear connector studs also may be welded using approved welding procedures and the shielded metal arc welding process.

5.0 QUALIFICATION

5.1 Approved Procedures

5.1.1 Welding procedures which conform in all respects to the provisions of sections 2, 3, and 4 as well as pertinent provisions of section 8 or 9, whichever is applicable, shall be deemed as prequalified and shall be exempt from tests or qualification, except that all groove and fillet weld procedures for weld metal and base metal with a minimum specified yield strength of 90,000 psi (620 MPa) or higher shall be qualified prior to use by tests as prescribed in 5.2 in this section to the satisfaction of EN DES.

Note: The use of a prequalified joint welding procedure is not intended as a substitute for engineering judgment in the suitability of application of these joint welding procedures to a welded assembly or connection.

5.1.2 Welding procedures of Process Specification 1.M.1.2 meeting ASME Section IX requirements may be used to fabricate weldments in accordance with this specification.

5.1.3 All welding procedures used, both qualified or prequalified, shall be those in Process Specification 1.C.1.2 or 1.M.1.2.

5.2 Other Procedures

Except for the procedures exempted in 5.1, joint welding procedures which are to be employed in executing work under this specification shall be qualified prior to use to the satisfaction of EN DES by tests as prescribed in the AWS Structural Welding Code.

5.3 Welders and Welding Operators

Welders and welding operators qualified in accordance with the AWS Structural Welding Code or ASME Section IX may be employed on work in accordance with this specification. They shall be qualified using the test descriptions of Process Specifications 1.M.2.2 or 1.C.2.2.

6.0 INSPECTION

6.1 All fabrication by welding shall be performed in accordance with the requirements of this specification and the applicable EN DES-approved drawings.

6.2 Weldments shall be verified to be correct for the following requirements using the quality control program of 6.3 to 6.7 below: (Note: Drawings may contain additional inspection requirements. The additional requirements shall be implemented.)

Activity	Nuclear Safety Related	Other
A. Preweld		
1. Proper Material	WF	WF
2. Weld Joint Dimensions (Fitup)	WF	WF
3. Alignment	WF	WF
4. Surface Cleanliness	WF	WF
5. Qualified Welder	WF	WF
6. Proper Procedure	WF	WF
7. Proper Filler Metal	WF	WF
B. During Welding		
1. Procedure Adherence	WF	WF
C. After Welding (Section 8.6)		
1. Weld Defects	WI	WF
2. Weld Contour	WI	WF
3. Size and Location of Welds	WI	WF

Notes

WF - The welder and his foreman shall meet the requirement and shall be subject to the surveillance program of 6.3

WI - An inspector shall verify that the requirement is met. A record is required. The record may be the inspector's unique identifying mark on the weldment, marked drawings, individual inspection records, or as required by a quality assurance program.

6.3 Construction shall verify through a surveillance program that each inspector and welder's foreman is properly performing the required activities of section 6.2.

6.3.1 Each foreman's and inspector's work shall be monitored through a surveillance program at least once every two weeks.

6.3.2 The surveillance program shall check work that is in progress and work that has been completed to ensure compliance with the requirements of section 6.2.

6.4 Appropriate educational programs or other corrective action shall be taken to improve the capabilities of craftsmen and inspectors not meeting the requirements of section 6.2.

6.5 At nuclear construction sites, a monthly report of the surveillance program shall be submitted to the appropriate Design Project Manager or lead Branch Chief. The report shall list the plant features examined, major problems, and corrective action.

6.6 Inspectors shall be trained and qualified to levels equivalent of those of SNT-TC-1A, American Society of Nondestructive Testing Recommended Practice for Nondestructive Testing Personnel Qualification and Certification. Only Level II or III persons or Level I persons working under the direction of a Level II shall perform inspections.

6.7 Nondestructive testing and visual examination shall be performed to the requirements of section 6.7 of the AWS Structural Welding Code or to the requirements of ASME Section III for piping supports. All nondestructive testing shall be in accordance with the written procedures of General Construction Specification G-29C or G-29M.

7.0 STRENGTHENING AND REPAIRING EXISTING STRUCTURES

The fabrication requirements for strengthening and repairing existing structures shall be the same as those for fabrication of new structures.

8.0 NEW STEEL STRUCTURES

8.1 This section contains fabrication requirements for new steel structures and supplements sections 1 through 6.

8.2 Base Metals

8.2.1 Base metals to be welded in accordance with prequalified welding procedures shall be as specified in 8.2 of the AWS Structural Welding Code. Welding procedures for all other base metals shall be qualified in accordance with section 5 of this specification.

8.2.2 Extension bars, runoff plates, and steel backing shall be of one of the materials permitted in the welding procedure. Spacers shall be of the same material as the base metal.

8.3 Structural Details

Fillet welded angular connections of structural shapes shown on drawings may be made as shown in figure 8.3. This applies only to those connections designated on EN DES-approved drawings with the weld all-around symbol as used in the figure.

8.4 Dimensional Tolerances

Dimensional tolerances shall be in accordance with 3.5.

8.5 Temporary Welds

Temporary welds shall be subject to the same requirements as permanent welds. They shall be removed unless otherwise specified by EN DES. When they are removed, the remaining surface shall be approximately flush (see 3.6.3 for flush weld requirements).

8.6 Quality of Welds

8.6.1 A weld shall be acceptable by visual inspection if the inspection shows that:

8.6.1.1 The weld has no cracks.

8.6.1.2 Thorough fusion exists between adjacent layers of weld metal and between weld metal and base metal.

8.6.1.3 Craters are filled to the full cross-section of the weld.

8.6.1.4 Weld profiles are in accordance with 3.6.

8.6.1.5 Undercut shall not exceed 1/32-inch.

8.6.1.6 The sum of diameters of piping porosity in fillet welds does not exceed 3/8-inch in any linear inch of weld and does not exceed 3/4-inch in any one-foot length of weld.

8.6.1.7 A fillet weld in any single continuous weld shall be permitted to underrun the nominal fillet size required by 1/16-inch without correction provided that the undersize portion of the weld does not exceed 10 percent of the length of the weld. On web-to-flange welds on girders, no underrun is permitted to the ends for a length equal to twice the width of the flange.

8.6.1.8 Complete joint penetration groove welds in butt joints shall have no piping porosity.

8.6.1.9 Visual inspection of welds in steels except ASTM A514 and A517 may begin immediately after the completed welds have cooled to ambient temperature. Acceptance of ASTM A514 and A517 steel weldments shall be based on visual inspection performed not less than 48 hours after completion of the weld.

8.6.2 As a minimum, nondestructive testing of welds shall be performed when required by the drawing or specification. Nondestructive testing shall be performed in accordance with the requirements of 6.7 of this specification and the acceptance criteria of 8.15 of the AWS Structural Welding Code.

8.6.3 Acceptance criteria for visual examination and nondestructive testing of ASME Section III, subsection NF, may be substituted for the acceptance criteria of 8.6.1 and 8.6.2 above.

8.6.4 All visual examination and nondestructive testing shall be in accordance with the written procedures of General Construction Specifications G-29C or G-29M.

9.0 TUBULAR STRUCTURES

9.1 This section supplements sections 1 through 6 and contains fabrication requirements for tubular structures.

9.2 Base Metals

9.2.1 Base metals to be welded in accordance with prequalified welding procedures shall be as specified in 10.2 of the AWS Structural Welding Code. Welding procedures for all other base metals shall be qualified in accordance with section 5 of this specification.

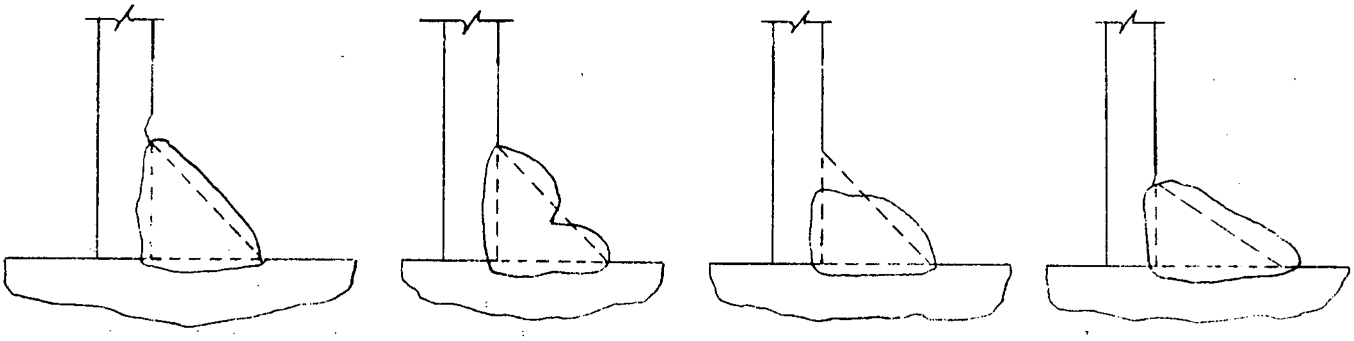
9.2.2 Extension bars, runoff plates, and steel backing shall be of one of the materials permitted in the welding procedure. Spacers shall be of the same material as the base metal.

9.3 Fillet welded angular connections of tubular shapes shown on drawings used may be made as shown in figure 9.3. This applies only to those connections designated on EN DES-approved drawings with the weld all-around symbol as used in the figure.

9.4 Workmanship and Quality

The requirements of 8.4, 8.5, and 8.6 shall be applicable to the fabrication of tubular structures.

Prepared by: W. P. Jost 4-14-83
Reviewed by: 4/14/83
Approved by: C. E. Roberts 4/15/83



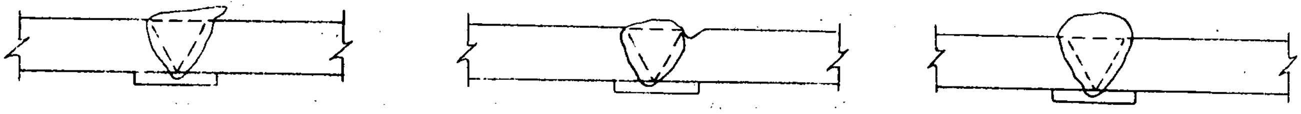
EXCESSIVE UNDERCUT

INSUFFICIENT THROAT

INSUFFICIENT LEG

OVERLAP

Figure 3.6.1 - Unacceptable Fillet Weld Profiles

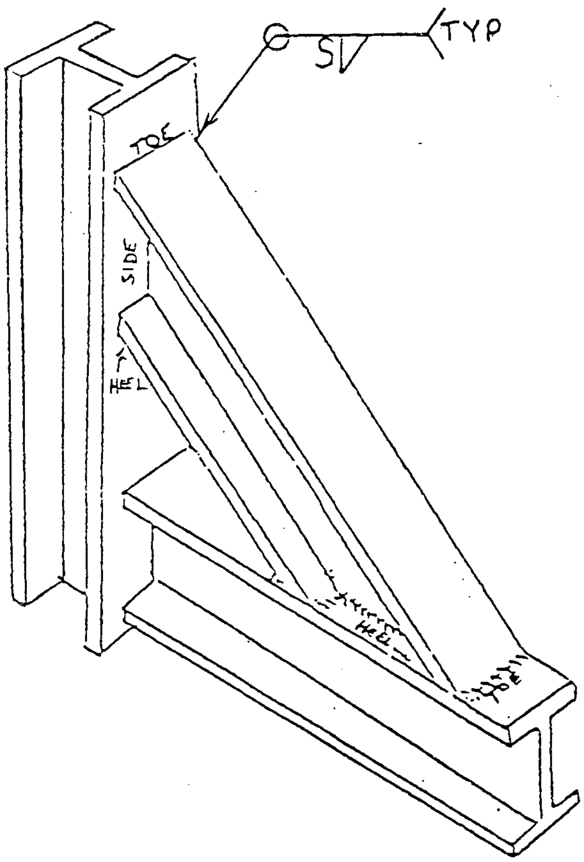


OVERLAP

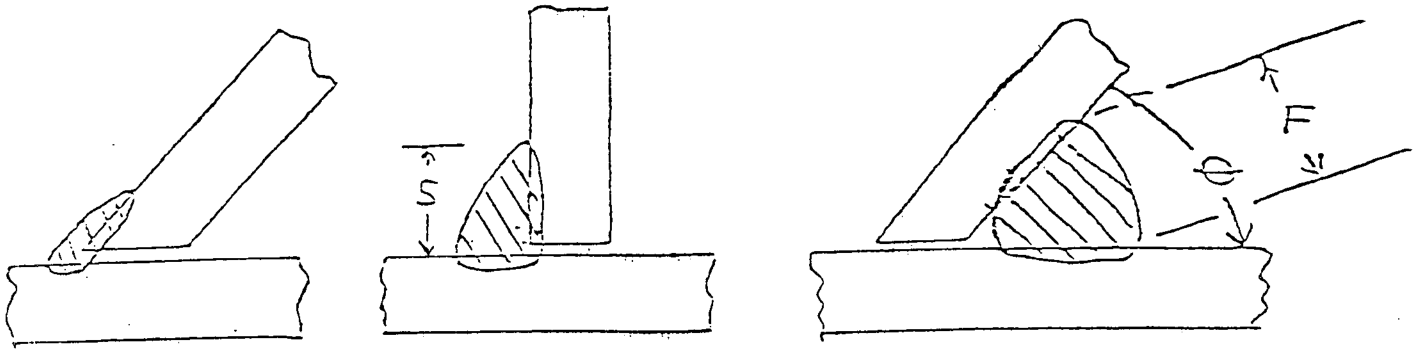
EXCESSIVE UNDERCUT

EXCESSIVE REINFORCEMENT

Figure 3.6.2.2 - Unacceptable Butt Weld Profiles



Fillet Size (S)	Heel Face (F) (inches)		
	25°-40°	40°-55°	55°-65°
3/16	1/4	1/4	5/16
1/4	1/4	5/16	3/8
5/16	5/16	5/16	7/16
3/8	3/8	3/8	1/2
7/16	3/8	7/16	9/16
1/2	3/8	1/2	5/8
9/16	3/8	9/16	11/16
5/8	7/16	9/16	3/4



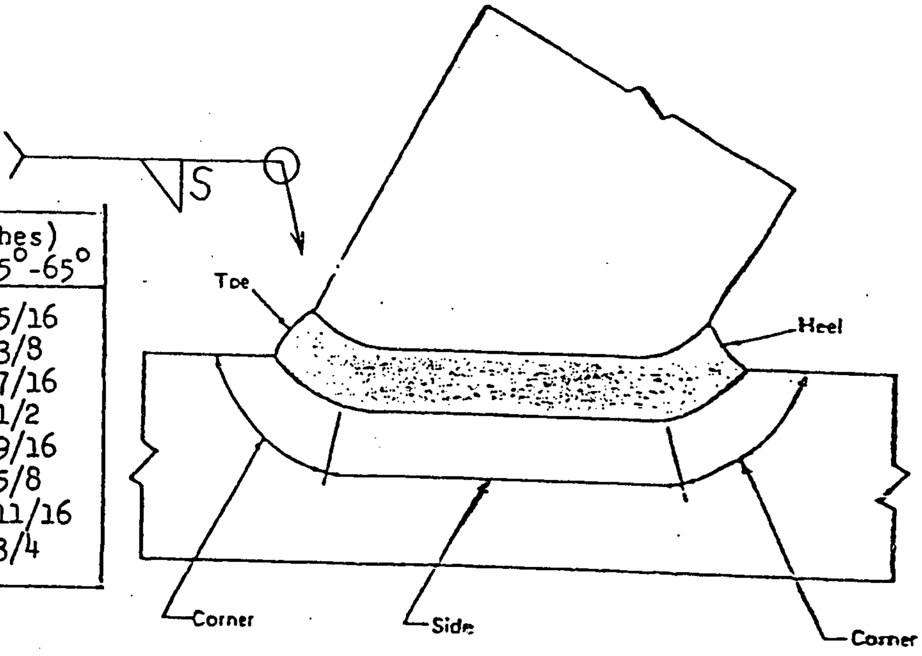
Toe Side Heel

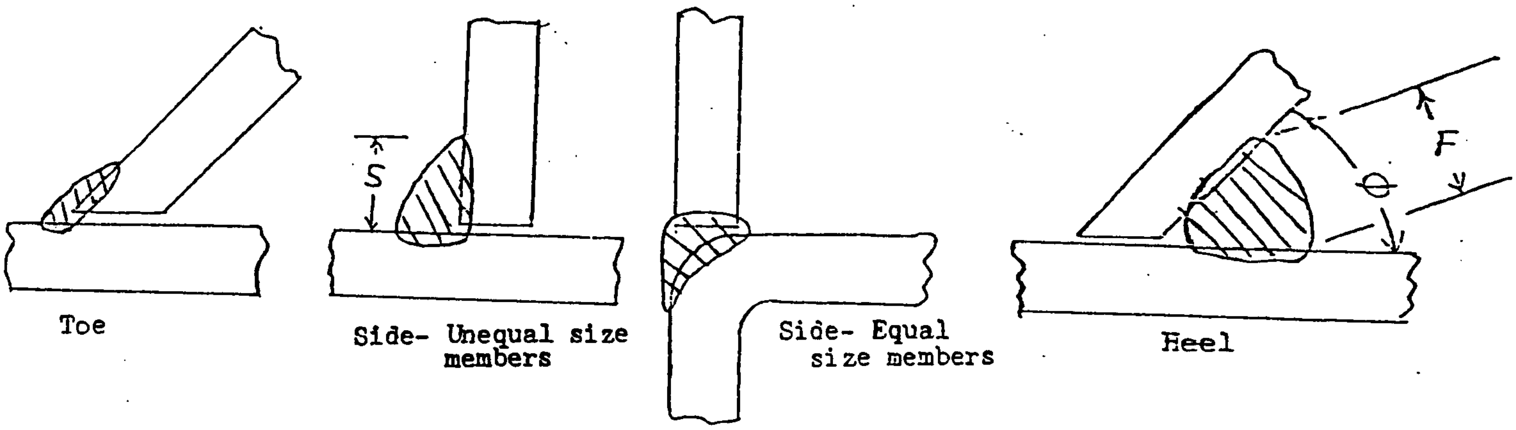
Note

1. Corners shall provide a smooth transition from the sides to the heel and toe.

Figure 8.3 - Alternate Fillet Weld all Around Connection for Members Meeting at an Angle

Fillet Size(S)	Heel Face (F) (inches)		
	25°-40°	40°-55°	55°-65°
3/16	1/4	1/4	5/16
1/4	1/4	5/16	3/8
5/16	5/16	5/16	7/16
3/8	3/8	3/8	1/2
7/16	3/8	7/16	9/16
1/2	3/8	1/2	5/8
9/16	3/8	9/16	11/16
5/8	7/16	9/16	3/4





Toe

Side- Unequal size members

Side- Equal size members

Heel

Notes
1. Side welds shall be at least flush with the outer surface.
2. Corners shall provide a smooth transition from the sides to the heel and toe.

Figure 9.3 - Alternate Fillet Weld All Around Connection for Members Meeting at an Angle

TENNESSEE VALLEY AUTHORITY

GENERAL WELDING PROCEDURE SPECIFICATION

(This specification is technically identical with Process Specification 1.C.1.2(b) with addenda 1-8.)

1.0 SCOPE

1.1 This welding procedure specification shall be applicable to all welding performed in accordance with the American Welding Society Structural Welding Code D1.1.

2.0 WELDING PROCEDURE SYSTEM

2.1 The following documents, used in conjunction, shall constitute a qualified welding procedure:

2.1.1 General Welding Procedure Specification

2.1.2 Detail Weld Procedure

2.1.3 Welding Procedure Qualification Record (for other than AWS prequalified procedures)

2.2 The Detail Weld Procedure shall specify the general welding procedure specification and, where applicable, the welding procedure qualification record to be used as reference documents.

2.3 Each Detail Weld Procedure shall be coded by letters to indicate the welding process and weld penetration category. A consecutive number shall follow to identify a separate procedure using the same combination of welding process and weld penetration category. A minor variation in procedure shall be indicated by a small case letter following the consecutive number. Letter codes shall be as follows:

Welding Process

SM - Manual Shielded Metal Arc
S - Submerged Arc
GM - Gas Metal Arc
GTA - Gas Tungsten Arc (Automatic)
GT - Gas Tungsten Arc
FC - Flux Cored Electrode
SD - Solid Electrode
SW - Stud Weld
ES - Electroslag
AW - Arc Weld

Penetration

L - Limited thickness, complete penetration
U - Unlimited thickness, complete penetration
P - Partial penetration
RB - Reinforcing bar, complete and partial penetration

2.4 Each joint design shall be coded by letter and number to indicate the joint type, use limitations,weld penetration and weld type in accordance with the following:

Joint Types

B - Butt
C - Corner
T - Tee
BC - Butt or Corner
TC - Tee or Corner
BTC - Butt, Tee, or Corner
LP - Lap

Limitations

L - Limited thickness, complete penetration
U - Unlimited thickness, complete penetration
P - Partial penetration
A - All diameters (applies to RB procedures only)

Weld Types*

1 - Square Groove
2 - Single V Groove
3 - Double V Groove
4 - Single Bevel Groove
5 - Double Bevel Groove
6 - Single U Groove
7 - Double U Groove
8 - Single J Groove
9 - Double J Groove
10 - Single-flare-V Groove
11 - Single-flare-Bevel Groove
12 - Double-flare-Bevel Groove
13 - Sleeve Splice
14 - Flare-Bevel Groove
15 - Double-Flare-Double-V Groove
16 - Fillet

*Letters following weld type indicate variation in joint design.

3.0 BASE MATERIALS

3.1 Steel base materials shall conform to the requirements of the latest edition of the specifications listed on the Detail Weld Procedures.

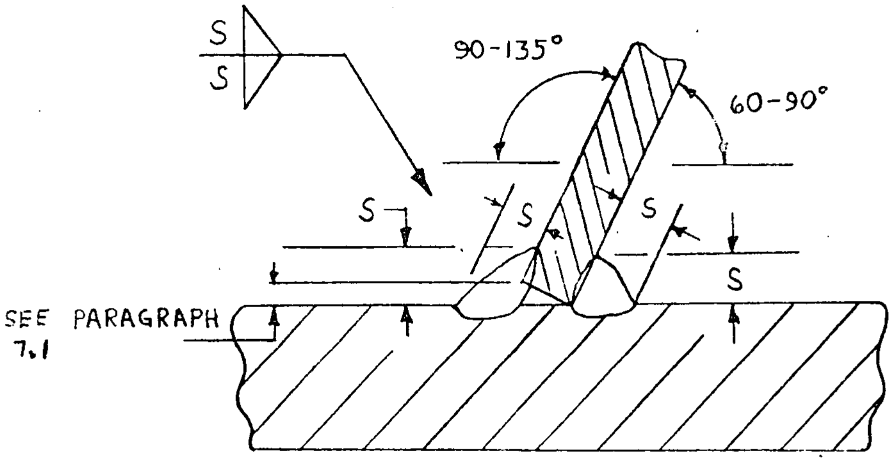
3.2 When structural steels other than those listed are used construction, a separate procedure must be qualified for the applications.

3.3 ASTM A242 and A606, Type 4, shall be shown suitable for welding to EN DES. Chemistry meeting ASTM A588 satisfies this requirement.

4.0 WELDING PROCEDURE QUALIFICATION

4.1 Weld joints conforming to those specified on the detail weld procedure without reference to qualification tests are those designated prequalified. All other procedures shall require weld procedure qualification tests, and the procedure qualification test number shall be referenced on the Detail Weld Procedure.

4.2 Fillet welds, plug welds, and slot welds shall be made in accordance with one of the prequalified or separately qualified detail Weld procedures without limitation on weld size. Fillet welds shall be in accordance with the following sketch:



DETAIL OF FILLET WELDS

5.0 WELDER AND WELDING OPERATOR PERFORMANCE QUALIFICATION

5.1 Each welder and welding operator shall be qualified in accordance with the requirements of AWS D1.1 (Process Specification 1.C.2.2) prior to performing welds in accordance with this specification.

6.0 BASE MATERIAL PREPARATION

6.1 Surfaces and edges to be welded shall be smooth, uniform, and free from fins, tears, cracks, and other defects which would adversely affect the quality or strength of the weld.

6.2 Surfaces to be welded and surfaces adjacent to a weld shall be free from loose or thick scale, slag, rust, grease, or other foreign material that would prevent proper welding or produce objectionable fumes.

6.3 Mill scale that withstands vigorous wire brushing, a light film of drying oil, or a thin rust inhibitive coating or antispatter compound may remain on surfaces, except that all mill scale shall be removed from the surfaces on which flange-to-web welds are to be made.

6.4 Carbozinc 11 inorganic zinc primer is an acceptable "weld through" primer when applied in dry film thicknesses of up to 2.0 mils. (Reference memorandum from R. M. Pierce to G. G. Stack, September 11, 1974.)

6.5 The cutting flame for oxygen cutting shall be adjusted and manipulated to avoid cutting beyond prescribed lines. Roughness of oxygen cut surfaces shall not be greater than that defined by the American National Standards Institute surface roughness value of 1000 microinches (ANSI B46.1 surface texture) for material up to 4 inches in thickness and 2000 microinches for material 4 to 8 inches in thickness, except that the ends of members not subject to calculated stress at the ends shall meet the surface roughness value of 2000 microinches. Roughness exceeding these values and occasional notches or gouges not more than 3/16-inch in depth on otherwise satisfactory surfaces shall be removed by machining or grinding. Cut surfaces and edges shall be left free of slag. Correction of defects shall be blended to the oxygen cut surfaces with a slope not exceeding 1 in 10. Defects in oxygen cut edges shall not be repaired by welding except with the approval of the Engineer, occasional notches or gouges less than 7/16-inch depth for material up to 4 inch thickness, and 5/8-inch depth for material over 4 inch thickness, may be repaired. Such weld repairs shall be made by suitably preparing the defect, welding with low hydrogen electrodes not exceeding 5/32-inch diameter, and grinding the completed weld smooth and flush with the adjacent surface.

6.6 Reentrant corners, except for the corners of weld access cope holes adjacent to a flange, shall be filleted to a radius of not less than 1/2-inch for buildings and tubular structures, and 3/4-inch for bridges. The fillet and its contiguous cuts shall meet without offset or cutting past the point of tangency.

6.7 Materials may be prepared by machining, grinding, air carbon arc oxygen cutting, chipping, or oxygen gouging, except that oxygen gouging shall not be used on quenched and tempered steel.

7.0 ASSEMBLY AND WELDING TOLERANCE

7.1 Parts to be joined by fillet welds shall be brought into as close contact as practicable. The separation between parts shall normally not exceed 3/16-inch, except in cases involving shapes and plates 3 inches or greater in thickness when, after straightening and in assembly, the separation cannot be closed sufficiently to meet this tolerance. In such cases, a maximum separation of 5/16-inch is acceptable provided a sealing weld or suitable backing material is used to support the weld metal. (Backing materials may consist of flux, glass tape, iron powder, or deposited weld metal and the weld joint shall have been qualified with the type of backing material used.) If the separation is 1/16-inch or greater, the leg of the fillet weld shall be increased by the amount of separation unless it can be determined or demonstrated that the required weld thickness has been obtained.

7.2 The separation between faying surfaces of lap joints and of butt joints on backing shall not exceed 1/16-inch. The use of fillers is prohibited unless specified on drawings.

7.3 Parts to be joined by partial penetration groove welds parallel to the length of the member, bearing joints excepted, shall be brought into as close contact as practicable. The separation between parts shall not exceed 3/16-inch except in cases involving rolled shapes and plates over 3 inches thickness when, after straightening and assembly, the separation cannot be closed sufficiently to meet this tolerance. In such cases, a maximum separation of 5/16-inch is acceptable provided a sealing weld or suitable backing material is used to support the weld metal.

7.4 Abutting parts to be joined by butt welds shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignment, an offset not exceeding 10 percent of the thickness of the thinner part joined, but in no case more than 1/8-inch, may be permitted as a departure from the theoretical alignment. In correcting misalignment in such cases, the parts shall not have a greater slope than 1/2-inch in 12 inches, with measurement of offset based on midplane of parts unless otherwise shown on drawings.

7.5 In tubular structures, abutting parts to be joined by girth welds shall be carefully aligned. No two girth welds shall be located closer together than one pipe diameter or 3 feet, whichever is less. There shall be no more than two girth welds in any 10-foot interval of pipe except as otherwise approved. Radial offset of abutting edges of the girth seams shall not exceed 20 percent of the wall thickness and the maximum allowable shall be 1/4-inch provided that any offset exceeding 1/8-inch is welded from both sides. Weld seams of adjoining sections shall be staggered a minimum of 90 degrees unless closer spacing is otherwise approved.

7.6 For buildings and bridges, fitup tolerances shall be as specified in figures 1 and 2. Wider root openings (but not exceeding the lesser of 3/4-inch or twice the thickness of the thinner part) may be built up to acceptable dimensions prior to joining.

7.7 The following tolerances apply to complete joint penetration tubular groove welds made from one side only without backing:

	SMAW	GMAW	FCAW
Root face of joint, in.	± 1/16	± 1/32	± 1/16
Root opening of joints without steel backing, in.*	± 1/16	± 1/16	± 1/16
Groove angle of joint, degree	± 5	± 5	± 5

*Root openings wider than permitted by the above tolerances but not greater than the thickness of the thinner part may be built up by welding to acceptable dimensions prior to joining.

7.8 Members to be welded shall be brought into correct alignment held in position by bolts, clamps, wedges, guy lines, struts, other suitable devices, or by tack welds, until welding has been completed. The use of jigs and fixtures is recommended where practicable. Suitable allowance shall be made for distortion and shrinkage.

8.0 TACK WELDS AND TEMPORARY WELDS

8.1 Tack welds shall be of the same quality as final welds.

8.2 Temporary welds shall be subject to the same welding procedure requirements as the final welds.

8.3 Preheat is not mandatory for single pass tack welds which will be completely remelted and incorporated into continuous submerged arc welds.

8.4 Defects such as undercut, unfilled craters, and porosity in single pass tack welds which will be completely remelted and incorporated into continuous submerged arc welds, need not be removed prior to joint welding.

8.5 Tack welds which are incorporated into the final weld shall be cleaned thoroughly, and shall be made with electrodes meeting the requirements of the final welds. If not incorporated into the final weld, they shall be removed, except that they need not be removed for buildings unless required by the Engineer.

8.7 Temporary welds when not incorporated into the final weld shall be removed and the surface shall be made flush with the original surface.

8.8 There shall be no temporary welds in tension zones of members fabricated from quenched and tempered steels. Temporary welds at other locations shall be shown on shop drawings and shall be made with E701B low hydrogen electrodes.

8.9 Arc strikes outside of the area of permanent welds should be avoided on any material. The areas of arc strikes shall be ground to a smooth contour and examined for defects.

9.0 WELDING MATERIALS

9.1 Manual Shielded Metal Arc Process

9.1.1 Electrodes for manual shielded metal arc welding shall conform to the requirements of the latest edition of "Specification for Mild Steel Covered Arc Welding Electrodes," AWS A5.1, or to the requirements of "Specifications for Low Alloy Steel Covered Arc Welding Electrodes," AWS A5.5.

9.1.2 All low hydrogen type electrodes conforming to AWS A5.1 may be used directly from hermetically sealed undamaged coytainers or shall be dried for at least 2 hours between 450 and 500°F before they are used. Immediately after removal from hermetically sealed containers or from drying ovens, electrodes shall be stored in ovens held at a temperature of 250°F minimum. Electrodes that are not used within 4 hours after removal from hermetically sealed containers or from a drying or holding oven shall be redried for a minimum of 2 hours at 450 to 500°F prior to reissue. Electrodes that have become wet shall be destroyed.

9.1.3 All low hydrogen type electrodes conforming to AWS A5.5 may be used directly from hermetically sealed undamaged containers or shall be dried for at least 1 hour between 700 and 800°F before they are used. Immediately after removal from hermetically sealed containers or from drying ovens, electrodes shall be stored in ovens held at a temperature of 250°F minimum. Electrodes of E70XX that are not used within 4 hours, E80XX within 2 hours, E90XX within 1 hour, and E100XX or E110XX within 1/2 hour after removal from hermetically sealed containers or removal from dying or storage ovens shall be redried for 1 hour between 700 and 800°F prior to reissue. Electrodes that have become wet shall be destroyed.

9.1.4 The maximum size of electrodes shall be as follows:

9.1.4.1 5/16-inch for all welds made in the flat position, except root passes.

9.1.4.2 1/4-inch for horizontal fillet welds.

9.1.4.3 1/4-inch for root passes of fillet welds made in the flat position, and of groove welds made in the flat position with backing and with a root opening of 1/4-inch or more.

9.1.4.4 5/32-inch for welds made with EXX14 and low-hydrogen electrodes in the vertical and overhead positions.

9.1.4.5 3/16-inch for root passes of groove welds and for all other welds not included under 9.1.4.1, 9.1.4.2, 9.1.4.3, and 9.1.4.4 above.

9.1.6.6 The test record shall contain the following data:

(a) Electrode manufacturer and classification
(b) Moisture content of test environment
(c) Temperature and relative humidity of environment
(d) Time of exposure to environment
(e) Electrode moisture content as received
(f) Electrode moisture content after exposure

9.1.6.7 Meteorological data for a site as presented in the Safety Analysis Report or as gathered for cooling tower design purposes shall be used to determine the maximum moisture in the site air to which electrodes are to be exposed. Alternatively, air with a moisture content of 0.0247 lb/lb dry air may be used for all electrode exposure tests. This moisture content is based on a search of 30 years of National Climatic Center data which showed the maximum wet bulb temperature ever recorded in the Valley was 83°F at Memphis.

9.1.7 Electrodes listed below have been tested as prescribed in section 9.1.6 and have been found acceptable for exposure times as indicated.

This list will be updated periodically (for information only) as additional brands are tested and results made available to EN DES. Extended exposure times may be utilized immediately on satisfactory completion of the required tests.

Type	Brand	Permissible Exposure Time (Hours)	Test Ref.
E7018	Hobart 718 LMP	10	SME 801110 002
E7018	McKay 7018 XLM(1)	10	SME 810921 002
E7018	Lincoln JETLH 72(2)	10	SME 801110 002
E7018	Lincoln JETLH 78(2)	10	SME 801110 002
E7018	Chemtron Atom Arc 7018	10	SME 830106 001
E7018	RACO E7018 MP	10	SME 821004 002
E7018	Airco E7018 MR	10	SME 801110 002

(1) Procured after September 21, 1981.
(2) Procured after November 17, 1979.

9.1.8 Where color match of welds is desired in A 242 and A 588 steels, E8018C3 shall be substituted for E7016 and E7018 in the detail weld procedure.

9.1.9 At Hartsville and later nuclear plants, when welding low carbon (L) grades of 304 and 316 stainless steel or performing weld cladding which involves tie-in to these materials, types 308L, 316L, or 309L electrodes or filler metal, as appropriate, shall be used. Detail weld procedures specifying types 308, 316, or 309 electrodes or filler metals may be used for these applications provided the corresponding low carbon (L) grade of electrode or filler metal is substituted.

9.2 Gas Metal Arc and Flux Cored Arc Process

9.2.1 Electrodes and combinations of shielding for gas metal arc welding shall conform to the requirements of the latest edition of "Specification for Mild Steel Electrodes for Gas Metal-Arc Welding" (AWS A5.18 or AWS A5.20).

9.2.2 For weld metal having a minimum specified yield strength greater than 60,000 pounds per square inch, each combination of electrode and shielding proposed for use must produce a low-alloy weld metal having the mechanical properties listed below. The mechanical properties shall be determined from a multiple-pass weld made in accordance with the test requirements of the latest edition of AWS A5.18 or AWS A5.20.

GMAW GRADE E80S AND FCAW GRADE E80T

Tensile strength, lb/in^2 min	80,000
Yield Strength, lb/in^2 min	65,000
Elongation in 2 inches, percent min	18
Impact Strength, min.	
Charpy V-Notch*	20 ft-lb at zero°F

GMAW GRADE E90S AND FCAW GRADE E90T

Tensile strength, lb/in^2 min	90,000
Yield Strength, lb/in^2 min	78,000
Elongation in 2 inches, percent min	17
Impact Strength, min.	
Charpy V-Notch*	20 ft-lb at zero°F

GMAW GRADE E100S AND FCAW GRADE E100T

Tensile strength, lb/in^2 min	100,000
Yield Strength, lb/in^2 min	90,000
Elongation in 2 inches, percent min	16
Impact Strength, min.	
Charpy V-Notch*	20 ft-lb at zero°F

GMAW GRADE E110S AND FCAW GRADE E110T

Tensile strength, lb/in^2 min	110,000
Yield Strength, lb/in^2 min	98,000
Elongation in 2 inches, percent min	16
Impact Strength, min.	
Charpy V-Notch*	20 ft-lb at zero°F

*For bridge application only. This value shall govern unless base metal requirements are more restrictive in which case the latter shall govern.

9.2.3 The mechanical property tests required in 9.2.2 above for grades E100S and E110S shall be made using ASTM A 514 base metal.

9.2.4 The Engineer, at his discretion may accept recorded evidence of a combination that has been satisfactorily tested in lieu of the test required in 9.2.2 above, providing the same welding procedure is used.

9.2.5 The electrode manufacturer shall furnish certification that the electrode will meet the above requirements of classification or grade.

9.2.6 The shielding gas or gas mixture shall have a dewpoint of -40°F or lower.

9.2.7 Electrodes shall be dry and in suitable condition for use.

9.2.8 The maximum electrode diameter shall be 5/32-inch for the flat and horizontal positions, 3/32-inch for the vertical, and 5/64-inch for the overhead positions.

9.2.9 E70S-6 electrodes may be used whenever a Detail Weld Procedure specifies E70S-3 electrodes.

9.2.10 Where color match of welds is desired in A242 and A588 steel, the SMAW process shall be used.

9.2.11 Where detail weld procedures specify type E70T-1 flux-cored wire, type E71T-1 may be substituted.

9.2.12 Where Detail Weld Procedures specify type E70S-2, E70S-3, or D70S-6 electrodes or filler metal, types ER70S-2, ER70S-3, or ER70S-6, respectively, may be substituted.

9.3 Electroslag Process

9.3.1 Prior to use, it shall be demonstrated that each combination of shielding and filler metal will produce welds having the following mechanical properties when welded in accordance with the Process Specification. The Engineer, at his discretion, may accept recorded evidence of a combination that has been satisfactorily tested in lieu of the required testing provided the same welding procedure is used.

Weld Metal Properties for ASTM A36 Steel

Tensile Strength, jb/in min.	60,000
Yield Point, lb/in min.	36,000
Elongation in 2 inches, percent min.	24*

Weld Metal Properties for Joining ASTM A242 or A441 Steel

Material Thickness, in.	3/4 & Under	Over 3/4
Tensile Strength, lb/in min.	70,000	67,000
Yield Point, lb/in min.	50,000	46,000
Elongation in 2 inches, percent min.	22	22

Material Thickness, in.	Over 1-1/2	Over 4
Tensile Strength, lb/in min.	63,000	60,000
Yield Point, lb/in min.	42,000	40,000
Elongation in 2 inches, percent min.	24*	24*

Weld Metal Properties for Joining ASTM A572 Steel

Material Grade	42	45	50
Tensile Strength, lb/in min.	60,000	60,000	65,000
Yield Point, lb/in min.	42,000	45,000	50,000
Elongation in 2 inches, percent min.	24*	22	21
Material Grade	55	60	65
Tensile Strength, lb/in min.	70,000	75,000	80,000
Yield Point, lb/in min.	55,000	60,000	65,000
Elongation in 2 inches, percent min.	20	18	17

Weld Metal Properties for Joining ASTM A588

Material Thickness, in.	4 & Under	Over 4 to 5, Incl	Over 5
Tensile Strength, lb/in min.	70,000	67,000	63
Yield Point, lb/in min.	50,000	46,000	42,000
Elongation in 2 inches, percent min.	21*	21*	21

*A reduction in specified percentage of elongation of 0.5 shall be made for each 1/2-inch increase in thickness above 3-1/2 inches. This reduction shall not exceed 3.0 percent.

9.3.2 Electrodes and consumable guide tubes shall be dry, clean, and in a suitable condition for use.

9.3.3 Welding flux shall be dry and free of contamination from dirt, mill scale, or other foreign material. All flux shall be purchased in packages capable of being stored under normal conditions for at least 6 months without such storage affecting its welding characteristics or properties. Flux from damaged packages shall be discarded or dried before use at a minimum temperature of 250°F for 1 hour. Flux that has been wet shall not be used.

9.4 Submerged Arc Welding Process

9.4.1 The bare electrodes and flux used in combination for submerged arc welding of steels shall conform to the requirements in the latest edition of AWS A5.17, Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding.

9.4.2 Flux used for submerged arc welding shall be dry and free of contamination from dirt, mill scale, or other foreign material. All flux shall be purchased in packages that can be stored, under normal conditions, for six months without such storage affecting its welding characteristics or weld or properties. Flux from damaged packages shall be discarded or shall be dried at a minimum temperature of 250°F (120°C) for one hour before use. Flux shall be placed in the dispensing system immediately upon opening a package, or, if used from an opened package, the top one inch shall be discarded. Flux that has been wet shall not be used. Flux fused in welding shall not be reused.

10.0 PREHEAT AND INTERPASS TEMPERATURES

10.1 Preheat for welding may be applied by flame, inductance, resistance or any other method of heating which is not detrimental to the materials involved.

10.2 When oxyacetylene flame heating is used, care shall be exercised to ensure that only a neutral flame is used and also that local overheating is avoided.

10.3 Preheating temperature may be measured by temperature indication crayons (tempilsticks), contact pyrometers, infrared thermometers, optical pyrometers, or thermocouples, but not by low melting metallic alloys.

10.4 The minimum preheat temperature specified on the Detail Weld Procedure shall be maintained for a distance equal to the material thickness or 3 inches, whichever is greater, from the weld in all directions.

10.5 The material thickness to be used in establishing minimum preheat temperatures is that of the thickest member at the point of welding.

11.0 WELDING REQUIREMENTS

11.1 General Requirements

11.1.1 Extension bars, runoff plates, and backing materials shall be made from one of the materials listed in paragraph 3.0.

11.1.2 Spacers shall be made from the same material as the base material.

11.1.3 All equipment for welding and flame cutting shall be designed, manufactured, and in such condition to enable qualified welders and welding operators to follow prescribed procedures and provide the desired results.

11.1.4 Welding shall not be performed when the ambient temperature is lower than $0^{\circ}F$; when surfaces are exposed to rain, snow, sleet, or high wind; nor when welders are exposed to inclement conditions.

11.1.5 The sizes and lengths of welds shall not be less than those specified by design requirements and indicated on drawings, nor shall they be substantially in excess of those requirements without approval. The location of welds shall not be changed without approval.

11.1.6 Prior to welding over previously deposited weld metal, all slag shall be removed and the weld and adjacent base metal shall be wire brushed. This requirement shall apply not only to successive layers but also to individual passes and to the weld crater area when welding is resumed after any interruption. It shall not restrict the making of plug and slot welds.

11.1.7 Full penetration groove welds without permanent steel backing shall be gouged, chipped, or prepared by grinding to sound metal on the opposite side from the root pass prior to deposition of weld metal on the second side. Temporary ceramic or flux backing may be utilized as an aid in making such joints provided the reverse side is examined and backgouged, ground, or backwelded as necessary to provide a contour meeting visual acceptance criteria. Copper or aluminum temporary backing shall not be used with any welding operation without EN DES concurrence.

11.1.8 Groove welds with metal backing shall be thoroughly fused with the backing material. Metal backing material need not be removed unless required by the Engineer.

11.1.9 Groove welds shall be terminated at the joint ends in a manner that will ensure sound welds. Where possible, this shall be accomplished by the use of extension bars or runoff plates. In building construction extension bars or runoff plates need not be removed unless required by the Engineer.

11.1.10 No peening shall be done on the root or surface layers of welds. Peening of intermediate layers may only be done if authorized by the welding engineering unit.

11.1.11 Caulking or slugging of welds shall not be permitted.

11.2 Manual Shielded Metal Arc Process

11.2.1 The work shall be positioned for flat welding whenever practicable.

11.2.2 The maximum thickness of weld layers subsequent to the root pass in fillet welds and all layers in groove welds shall be:

11.2.2.1 1/4-inch for root passes of groove welds.

11.2.2.2 1/8-inch for subsequent layers of welds in the flat position.

11.2.2.3 3/16-inch for subsequent layers of welds in the vertical, overhead, and horizontal positions.

11.2.3 The maximum size fillet weld which may be made in one pass shall be:

11.2.3.1 3/8-inch for flat position.

11.2.3.2 5/16-inch for horizontal and overhead position.

11.2.3.3 1/2-inch for vertical position.

11.2.4 When welding in a vertical position, the progressions for all passes shall be upwards except that undercut may be repaired vertically downwards when preheat is in accordance with section 10 but not lower than 70°F. However, in tubular structures the progression of vertical welding may be upwards or downwards but only in the directions for which the welder is qualified.

11.2.5 The classification and size of electrode, arc length, voltage, and current shall be suited to the thickness of the material, type of groove, welding positions, and other circumstances attending the work.

11.2.6 The maximum size of electrodes shall be in accordance with section 9.1.4.

11.3 Gas Metal-Arc and Flux Cored-Arc Processes

11.3.1 The maximum fillet weld size made in one pass shall be:

11.3.1.1 1/2-inch for flat and vertical position.

11.3.1.2 3/8-inch for the horizontal position.

11.3.1.3 5/16-inch for the overhead position.

11.3.2 The thickness of weld layers, except root and surface layers, shall not exceed 1/4-inch. When the root opening of a groove weld is 1/2-inch or greater, a multiple-pass, split-layer technique shall be used. The split-layer technique shall also be used in making all multiple-pass welds when the width of the layer exceeds 5/8-inch; however, for flux cored welding, the bead width may extend to but not exceed twice the gas cup diameter when approved by the site welding engineering or welding quality control unit.

11.3.3 The welding current, arc voltage, gas flow, mode of metal transfer, and speed of travel shall be such that each pass will have complete fusion with adjacent base metal and weld metal. There shall be no overlap, excessive porosity or undercutting.

11.3.4 Complete penetration groove welds made without the use of backing shall have the root of the initial weld gouged, chipped, or otherwise removed to all but intermittent remnants of the root of the initial weld before welding is started on the second side.

11.3.5 Gas metal-arc welding shall be protected from wind. Wind velocity in the vicinity of the weld shall be no greater than 5 mi/h.

11.3.6 Roots of groove or fillet welds may be backed to prevent melting through by the use of copper, flux, glass tape, iron powder, or similar material, or be sealed by root passes deposited by low-hydrogen electrodes or other arc welding processes.

11.4 Electroslag Welding

11.4.1 Electroslag welding of quenched and tempered steel is prohibited.

11.4.2 Welds shall be started in such a manner as to permit sufficient heat buildup for complete fusion of the weld metal to the groove face of the joint. Welds stopped at any point in the length of the joint and restarted after a delay of more than 1 minute shall be suitably identified as a restart point for reference in repair welding. After completion of the electroslag process, the area referenced by the restart point shall be excavated and repair welded utilizing the shielded metal-arc process. Excavation shall begin at a minimum distance of 1/2-inch below the restart point and shall extend upward for a minimum of 2 inches.

11.4.3 No welding shall be performed when the temperature of the base metal at the point of welding is below 32°F.

11.5 Submerged Arc Welding Process

11.5.1 All submerged arc welds except fillet welds shall be made in the flat position. Fillet welds may be made in either the flat or horizontal position except that single pass fillet welds made in the horizontal position shall not exceed 5/16-inch (8.0 mm).

11.5.2 The thickness of weld layers, except root and surface layers, shall not exceed 1/4-inch (6.4 mm). When the root opening is 1/2-inch (12.7 mm) or greater, a multiple pass, split-layer technique shall be used. The split-layer technique shall also be used in making multiple pass welds when the width of the layer exceeds 5/8-inch (15.9 mm).

11.5.3 The welding current, arc voltage, and speed of travel shall be such that each pass will have complete fusion with the adjacent base metal and weld metal and there will be no overlap or undue undercutting. The maximum welding current to be used in making a groove weld for any pass that has fusion to both faces of the groove shall be 600 A except that the final layer may be made using a higher current. The maximum current to be used for making fillet welds in the flat position shall be 1000 A.

11.5.4 Surfaces on which submerged arc welds are to be deposited and adjacent faying surfaces shall be clean and free of moisture.

11.5.5 When the joint to be welded requires specific root penetration, as in joints B-L1-S, TC-L1-S, B-L2b-S, C-L2B-S, B-U3A-S, B-L3-S, TC-L4-S, TC-U5-S, and B-U7-S unless the joint is backgouged, a sample joint shall be prepared and a cross-section macroetched to demonstrate that the proposed welding procedure will attain the required root penetration.

11.5.6 Roots of groove or fillet welds may be backed by flux, glass tape, iron powder, or similar materials to prevent melting through. They may also be sealed by means of root passes deposited with low hydrogen electrodes if shielded metal arc welding is used, or by other arc welding processes.

11.5.7 Neither the depth nor the maximum width in the cross-section of weld metal deposited in each weld pass shall exceed the width at the surface of the weld pass.

11.5.8 Tack welds (in the form of fillet welds 3/8-inch (9.5 mm) or smaller, or in the roots of joints requiring specific root penetration) shall not produce objectionable changes in the appearance of the weld surface or result in decreased penetration. Tack welds not conforming to the preceding requirements shall be removed or reduced in size by any suitable means before welding. Tack welds in the root of a joint with steel backing less than 5/16-inch (8.0 mm) thick shall be removed or made continuous for the full length of the joint using shielded metal arc welding with low hydrogen electrodes.

12.0 CONTROL OF DISTORTION, SHRINKAGE, AND LAMELLAR TEARING

12.1 In assembling and joining a structure or members forming part of a structure, the sequence of welding shall be such as to minimize distortion, shrinkage, and lamellar tearing.

12.2 Insofar as practicable, all welds shall be deposited in a sequence that will balance the applied heat of welding while the welding progresses.

12.3 The direction of the general progression in welding on a member shall be from points where the parts are relatively fixed in position with respect to each other toward points where they have a greater relative freedom of movement.

12.4 Joints expected to have significant shrinkage should usually be welded before joints expected to have lesser shrinkage. They should also be welded with as little restraint as possible.

12.5 In making welds under conditions of severe restraint, the welding shall be carried continuously to completion or to a point that will ensure freedom from cracking before the joint is allowed to cool below the minimum specified preheat and interpass temperature.

12.6 For members or structures fabricated to the requirements of this specification, the welding sequence shall be planned by the site welding engineer to minimize shrinkage, distortion, and lamellar tearing. The form and detail of the plan will be to the discretion of the site welding engineer.

12.7 Appendix A contains mandatory special requirements for precautions to be followed when making certain welded connections which transmit load through the thickness or section of a plate or rolled shape. Appendix A is mandatory unless alternative techniques to prevent lamellar tearing are developed.

12.8 Section 12.7 also applies for those situations in which the weld size is such that normal weld shrinkage is likely to cause lamellar tearing, regardless of the intended loading condition.

12.9 EN DES-NEB has considerable data relative to the subject of this section which will be made available upon request.

13.0 REPAIRS AND CORRECTIONS

13.1 A part or member containing welding which is unsatisfactory or which indicates inferior workmanship may be corrected by the methods listed below when approved by the Engineer. Defective welds or base material shall be corrected by removing or replacing the weld as follows:

13.3.1 Overlap or excessive convexity - Reduce by removal of excess weld metal.

13.1.2 Excessive concavity of weld, weld crater, undersize welds, undercutting - Clean the weld and deposit additional weld metal.

13.1.3 Excessive weld porosity, excessive slag inclusions, incomplete fusion - Remove the defective portions and reweld.

13.1.4 Cracks in weld or base metal - Determine the extent of cracks by the use of acid etching, magnetic particle, or liquid penetrant examination. Remove the crack and additonal weld metal for 2 inches beyond each end of the crack and reweld.

13.2 The removal of weld metal or portions of base metal may be done by machining, chipping, grinding, oxygen gouging, or air carbon arc gouging, and in such a manner that the remaining weld or base metal is not nicked or undercut. Oxygen gouging shall not be used on quenched and tempered steels. Care shall be exercised in order to remove as little of the base material as practicable.

13.3 Repair welding shall be performed using welding electrodes of diameter appropriate for the size of the repair and position of welding. Areas to be repair-welded shall be cleaned to the same requirements as for the initial weld.

13.4 In cases where work, subsequent to the deposition of deficient welding, has rendered the weld inaccessible or has caused new conditions which would render the correction dangerous or ineffectual, the original conditions shall be restored by removing welds or members, or both, before making the corrections. As an alternate, the deficiency may be corrected by work performed to a revised and approved design.

13.5 Improperly fitted parts may be cut apart and rewelded. Members distorted by welding shall be straightened by mechanical means or by carefully supervised application of a limited amount of local heating. The temperature of heated areas as measured by approved mehods shall not exceed 1100^{o}F for quenched and tempered steel nor 1200^{o}F for other steels. Parts to be heated for straightening shall be substantially free of stress from external forces except those stresses resulting from mechanical means used in conjunction with the application of heat.

14.0 POST WELD HEAT TREATMENT

14.1 When required by specifications, welded assemblies or components shall be post weld heat treated. The assembly or component shall be adequately supported during the heat treatment operation.

14.2 Postweld heat treatment shall be performed in accordance with Process Specification 2.C.1.1.

15.0 CLEANING OF WELDS

15.1 Slag shall be removed from all welds. Welded joints shall not be painted until after the welding has been examined and accepted. In addition, when so noted on design drawings, flush grinding, or other surface preparation of the weld bead or reinforcement may be required to provide a smooth, neat surface for finish painting.

16.0 STUD WELDING

16.1 Studs shall be of a design suitable for arc welding to steel members with automatically timed stud welding equipment connected to a suitable power source. Studs may be manually welded or repaired using the applicable detail weld procedure.

16.2 Studs with qualified stud bases shall be used. The arc shield used in production shall be the same as used in qualification tests by the manufacturer. The manufacturer shall submit certification of qualification tests for each combination of stud base and arc shield, in accordance with the requirements of AWS D1.1.

16.3 If two or more stud welding guns are to be operated from the same power source, they shall be interlocked so that only one gun can be operated at a time and also to allow sufficient recovery time between completion of one weld and initiation of the next weld cycle.

16.4 The stud welding gun shall be held in position without movement during the welding cycle and until the weld metal has solidified.

16.5 Studs shall be free of rust, rust pits, scale, oil, or other deleterious matter that would affect the welding operation.

16.6 The stud base shall not be painted, galvanized, or cadmium plated prior to welding.

16.7 The areas on material to which studs are welded by the automatic timed arc process shall be free of rust, scale, or other foreign material to the extent necessary to obtain satisfactory welds.

16.8 Welding shall not be done when the base metal temperature is below 0°F or when the surface is wet or exposed to falling rain or snow. When the temperature of the base metal is below 32°F, one stud in each 100 studs welded shall be bent to an angle of 15° from its original axis and evaluated to section 17.3 in addition to the first two tested as specified in section 17.1 or 17.2. If the additional stud test is unacceptable, the procedure shall be tested by bending two studs as outlined in section 17.1 or 17.2. If either of these two studs fail, all of the studs represented by the tests shall be torque tested, bend tested, or rejected.

16.9 Longitudinal and lateral spacings of stud shear connectors with respect to each other and to edges of beam or girder flanges may vary a minimum of 1 inch from the location shown in the drawings, provided the adjacent studs are not closer than 2-1/2 inches center-to-center. The minimum distance from the edge of a stud base to the edge of a flange shall be the diameter of the stud plus 1/8 inch but preferably not less than 1-1/2 inches. Other types of studs shall be so located as to permit a workmanlike assembly of attachments without alterations or reaming.

16.10 Arc shields shall be broken free after welding on all shear connector and anchor studs and on all other studs where practicable.

16.11 Studs, after welding, shall be free from defects or substances that would interfere with their intended function. However, nonfusion on the vertical leg of the flash and small shrink fissures are acceptable.

16.12 Extreme care must be used when welding shear connectors through metal decking. Detail weld procedures and weld procedure qualification tests with size of studs, thickness of decking, and kind and thickness of coating as essential variables are required for such welding.

17.0 STUD WELD QUALITY CONTROL

17.1 The first two stud shear connectors welded to the flange of a wide flange beam, after cooling, shall be tested by bending to an angle of 30° by striking the stud with a hammer. If failure occurs in the weld zone of either stud, the procedure shall be corrected and two additional studs welded and tested. If either of the two studs fail in the weld zone, additional studs shall be welded on separate material until two consecutive studs are tested and found to be satisfactory. Two consecutive studs must then be welded to the member, tested, and found to be satisfactory prior to resuming welding on the member. The foregoing tests shall be performed when changing from one size and type of stud to another with a given welding procedure or with the beginning of a new production shift.

17.1.1 The bent stud shear connectors and concrete anchors that show no sign of failure shall be acceptable for use and left in the bent position if no portion of the stud is less than 1 inch from a proposed concrete surface.

17.1.2 All required bending and straightening shall be done without heating.

17.2 For applications other than shear connectors or when the stud application is not identified, the tests outlined in 17.1 shall be performed, except that the first two studs at the beginning of production welding for that shift shall be welded to separate material in the same general position as the production weld, and of thickness and material similar to the member, and tested by bending to an angle of 30°. Thereafter at least one stud in every 100 shall be tested by bending to an angle of 15°.

17.3 If a visual inspection reveals any stud shear connector that does not show a full 360° flash, any stud that has been repaired by welding, or any stud in which the reduction in length due to welding is less than normal (length of stud more than 1/16-inch greater than specified) it shall be struck with a hammer and bent to an angle of 15° from its original axis.

17.3.1 For studs showing less than 360° flash, the direction of bending shall be opposite to the missing flash.

17.3.2 Studs that crack in the weld, the base metal, or the shank under inspection or subsequent straightening shall be replaced.

17.4 The quality control requirements of section 17.0 are applicable only to studs welded by the automatic-timed arc process. Studs manually welded by the SMAW process are to be visually examined to the requirements of Process Specification 3.C.5.2.

17.5 The parameters given on the Detail Weld Procedures for stud welding will normally produce satisfactory welds. It may be necessary, however, to operate outside these limits in some cases because of variations in the electrical characteristics of individual power supplies. This is permissible provided that, for the parameters actually used and for each change thereto, the quality control requirements of paragraph 17.0 (Process Specification 1.C.1.2) are observed.

18.0 STUD WELD CORRECTIONS

18.1 Studs on which a full 360° weld fillet is not obtained may be repaired by adding a 5/16-inch fillet by the manual shielded metal arc process and low hydrogen electrodes. Welding shall be done using 5/32- or 3/16-inch-diameter electrodes except that smaller electrodes may be used on studs 7/16-inch or less in diameter or for out-of-position welds. The repair weld shall extend a minimum of 3/8-inch beyond each end of the area requiring repair.

18.2 The areas of components subjected to tensile stress where a defective stud has been removed shall be prepared by grinding to a smooth contour. If base material has been extracted in the removal of studs, the area shall be weld repaired with low hydrogen electrodes followed by grinding to an acceptable contour.

18.3 In compression areas of members where stud failures are confined to shanks or fusion zones of studs, a new stud may be welded adjacent to the defective area in lieu of repair and replacement on the same weld area. If base material has been extracted in removing the defective stud, repairs shall be made in the same manner as for tensile areas, except that when the depth of defect is the smaller of 1/8-inch or 7 percent of base material thickness, the area may be blended by grinding. If a replacement stud must be replaced in the same area where the defective stud was removed, the area shall be repair welded prior to attachment of the replacement stud. Replacement shear connector studs shall be tested by bending to a 15° angle.

18.4 The areas of components which will be exposed to view in completed structures shall be weld repaired and the surface prepared flush by grinding, where defective studs have been removed.

19.0 ADDITIONAL REQUIREMENTS FOR WELDING OF BRIDGES

19.1 Fillet welds which support a tensile force that is not parallel to the axis of the weld or which are proportioned to withstand repeated stress shall not terminate at corners of parts or members, but shall be returned continuously, full size around the corner for a length equal to twice the weld size where such return can be made in the same plane.

19.2 Seal welding shall preferably be accomplished by a continuous weld combining the functions of sealing and strength.

19.3 Edges of material thicker than specified in the following list shall be trimmed as required to produce a satisfactory welding edge whenever a weld along the edge is to carry calculated stress:

19.3.2 Rolled edges of plate (other than Universal Mill plates) thicker than 3/8-inch.

19.3.3 Toes of angles or rolled shapes (other than wide flange sections) thicker than 5/8-inch.

19.3.4 Universal Mill plates or edges of flanges of wide flange sections thicker than 1 inch.

20.0 "THE ENGINEER"

"The Engineer" as referenced in this specification is the Manager of Engineering Design.

Prepared by: 4/14/83
Reviewed by: 4/14/83
Approved by: C E Roberts 4/15/83

APPENDIX A

SPECIAL REQUIREMENTS FOR WELDS TRANSMITTING LOADS THROUGH THE THICKNESS OR CROSS SECTION OF PLATE OR SHAPES

1.0 SCOPE

1.1 This appendix is applicable to the welded connections defined in section 3.0. The information in this appendix supplements the requirements contained in Process Specification 1.C.1.2 and the Detail Weld Procedure.

2.0 PURPOSE

2.1 The requirements of this appendix represent precautionary measures to prevent or minimize the occurrence of lamellar tearing in certain welded connections in which the through-thickness ductility of the base material is insufficient to accommodate the strain produced by weld shrinkage stress.

3.0 APPLICABILITY

3.1 This appendix is applicable to the following welds:

3.1.1 Single- or double-fillet welded tee connections with leg size greater than 1 inch.

3.1.2 Full penetration, single bevel tee connections when the beveled member is greater than 1 inch in thickness.

3.1.3 Full penetration, double beveled tee joints when the beveled member is greater than 1-1/2 inch in thickness.

3.1.4 Single- or double-beveled partial penetration tee joints when the effective bevel depth plus the leg size of any required reinforcing fillet totals more than 1 inch.

4.0 REQUIREMENTS

4.1 Unless the base material of the member that is subjected to through-thickness stress is certified to have a minimum of 25 percent reduction of area in that direction, one of the techniques described in 4.2, 4.3, or 4.4 shall be employed. Selection of the technique to be employed shall be by CONST in accordance with the following:

Technique	Applicability
a. 4.2, 4.3, or 4.4	Connections accessible for UT inspection per Process Specification 3.C.10.1 after completion of welding.
b. 4.3 only	Connections not accessible for UT inspection per Process Specification 3.C.10.1 after completion of welding.

4.2 In-Place Buttering - In this technique the weld is developed by depositing weld layers on and parallel to the through-member. The first layer should extend beyond the required leg length by a minimum of 3/8-inch. Each layer is begun at the standing member with progression away from this member. (See Figure 1)

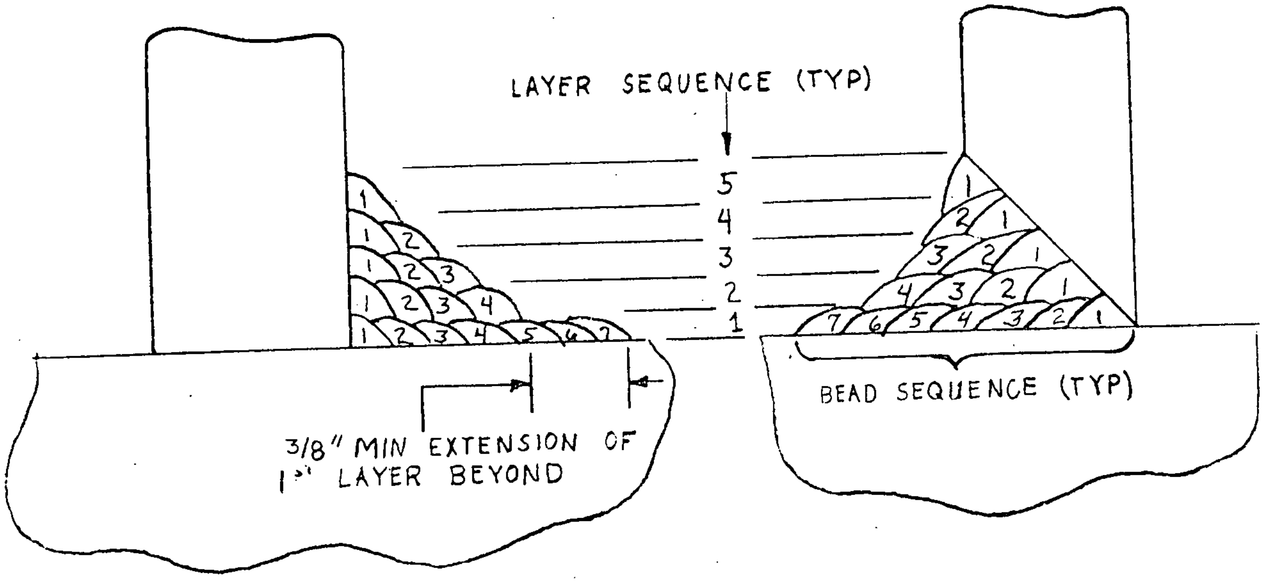


Figure 1
In-Place Buttering Technique

4.3 Overlay or Inlay Buttering - In this technique, weld buttering is deposited on through-member prior to fitup and welding of the standing member. The buttering may be deposited on the surface of the member as an overlay (Figure 2A) or as an inlay in a prepared cavity (Figure 2B). In either case, it will be necessary to lay out the location of the overlay with due regard for subsequent fitup tolerances. Thickness of the overlay or inlay shall be in accordance to the following schedule:

Connection	Minimum Overlay/Inlay Thickness
A. Fillet Welds (3.1.1) and Partial Pen. Welds (3.1.4)	
Leg Size 1 Through 1-1/2"	1/4"
Leg Size 1-1/2" Through 2"	3/8"
Leg Size 2"	1/2"
B. Single Bevel Full Pen. Tee Welds (3.1.2)	
Standing Member 1" Through 1-1/2" Thick	1/4"
Standing Member 1-1/2" Through 2" Thick	3/8"
Standing Member 2" Thick	1/2"
C. Double Bevel Full Pen. Tee Welds (3.1.2)	
Standing Member 1-1/2" Through 2" Thick	1/4"
Standing Member 2" Through 3" Thick	3/8"
Standing Member 3" Thick	1/2 "

Extent of the buttering should be a minimum of 3/8-inch in all directions beyond the area of the attachment weld.

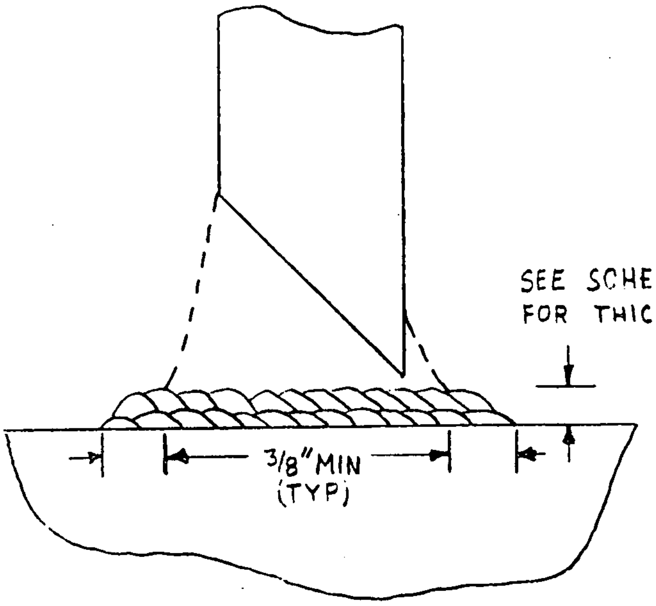


Figure 2A
Overlay Buttering

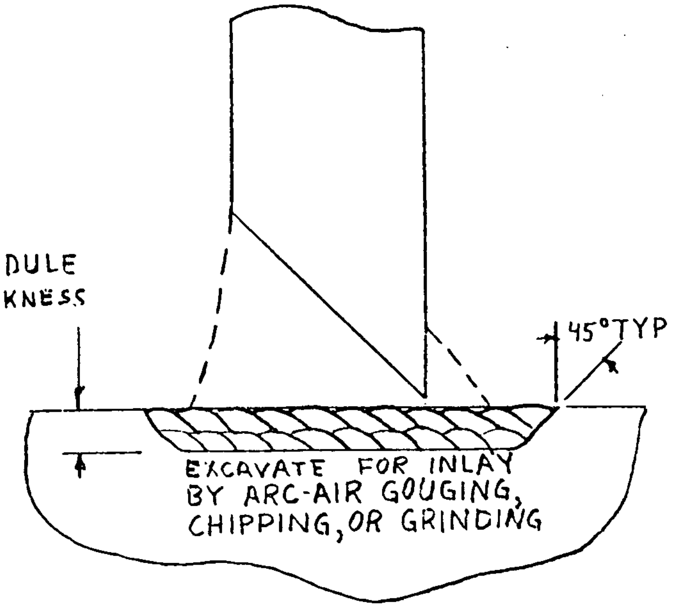


Figure 2B
Inlay Buttering

4.4 Peening - When this technique is used, it shall be performed in accordance with Process Specification 1.C.3.1.

4.5 Inspection - When making welded connections defined in 3.1, and unless a steel is used meeting the requirements of 4.1, ultrasonic inspection per Process Specification 3.C.10.1 shall be performed as follows:

Technique Used	Inspection Required
4.2 or 4.4	UT of completed weld
4.3	UT of buttering or UT of completed weld

4.6 Repairs - Rejectable indications shall be removed, the areas weld repaired and reinspected.

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Figure 1
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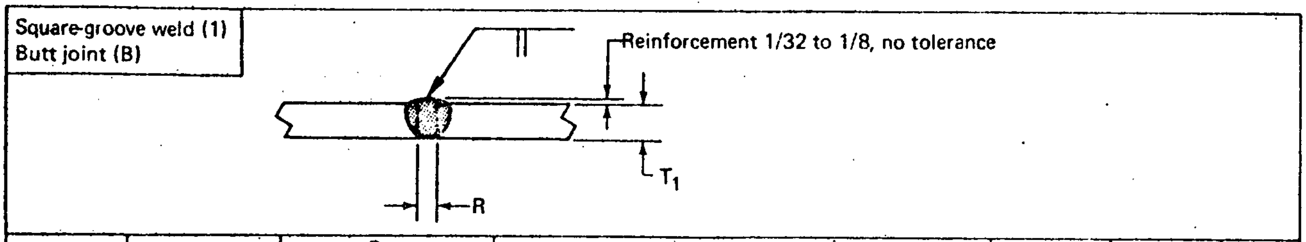
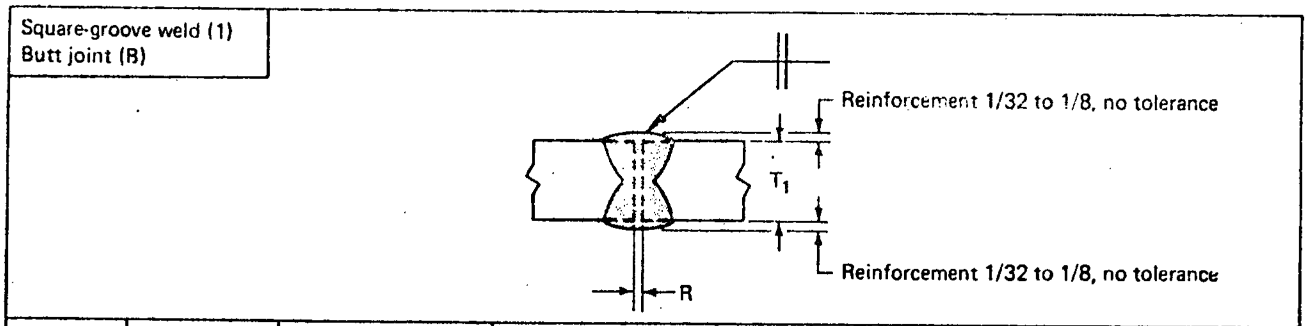


Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
					Tolerances				
		T_1	T_2	Root opening	As detailed	As fit up			
SMAW	B-P1a	1/8	–	R = 0 to 1/16	+1/16,–0	±1/16	All	T_1	B
	B-P1c	1/4 max	–	$R = \frac{T_1}{2}$ min	+1/16,–0	±1/16	All	$\frac{3T_1}{4}$	B



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
					Tolerances				
		T_1	T_2	Root opening	As detailed	As fit up			
SMAW	B-P1b	1/4 max	–	R = 0 to 1/16	±0	+3/16 see also 3.3.2	All	T_1	C2

Note B: Joints welded from one side. These welds are not applicable to bridges.

Note C2: Root need not be gouged before welding second side. This weld is not applicable to bridges.

Fig. 1 —Prequalified partial joint penetration groove welded joints

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Figure 1
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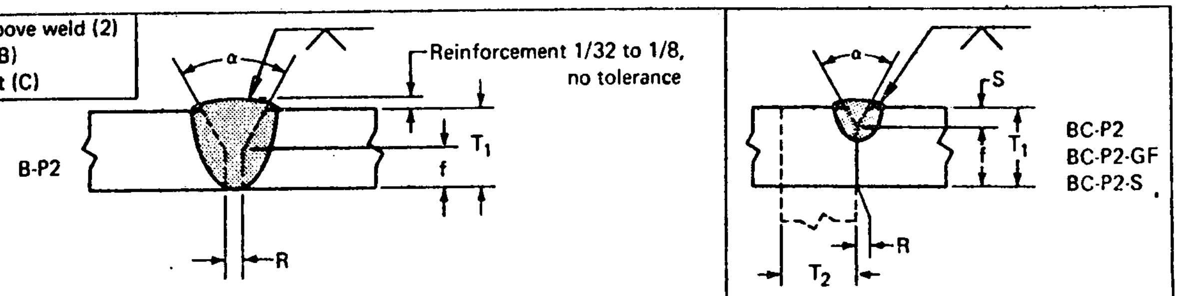
Single-V-groove weld (2)
Butt joint (B)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
		T_1	T_2	Root opening Root face Groove angle	Tolerances: As detailed	Tolerances: As fit up			
SMAW	B-P2	1/2 max	–	R = 3/32 min f = 0 to 1/8 α = 60°	±1/16 ±1/16 +10°,–0°	±1/16 ±1/16 +10°,–5°	All	T_1	B, L
SMAW	BC-P2	1/4 min (for bridges 5/16 min)	U	R = 0 f = 1/8 min α = 60°	±0 ±1/16 +10°,–0°	+1/16,–0 ±1/16 +10°,–5°	All	S	E, L
GMAW FCAW	BC-P2-GF	1/4 min (for bridges 5/16 min)	U	R = 0 f = 1/8 min α = 60°	±0 ±1/16 +10°,–0°	+1/16,–0 ±1/16 +10°,–5°	All	S	A, E, L
SAW	BC-P2-S	3/8 min (for bridges 7/16 min)	U	R = 0 f = 1/4 min α = 60°	±0 ±1/16 +10°,–0°	+1/16,–0 ±1/16 +10°,–5°	Flat	S	E, L

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

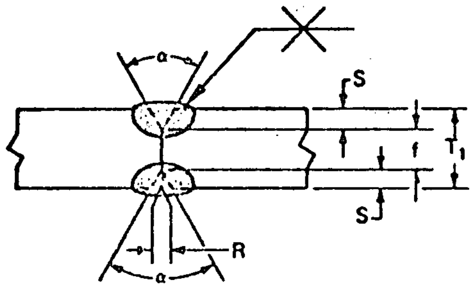
Note B: Joint is welded from one side only.

Note E: Minimum effective throat (E) as shown ; S as specified on drawings.

Note L: Butt and T-joints are not prequalified for bridges.

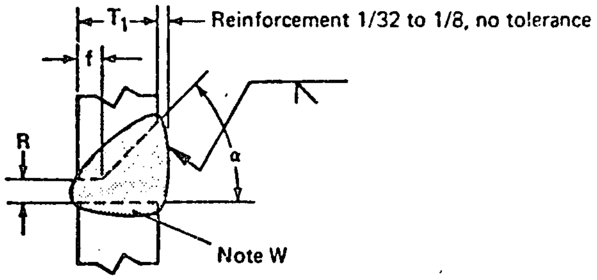
Fig. 1 (continued)–Prequalified partial joint penetration groove welded joints

Double-V-groove weld (3)
Butt joint (B)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
		T_1	T_2	Root opening Root face Groove angle	Tolerances As detailed	Tolerances As fit up			
SMAW	B-P3	1/2 min	–	R = 0 f = 1/8 min α = 60°	+1/16,–0 –0 +10°,–0°	±1/16 ±1/16 +10°,–5°	All	S	E, L Mp
GMAW FCAW	B-P3-GF	1/2 min	–	R = 0 f = 1/8 min α = 60°	+1/16,–0 –0 +10°,–0°	±1/16 ±1/16 +10°,–5°	All	S	A, E,L, Mp
SAW	B-P3-S	3/4 min	–	R = 0 f = 1/4 min α = 60°	±0 –0 +10°,–0°	+3/16,–0‡ ±1/16 +10°,–5°	Flat	S	E, L Mp

Single-bevel-groove weld (4)
Butt joint (B)
T-joint (T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
		T_1	T_2	Root opening Root face Groove angle	Tolerances As detailed	Tolerances As fit up			
SMAW	B-P4 TC-P10	1/2 max	–	R = 3/32 min f = 0 to 1/8 α = 45°	R = min ±1/16 +10°,–0°	±1/16 ±1/16 +10°,–5°	All	T_1	B, L, W

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note B: Joint is welded from one side only.

Note E: Minimum effective throat (E) as shown ; S as specified on drawings.

Note L: Butt and T-joints are not prequalified for bridges.

Note Mp. Double-groove welds may have grooves of unequal depth, provided they conform to the limitations of Note E. Also, the effective throat (E), less any reduction, applies individually to each groove.

Note W: Unbeveled face is the lower edge for horizontal position.

‡ Fit-up tolerance, SAW: for rolled shapes R may be 5/16 inches in thick plates if backing is provided.

Fig. 1 (continued)–Prequalified partial joint penetration groove welded joints

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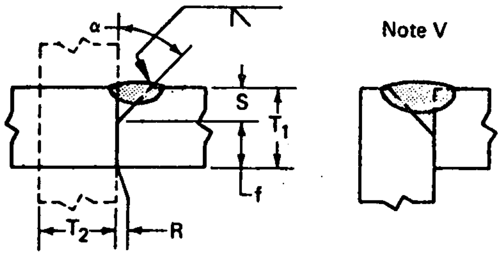
Single-bevel-groove (4)
Butt joint (B)
T-joint(T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions*	Effective throat (E)	Notes
		T_1	T_2	Root opening Root face Groove angle	Tolerances				
					As detailed	As fit up			
SMAW	BTC-P4	1/4 min (for bridges 5/16 min)	U	R = 0 f = 1/8 min α = 45°	+1/16,−0 −0 +10°,−0°	±1/16 ±1/16 +10°,−5°	All	S −1/8	E, L, V
GMAW FCAW	BTC-P4-GF	1/4 min (for bridges 5/16 min)	U	R = 0 f = 1/8 min α = 45°	+1/16,−0 −0 +10°,−0°	±1/16 ±1/16 +10°,−5°	F,H V,OH	S S −1/8	A, E, L, V.
SAW	TC-P4-S	3/8 min (for bridges 7/16 min)	U	R = 0 f = 1/4 min α = 60°	±0 −0 +10°,−0°	+3/16,−0‡ ±1/16 +10°,−5°	Flat	S	E, L, V

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note E: Minimum effective throat (E) as shown : S as specified on drawings.

Note L: Butt and T-joints are not prequalified for bridges.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

‡ Fit-up tolerance, SAW: for rolled shapes R may be 5/16 inches in thick plates if backing is provided.

* F = Flat, H = Horizontal, V = Vertical, OH = Overhead.

Fig. / (continued)—Prequalified partial joint penetration groove welded joints

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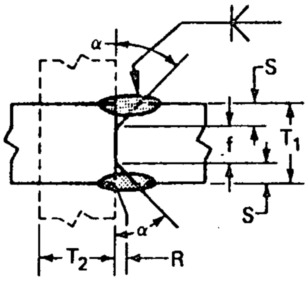
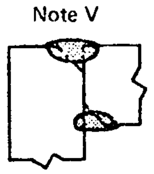
Double-bevel-groove weld (5)
Butt joint (B)
T-joint (T)
Corner joint (C)





Welding process	Joint designation	Base metal thickness (U = unlimited) T_1	T_2	Groove preparation: Root opening Root face Groove angle	Tolerances: As detailed	Tolerances: As fit up	Permitted welding positions*	Effective throat (E)	Notes
SMAW	BTC-P5	3/8 min (for bridges 1/2 min)	U	R = 0 f = 1/8 min α = 45°	+1/16,–0 –0 +10°,–0°	±1/16 ±1/16 +10°,–5°	All	S – 1/8	E, L, Mp, V
GMAW FCAW	BTC-P5-GF	3/8 min (for bridges 1/2 min)	U	R = 0 f = 1/8 min α = 45°	+1/16,–0 –0 +10°,–0°	±1/16 ±1/16 +10°,–5°	F,H V,OH	S S – 1/8	A, E, L, Mp, V
SAW	TC-P5-S	1/2 min (for bridges 5/8 min)	U	R = 0 f = 1/4 min α = 60°	±0 –0 +10°,–0°	+3/16,–0‡ ±1/16 +10°,–5°	Flat	S	E, L, Mp, V

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note E: Minimum effective throat (E) as shown ; S as specified on drawings.

Note L: Butt and T-joints are not prequalified for bridges.

Note Mp: Double-groove welds may have grooves of unequal depth, provided they conform to the limitations of Note E. Also, the effective throat (E), less any reduction, applies individually to each groove.

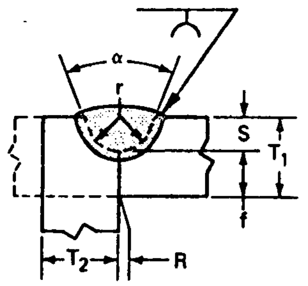
Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

‡ Fit-up tolerance, SAW: for rolled shapes R may be 5/16 inches in thick plates if backing is provided.

* F = Flat, H = Horizontal, V = Vertical, OH = Overhead.

Fig. 1 (continued)—Prequalified partial joint penetration groove welded joints

Single-U-groove weld (6)
Butt joint (B)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
		T1	T2	Root opening Root face Groove radius Groove angle	Tolerances: As detailed	Tolerances: As fit up			
SMAW	BC-P6	1/4 min (for bridges 5/16 min)	U	R = 0 to 1/8 f = 1/8 min r = 1/4 α = 45°	+1/16,−0 −0 +1/4,−0 +10°,−0°	±1/16 ±1/16 ±1/16 +10°,−5°	All	S	E, L
GMAW FCAW	BC-P6-GF	1/4 min (for bridges 5/16 min)	U	R = 0 f = 1/8 min r = 1/4 α = 20°	+1/16,−0 −0 +1/4,−0 +10°,−0°	±1/16 ±1/16 ±1/16 +10°,−5°	All	S	A, E, L
SAW	BC-P6-S	3/8 min (for bridges 7/16 min)	U	R = 0 f = 1/4 min r = 1/4 α = 20°	±0 −0 +1/4,−0 +10°,−0°	+3/16,−0‡ ±1/16 ±1/16 +10°,−5°	Flat	S	E, L

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

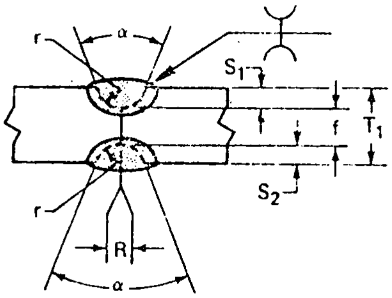
Note E: Minimum effective throat (E) as shown ; S as specified on drawings.

Note L: Butt and T-joints are not prequalified for bridges.

‡ Fit-up tolerance, SAW: for rolled shapes R may be 5/16 inches in thick plates if backing is provided.

Fig. 1 (continued)—Prequalified partial joint penetration groove welded joints

Double-V-groove weld (7)
Butt joint (B)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
		T_1	T_2	Root opening Root face Groove radius Groove angle	Tolerances: As detailed	Tolerances: As fit up			
SMAW	B-P7	3/8 min (for bridges 1/2 min)	–	R = 0 to 1/8 f = 1/8 min r = 1/4 α = 45°	+1/16,–0 –0 +1/4,–0 +10°,–0°	±1/16 ±1/16 ±1/16 +10°,–5°	All	S	E, L, Mp
GMAW FCAW	B-P7-GF	3/8 min (for bridges 1/2 min)	–	R = 0 f = 1/8 min r = 1/4 α = 20°	+1/16,–0 –0 +1/4,–0 +10°,–0°	±1/16 ±1/16 ±1/16 +10°,–5°	All	S	A, E, L, Mp
SAW	B-P7-S	1/2 min (for bridges 5/8 min)	–	R = 0 f = 1/4 min r = 1/4 α = 20°	±0 –0 +1/4,–0 +10°,–0°	+3/16,–0‡ ±1/16 ±1/16 +10°,–5°	Flat	S	E, L, Mp

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note E: Minimum effective throat (E) as shown ; S as specified on drawings.

Note L: Butt and T-joints are not prequalified for bridges.

Note Mp: Double-groove welds may have grooves of unequal depth, provided they conform to the limitations of Note E. Also, the effective throat (E), less any reduction, applies individually to each groove.

‡ Fit-up tolerance, SAW: ; for rolled shapes R may be 5/16 inches in thick plates if backing is provided.

Fig. 1 (continued)—Prequalified partial joint penetration groove welded joints

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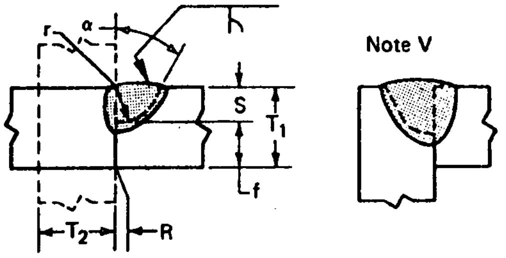
Single-J-groove weld (B)
Butt joint (B)
T-joint (T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
		T_1	T_2	Root opening Root face Groove radius Groove angle	Tolerances As detailed	Tolerances As fit up			
SMAW	BTC-P8	1/4 min (for bridges 5/16 min)	U	α = 45°	+10°,−0°	+10°,−5°	All	S	E, L, V
				R = 0 to 1/8 f = 1/8 min r = 3/8	+1/16,−0 −0 +1/4,−0	±1/16 ±1/16 ±1/16			
GMAW FCAW	BTC-P8-GF	1/4 min (for bridges 5/16 min)	U	α = 30°	+10°,−0°	+10°,−5°	All	S	A, E, L, V
SAW	C-P8-S	3/8 min (for bridges 7/16 min)	U	α = 20°	+10°,−0°	+10°,−5°	Flat	S	E, V
				R = 0 f = 1/4 min r = 1/2	± 0 − 0 +1/4,−0	+3/16,−0 ‡ ±1/16 ± 1/16			
SAW	T-P8-S	3/8 min	U	α = 45°	+10°,−0°	+10°,−5°	Flat	S	E, L

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note E: Minimum effective throat (E) as shown ; S as specified on drawings.

Note L: Butt and T-joints are not prequalified for bridges.

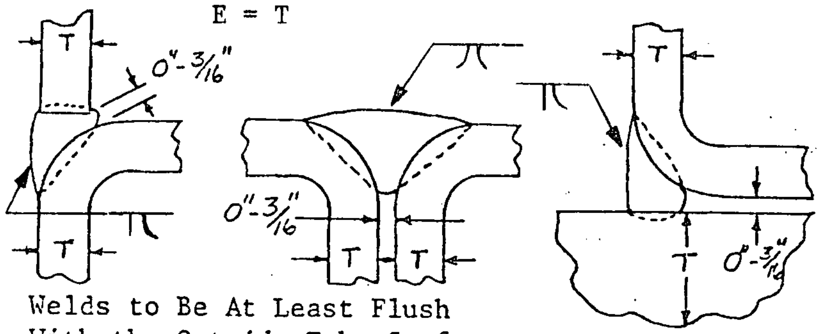
Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

‡ Fit-up tolerance, SAW: ; for rolled shapes R may be 5/16 inches in thick plates if backing is provided.

Fig. 1 (continued)—Prequalified partial joint penetration groove welded joints

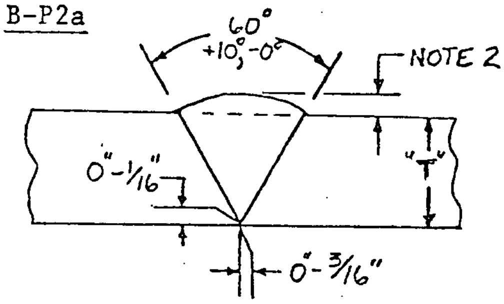
Sq. or Rect. Tubing- Tube to Tube or Tube to Flat Plate (BTC-P-9/BTC-P9GF ALT.)

Single Flare Bevel and Flare Vee Groove Welds
T = Unlimited Thickness
E = T



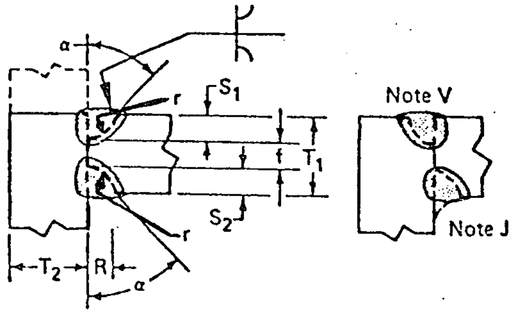
Welds to Be At Least Flush With the Outside Tube Surface

B-P2a



1) 1/2" <"T"≤3/4"
2) 1/16" min; 1/8" max
3) "T"=effective throat
4) Joint may be used only with DWP SM-P-1 and the restrictions noted thereon

Double-J-groove weld (9)
Butt joint (B)
T-joint (T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Effective throat (E)	Notes
				Root opening Root face Groove radius Groove angle	Tolerances				
		T_1	T_2		As detailed	As fit up			
SMAW	BTC-P9	1/2 min (for bridges 5/8 min)	U	R = 0 to 1/8 f = 1/8 min r = 3/8 α = 45°	+1/16,−0 −0 +1/4,−0 +10°,−0°	±1/16 ±1/16 ±1/16 +10°,−5°	All	S	E, L, J, V
GMAW FCAW	BTC-P9-GF	1/2 min (for bridges 5/8 min)	U	R = 0 f = 1/8 min r = 3/8 α = 30°	+1/16,−0 −0 +1/4,−0 +10°,−0°	±1/16 ±1/16 ±1/16 +10°,−5°	All	S	A, E, L, V, J
SAW	C-P9-S	3/4 min (for bridges 7/8 min)	U	α = 20°	+10°,−0°	+10°,−5°	Flat	S	E, V, J
				R = 0 f = 1/4 min r = 1/2	±0 −0 +1/4,−0	+3/16,−0‡ ±1/16 ±1/16			
	T-P9-S	3/4 min	U				Flat	S	E, L
				α = 45°	+10°,−0°	+10°,−5°			

Note A: Not prequalified for gas metal arc welding using short circuiting transfer. Refer to Appendix D.

Note E: Minimum effective throat (E) as shown ; S as specified on drawings.

Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

Note L: Butt and T-joints are not prequalified for bridges.

Note Mp: Double-groove welds may have grooves of unequal depth, provided they conform to the limitations of Note E. Also, the effective throat (E), less any reduction, applies individually to each groove.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

‡ Fit-up tolerance, SAW: ; for rolled shapes R may be 5/16 inches in thick plates if backing is provided.

Fig. 1 (continued)–Prequalified partial joint penetration groove welded joints

Process Speification: 1.C.1.2
Figure 1
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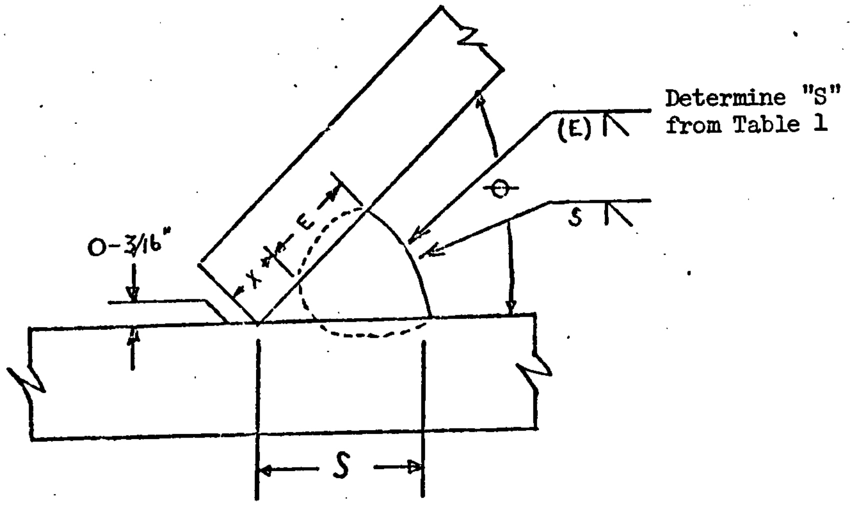
Prepared JOW Approved CEK



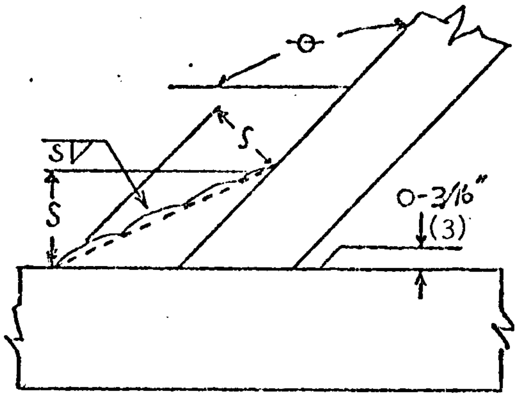
DETAIL A

DET A - PARTIAL PENETRATION GROOVE WELDS FOR ANGLE θ OF $30^{\circ} \leq 60^{\circ}$

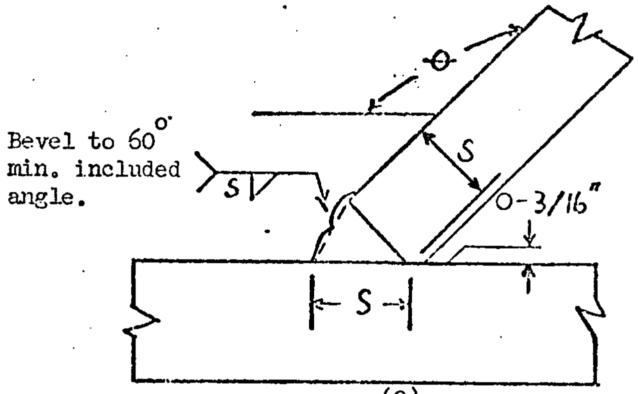
TABLE 1

Welding Process	Joint Designation	Base Metal Thickness	Root Opening(R)	Groove Angle(θ)	Permitted Welding Positions	Weld Sizes
SMAW	SJ-Pl	Unlimited	0-3/16"	$45 \leq \theta < 60$	All	E + 1/8
				$37.5 \leq \theta < 45$	F	E + 3/16
					H, V, OH	E + 1/4
				$30 \leq \theta < 37.5$	F	E + 1/4
					H, V, OH	E + 5/16
GMAW FCAW	SJ-Pl-GF	Unlimited	0-3/16"	$45 \leq \theta < 60$	F, H V, OH	E + 0 E + 1/8

NOTES:
E = Required Effective Throat
X = Penalty
S = Required Weld Size (See Table 1)
E + X equates to depth of chamfer
S = E + X



DETAIL B (1)



DETAIL C (2)

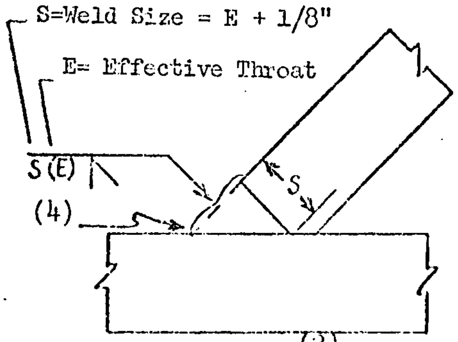
Details B and C- FILLET WELDS FOR ANGLE θ GREATER THAN 90°

(1) For angle θ from 90° - 135° weld may be designated as a fillet weld with leg size "S" measured as indicated in Detail B.

(2) For angle θ greater than 135° skewed member must (and for θ greater than 120° may, when indicated by drawing) be beveled to provide a 60° minimum included angle with through member as indicated in Detail C. Weld will be indicated on drawing as either a fillet weld (Detail C) or a groove weld (Detail D).

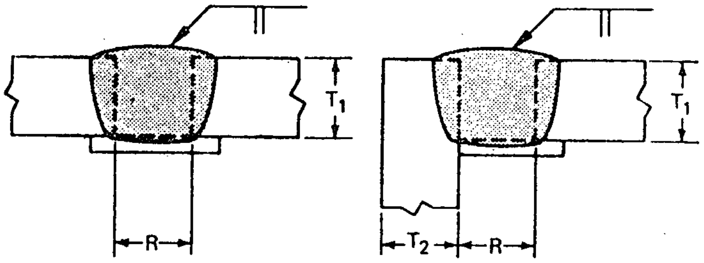
(3) For gaps greater than 1/16 inch but less than 3/16 inch, increase weld size by the gap distance.

(4) Line projected parallel to surface of skewed member.



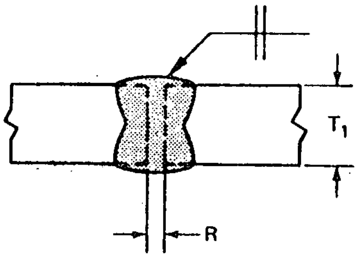
DETAIL D (2)

Square-groove weld (1)
Butt joint (B)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Tolerances				
					As detailed	As fit up			
SMAW	B-L1a	1/4 max	–	$R=T_1$	+1/16,–0	+1/4,–1/16	All	–	–
	C-L1a	1/4 max	U	$R=T_1$	+1/16,–0	+1/4,–1/16	All	–	–
GMAW FCAW	B-L1a-GF	3/8 max	–	$R=T_1$	+1/16,–0	+1/4,–1/16	All	Not required	A

Square-groove weld (1)
Butt joint (B)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Tolerances				
					As detailed	As fit up			
SMAW	B-L1b	1/4 max	–	$R = T_1/2$	+1/16,–0	+1/16,–1/8	All	–	C
GMAW FCAW	B-L1b-GF	3/8 max	–	R = 0 to 1/8	+1/16,–0	+1/16,–1/8	All	Not required	A,C
SAW	B-L1-S	1/2 max	–	R = 0	±0	+1/16,–0	Flat	–	D

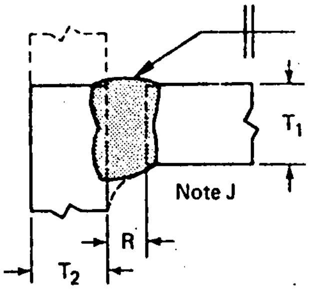
Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root before welding other side.

Note D: Welds must be centered on joint.

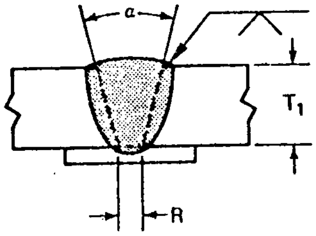
Fig. 2 —Prequalified complete joint penetration groove welded joints

Square-groove weld (1)
T-joint (T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
					Tolerances				
		T_1	T_2	Root opening	As detailed	As fit up			
SMAW	TC-L1b	1/4 max	U	$R = T_1/2$	+1/16,−0	+1/16,−1/8	All	–	C,J
GMAW FCAW	TC-L1-GF	3/8 max	U	R = 0 to 1/8	+1/16,−0	+1/16,−1/8	All	Not req.	A,C,J
SAW	TC-L1-S	3/8 max	U	R = 0	±0	+1/16,−0	Flat	–	J

Single-V-groove weld (2)
Butt joint (B)



Tolerances	
As detailed	As fit up
R = +1/16,−0	+1/4,−1/16
α = +10°,−0°	+10°,−5°

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation		Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle			
SMAW	B-U2a	U	–	R = 1/4	α = 45°	All	–	–
				R = 3/8	α = 30°	F,OH	–	–
				R = 1/2	α = 20°	F,OH	–	–
GMAW FCAW	B-U2a-GF	U	–	R = 3/16	α = 30°	F,V,OH	Required	A
				R = 3/8	α = 30°	F	Not req.	A
				R = 1/4	α = 30°	V,OH	Not req.	A
SAW	B-L2a-S	1/2 max	–	R = 1/4	α = 30°	F	–	–
SAW	B-U2-S	U	–	R = 5/8	α = 20°	F	–	–

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

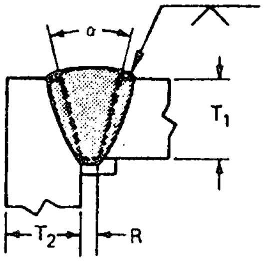
Note C: Gouge root before welding other side.

Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

* F = Flat, OH = Overhead.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

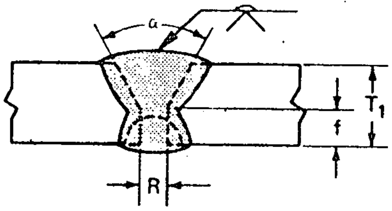
Single-V-groove weld (2)
Corner joint (B)



Tolerances	
As detailed	As fit up
R = +1/16,−0	+1/4,−1/16
α = +10°,−0°	+10°,−5°

Welding process	Joint designation	Base metal thickness U = unlimited		Groove preparation		Permitted welding positions	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle			
SMAW	C-U2a	U	U	R = 1/4	α = 45°	All	–	–
				R = 3/8	α = 30°	F,OH	–	–
GMAW FCAW	C-U2a-GF	U	U	R = 1/2	α = 20°	F,OH	–	–
				R = 3/16	α = 30°	F,V,OH	Required	A
				R = 3/8	α = 30°	F	Not req.	A
				R = 1/4	α = 30°	V,OH	Not req.	A
SAW	C-L2a-S	1/2 max	U	R = 1/4	α = 30°	F	–	–
SAW	C-U2-S	U	U	R = 5/8	α = 20°	F	–	–

Single-V-groove weld (2)
Butt joint (B)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
				Root opening Root face Groove angle	Tolerances				
		T_1	T_2		As detailed	As fit up			
SMAW	B-U2	U	–	R = 0 to 1/8 f = 0 to 1/8 α = 60°	+1/16,−0 +1/16,−0 +10°,−0°	+1/16,−1/8 Not limited +10°,−5°	All	–	C
GMAW FCAW	B-U2-GF	U	–	R = 0 to 1/8 f = 0 to 1/8 α = 60°	+1/16,−0 +1/16,−0 +10°,−0°	+1/16,−1/8 Not limited +10°,−5°	All	Not required	A,C
SAW	B-L2b-S	Over 1/2 to 1 inclusive	–	R = 0 f = 1/4 max α = 60°	±0 +0,−1/4 +10°,−0°	+1/16,−0 ±1/16 +10°,−5°	Flat	–	K
SAW	B-L2c-S	Over 1/2 to 1	–	R = 0, α = 60° f = 1/4 max	R = ±0 f = +0,−f α = +10°,−0°	+1/16,−0 ±1/16 +10°,−5°	Flat	–	C
		Over 1 to 1-1/2	–	R = 0, α = 60° f = 1/2 max					
		Over 1-1/2 to 2	–	R = 0, α = 60° f = 5/8 max					

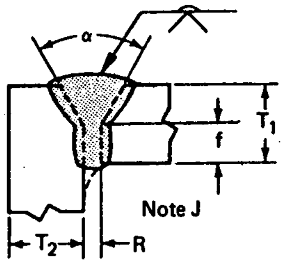
Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root before welding other side.

Note K: Weld root after welding at least one pass on arrow side.

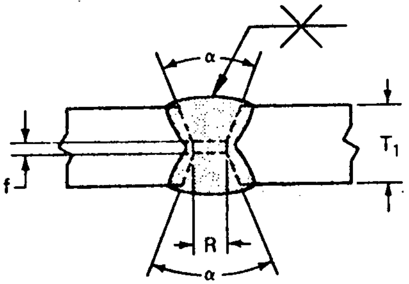
Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

Single-V-groove weld (2)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
				Root opening Root face Groove angle	Tolerances				
		T_1	T_2		As detailed	As fit up			
SMAW	C-U2	U	U	R = 0 to 1/8 f = 0 to 1/8 α = 60°	+1/16,−0 +1/16,−0 +10°,−0°	+1/16,−1/8 Not limited +10°,−5°	All	–	C,J
GMAW FCAW	C-U2-GF	U	U	R = 0 to 1/8 f = 0 to 1/8 α = 60°	+1/16,−0 +1/16,−0 +10°,−0°	+1/16,−1/8 Not limited +10°,−5°	All	Not required	A,C,J
SAW	C-L2b-S	1 max	U	R = 0 f = 1/4 max α = 60°	±0 +0,−1/4 +10°,−0°	+1/16,−0 ±1/16 +10°,−5°	Flat	–	J,K

Double-V-groove weld (3)
Butt joint (B)



Tolerances	
As detailed	As fit up
R = ±0	+1/16,−0
f = ±0	+1/16,−0
α = +10°,−0°	+10°,−5°
Spacer = ±0	+1/16,−0

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Root face	Groove angle			
SMAW	B-U3a	U, preferably 5/8 or thicker Spacer = 1/8 x R	–	R = 1/4	f = 0 to 1/8	α = 45°	All	–	C,M
				R = 3/8	f = 0 to 1/8	α = 30°	F,OH	–	
				R = 1/2	f = 0 to 1/8	α = 20°	F,OH	–	
SAW	B-U3a-S	U Spacer = 1/4 x R	–	R = 5/8	f = 0 to 1/4	α = 20°	F	–	M

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root before welding other side.

Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

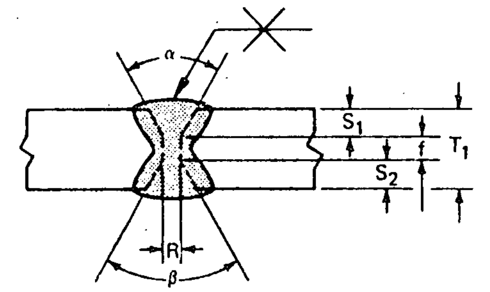
Note K: Weld root after welding at least one pass on arrow side.

Note M: Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.

* F = Flat, OH = Overhead.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

Double-V-groove weld (3)
Butt joint (B)



For B-U3c-S only

T$_1$		S$_1$
Over	to	
2	2-1/2	1-3/8
2-1/2	3	1-3/4
3	3-5/8	2-1/8
3-5/8	4	2-3/8
4	4-3/4	2-3/4
4-3/4	5-1/2	3-1/4
5-1/2	6-1/4	3-3/4

For $T_1 > 6\text{-}1/4$, or $T_1 \leqslant 2$
$S_1 = 2/3 (T_1 - 1/4)$

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
		T$_1$	T$_2$	Root opening Root face Groove angle	Tolerances				
					As detailed	As fit up			
SMAW	B-U3b	U, preferably 5/8 or thicker	–	R = 0 to 1/8 f = 0 to 1/8 $\alpha = \beta = 60°$	+1/16,–0 +1/16,–0 +10°,–0	+1/16,–1/8 Not limited +10°,–5°	All	–	C,M
GMAW FCAW	B-U3-GF						All	Not required	A,C,M
SAW	B-U3b-S	1-1/8 min	–	R = 1/8 f = 0 $\alpha = \beta = 60°$ $S_1 = 2/3\ T_1$, $S_2 = 3/8$ min	+1/16,–0 +1/16,–0 +10°,–0°	+1/16,–1/8 Not limited +10°,–5°	Flat	–	P
SAW	B-L3-S	1-1/2 max	–	R = 0 f = 1/4 max $\alpha = 60°; \beta = 80°$ $S_1 = 2/3 (T_1 - 1/4)$, $S_2 = 1/3 (T_1 - 1/4)$	±0 +0,–1/4 +10°,–0°	+1/16,–0 Not limited +10°,–5°	Flat	–	K
SAW	B-U3c-S	U	–	R = 0 f = 1/4 max $\alpha = \beta = 60°$ To find S$_1$ see table above; $S_2 = (T_1 - S_1 + 1/4)$	±0 +0,–1/4 +10°,–0°	+1/16,–0 Not limited +10°,–5°	Flat	–	C

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root before welding other side.

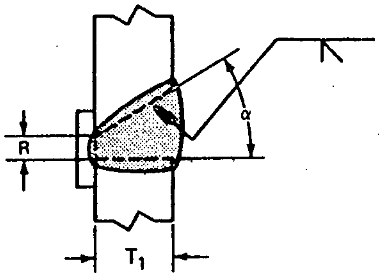
Note K: Weld root after welding at least one pass on arrow side.

Note M: Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.

Note P: Weld S$_2$ first with shielded metal arc low-hydrogen electrodes. Root of this weld shall be back gouged. Weld S$_1$ with single- or multiple-pass submerged arc weld in flat position after manual arc welding is completed on other side.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

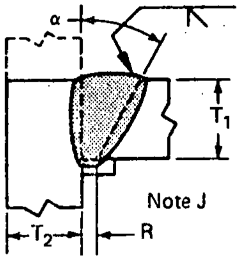
Single-level-groove weld (4)
Butt joint (B)

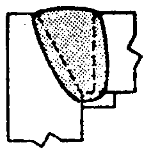


Tolerances	
As detailed	As fit up
R = +1/16,−0	+1/4,−1/16
α = +10°,−0°	+10°,−5°

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation		Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle			
SMAW	B-U4a	U	–	R = 1/4	α = 45°	All	–	Br
				R = 3/8	α = 30°	F,OH	–	Br
GMAW FCAW	B-U4a-GF	U	–	R = 3/16	α = 30°	All	Required	A,Br
				R = 1/4	α = 45°	All	Required	A,Br
				R = 3/8	α = 30°	Flat	Not req.	A,Br
				R = 1/4	α = 45°	All	Not req.	A,Br

Single-bevel-groove weld (4)
T-joint (T)
Corner joint (C)





Tolerances	
As detailed	As fit up
R = +1/16,−0	+1/4,−1/16
α = +10°,−0°	+10°,−5°

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation		Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle			
SMAW	TC-U4c	U	U	R = 1/4	α = 45°	All	–	J,V
				R = 3/8	α = 30°	F, OH	–	J,V
GMAW FCAW	TC-U4c-GF	U	U	R = 3/16	α = 30°	All	Required	A, J, V
				R = 1/4	α = 45°	All	Required	A, J, V
				R = 3/8	α = 30°	Flat	Not req.	A, J, V
				R = 1/4	α = 45°	All	Not req.	A, J, V
SAW	TC-U4a-S	U	U	R = 3/8	α = 30°	Flat	–	J,V
				R = 1/4	α = 45°			

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note Br: Bridge application limits the use of these joints to the horizontal position

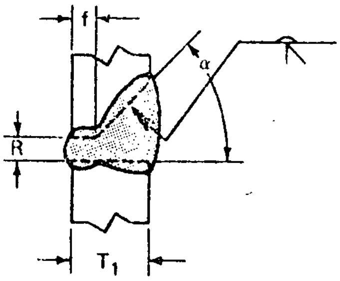
Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

*F = Flat, OH = Overhead.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

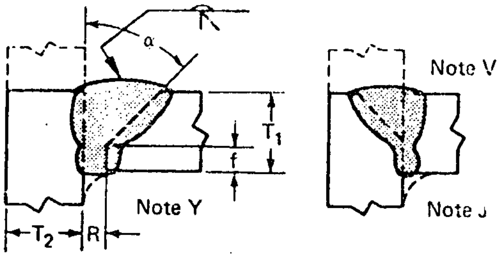
Single-bevel-groove weld (4)
Butt joint (B)



Limitations
Bridge application limits the use of these joints to horizontal position

Welding process	Joint designation	Base metal thickness (U = unlimited) T_1	T_2	Groove preparation: Root opening Root face Groove angle	Tolerances: As detailed	Tolerances: As fit up	Permitted welding positions	Gas shielding for FCAW	Notes
SMAW	B-U4	U	–	R = 0 to 1/8 f = 0 to 1/8 α = 45°	+1/16,–0 +1/16,–0 +10°,–0°	+1/16,–1/8 not limited +10°,–5°	All	–	C
GMAW FCAW	B-U4-GF	U	–				All	Required	A,C

Single-bevel-groove weld (4)
T-joint (T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited) T_1	T_2	Groove preparation: Root opening Root face Groove angle	Tolerances: As detailed	Tolerances: As fit up	Permitted welding positions	Gas shielding for FCAW	Notes
SMAW	TC-U4a	U	U	R = 0 to 1/8 f = 0 to 1/8 α = 45°	+1/16,–0 +1/16,–0 +10°,–0°	+1/16,–1/8 Not limited +10°,–5°	All	–	C,J,V
GMAW FCAW	TC-U4a-GF	U	U				All	Not req.	A,C,J,V
SAW	TC-L4a-S	3/4 max	U	R = 0 f = 1/8 max α = 60°	±0 +0,–1/8 +10°,–0°	+1/4,–0 ±1/16 +10°,–5°	Flat	–	J,V,Y

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root of joint before welding the other side.

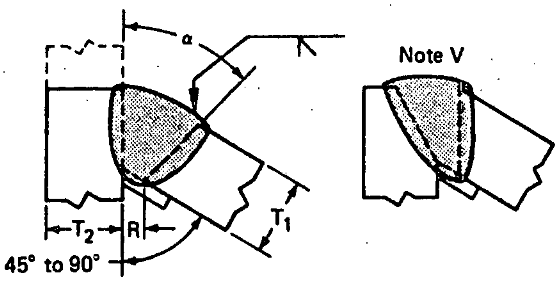
Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

Note Y: Shielded metal arc or submerged arc backing fillet weld required.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

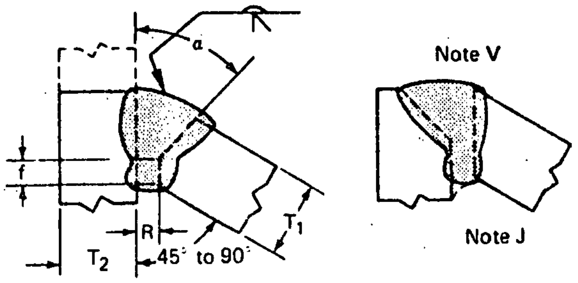
Single-bevel-groove weld (4)
T-joint (T)
Corner joint (C)



Tolerances	
As detailed	As fit up
R = +1/16,−0	+1/4,−1/16
α = +10°,−0°	+10°,−5°

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation		Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle			
SMAW	TC-U4d	U	U	R = 1/4	α = 45°	All	–	J,V
				R = 3/8	α = 30°	F,OH	–	
GMAW FCAW	TC-U4d-GF	U	U	R = 3/16	α = 30°	All	Required	A,J,V
				R = 1/4	α = 45°			
				R = 3/8	α = 30°	Flat	Not req.	
				R = 1/4	α = 45°	All		
SAW	TC-U4b-S	U	U	R = 3/8	α = 30°	Flat	–	J,V
				R = 1/4	α = 45°			

Single-bevel-groove weld (4)
T-joint(T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
				Root opening Root face Groove angle	Tolerances				
		T_1	T_2		As detailed	As fit up			
SMAW	TC-U4b	U	U	R = 0 to 1/8	+1/16,−0	+1/16,−1/8	All	–	C,J,V
GMAW FCAW	TC-U4b-GF	U	U	f = 0 to 1/8 α = 45°	+1/16,−0 +10°,−0°	Not limited +10°,−5°	All	Not required	A,C J,V
SAW	TC-L4b-S	3/4 max	U	R = 0 f = 1/8 max α = 60°	±0 +0,−1/8 +10°,−0°	+1/4,−0 ±1/16 +10°,−5°	Flat	–	J, V, Y

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root of joint before welding the other side.

Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

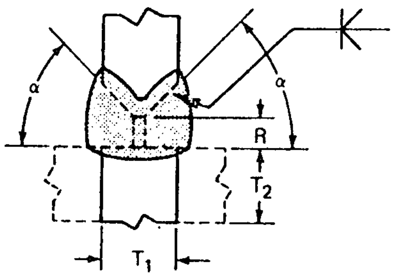
Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

Note Y: Shielded metal arc or submerged arc backing weld required.

*F = Flat, OH = Overhead.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

Double-bevel-groove weld (5)
Butt joint (B)
T-joint (T)
Corner joint (C)



Tolerances	
As detailed	As fit up
R = ±0	+1/16,–0
f = +1/16,–0	±1/16
α = +10°,–0°	+10°,–5°
Spacer = ±0	+1/16,–0

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Root face	Groove angle			
SMAW	B-U5b	U, preferably 5/8 or thicker Spacer = 1/8 X R	–	R = 1/4	f = 0 to 1/8	α = 45°	All	–	Br, C, M
	TC-U5a	U, preferably 5/8 or thicker Spacer = 1/8 X R	U	R = 1/4	f = 0 to 1/8	α = 45°	All	–	C, J, M, V
				R = 3/8	f = 0 to 1/8	α = 30°	F, OH	–	C, J, M, V

Note Br: Bridge application limits the use of these joints to the horizontal position.

Note C: Gouge root of joint before welding the other side.

Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

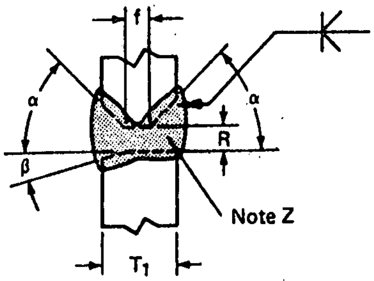
Note M: Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

*F = Flat, OH = Overhead.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

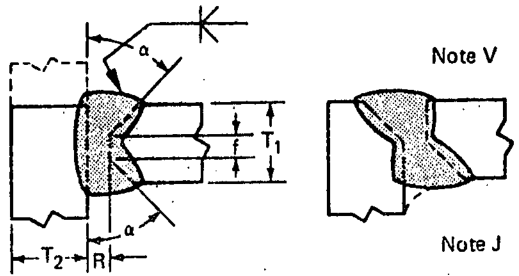
Double-bevel-groove weld (5)
Butt joint (B)



Limitations
Bridge applications limited to horizontal position

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
				Root opening Root face Groove angles	Tolerances				
		T_1	T_2		As detailed	As fit up			
SMAW	B-U5a	U, preferably 5/8 or thicker	–	R = 0 to 1/8 f = 0 to 1/8 α = 45° β = 0° to 15°	+1/16,–0 +1/16,–0 $\alpha + \beta$, $^{+10}_{-0}$	+1/16,–1/8 Not limited $\alpha + \beta$, $^{+10}_{-5}$	All	–	C, M, Z
GMAW FCAW	B-U5-GF	U, preferably 5/8 or thicker	–	R = 0 to 1/8 f = 0 to 1/8 α = 45° β = 0°	+1/16,–0 +1/16,–0 +10°,–0° ±0°	+1/16,–1/8 Not limited +10°,–5° –	All	Not req.	A, C, M

Double-bevel-groove weld (5)
T-joint(T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
				Root opening Root face Groove angle	Tolerances				
		T_1	T_2		As detailed	As fit up			
SMAW	TC-U5b	U, preferably 5/8 or thicker	U	R = 0 to 1/8 f = 0 to 1/8 α = 45°	+1/16,–0 +1/16,–0 +10°,–0°	+1/16,–1/8 Not limited +10°,–5°	All	–	C, J, M, V
GMAW FCAW	TC-U5-GF	U, preferably 5/8 or thicker	U				All	Not required	A, C, J, M, V
SAW	TC-U5-S	U	U	R = 0 f = 3/16 max α = 60°	±0 +0,–3/16 +10°,–0°	+1/16,–0 ±1/16 +10°,–5°	Flat	–	J, M, V

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root of joint before welding the other side.

Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

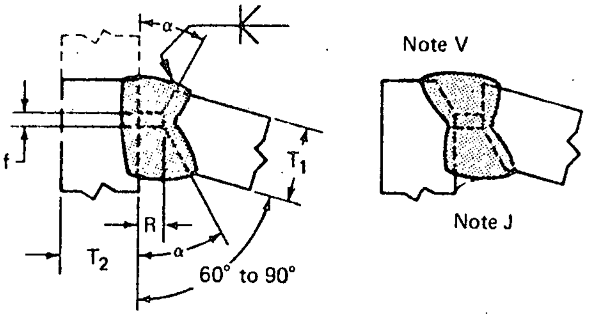
Note M: Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

Note Z: When lower plate is beveled, make the first root pass on this side.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

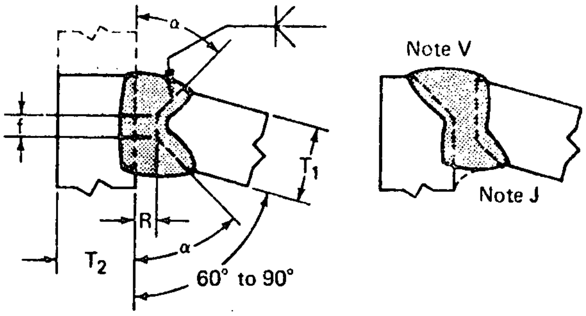
Double-bevel-groove weld (5)
T-joint (T)
Corner joint (C)



Tolerances	
As detailed	As fit up
R = ±0	+1/16,−0
f = +1/16,−0	Not limited
α = +10°,−0°	+10°,−5°
Spacer = ±0	+1/16,−0

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions*	Gas shielding for (FCAW)	Notes
		T1	T2	Root opening	Root face	Groove angle			
SMAW	TC-U5c	U, preferably 5/8 or thicker Spacer = 1/8 X R	U	R = 1/4	f = 0 to 1/8	α = 45°	All	–	C, J, V, M
				R = 3/8	f = 0 to 1/8	α = 30°	F, OH	–	C, J, V, M

Double-bevel-groove weld (5)
T-joint (T)
Corner joint (C)



Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation			Permitted welding positions	Gas shielding for FCAW	Notes
				Root opening Root face Groove angle	Tolerances				
		T1	T2		As detailed	As fit up			
SMAW	TC–U5d	U, preferably 5/8 or thicker	U	R = 0 to 1/8 f = 0 to 1/8 α = 45°	+1/16,−0 +1/16,−0 +10°,−0°	+1/16,−1/8 Not limited +10°,−5°	All	–	C, J, V, M

Note C: Gouge root of joint before welding the other side.

Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

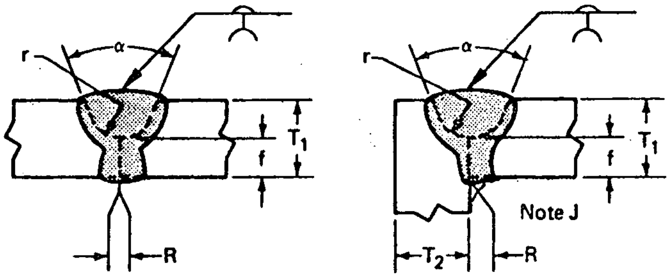
Note M: Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

*F = Flat, OH = Overhead.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

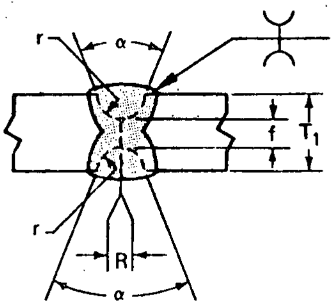
Single-U-groove weld (6)
Butt joint (B)
Corner joint (C)



Tolerances	
As detailed	As fit up
R = +1/16,–0	+1/4,–1/16
α = +10°,–0°	+10°,–5°
f = ±1/16	Not limited
r = +1/4,–0	±1/16

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove prepartion				Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle	Root face	Groove radius			
SMAW	B-U6	U	U	R = 0° to 1/8	α = 45°	f = 1/8	r = 1/4	All	–	C
				R = 0° to 1/8	α = 20°	f = 1/8	r = 1/4	F,OH	–	C
	C-U6	U	U	R = 0° to 1/8	α = 45°	f = 1/8	r = 1/4	All	–	C,J
				R = 0° to 1/8	α = 20°	f = 1/8	r = 1/4	F,OH	–	C,J
GMAW FCAW	B-U6-GF	U	U	R = 0° to 1/8	α = 20°	f = 1/8	r = 1/4	All	Not req.	A,C
	C-U6-GF	U	U	R = 0° to 1/8	α = 20°	f = 1/8	r = 1/4	All	Not req.	A,C,J

Double-V-groove weld (7)
Butt joint (B)



Tolerances	
For B-U7 and B-U7-GF	
As detailed	As fit up
R = +1/16,–0	+1/16,–1/8
α = +10°,–0	+10°,–5°
f = +1/16,–0	Not limited
r = +1/4,–0	±1/16

Tolerances	
For B-U7-S	
As detailed	As fit up
R = ±0	+1/16,–0
f = +0,–1/4	±1/16

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation				Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle	Root face	Groove radius			
SMAW	B-U7	U, preferably 5/8 or thicker	–	R = 0 to 1/8	α = 45°	f = 1/8	r = 1/4	All	–	C
				R = 0 to 1/8	α = 20°	f = 1/8	r = 1/4	F,OH	–	C
GMAW FCAW	B-U7-GF	U, preferably 5/8 or thicker	–	R = 0 to 1/8	α = 45°	f = 1/8	r = 1/4	All	Not required	A,C
SAW	B-U7-S	U	–	R = 0	α = 20°	f = 1/4 max	r = 1/4	F	–	–

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root of joint before welding the other side.

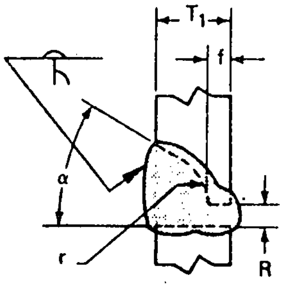
Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

Note M: Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.

*F = Flat, OH = Overhead.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

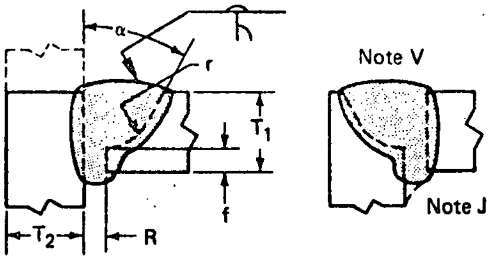
Single-J-groove weld (8)
Butt joint (B)



Tolerances	
As detailed	As fit up
R = +1/16,−0	+1/16,−1/8
α = +10°,−0°	+10°,−5°
f = +1/16,−0	Not limited
r = +1/4,−0	±1/16

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation				Permitted welding positions	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle	Root face	Groove radius			
SMAW	B-U8	U	–	R = 0 to 1/8	α = 45°	f = 1/8	r = 3/8	All	–	Br, C
GMAW FCAW	B-U8-GF	U	–	R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	All	Not required	A,Br,C

Single-J-groove weld (8)
T-joint (T)
Corner joint (C)



Tolerances	
As detailed	As fit up
R = +1/16,−0	+1/16,−1/8
α = +10°,−0°	+10°,−5°
f = +1/16,−0	Not limited
r = +1/4,−0	±1/16

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation				Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle	Root face	Groove radius			
SMAW	TC-U8a	U	U	R = 0 to 1/8	α = 45°	f = 1/8	r = 3/8	All	–	C,J,V
				R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	F,OH	–	C,J,V
GMAW FCAW	TC-U8a-GF	U	U	R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	All	Not required	A, C, J, V

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note Br: Bridge application limits the use of these joints to the horizontal position

Note C: Gouge root before welding other side.

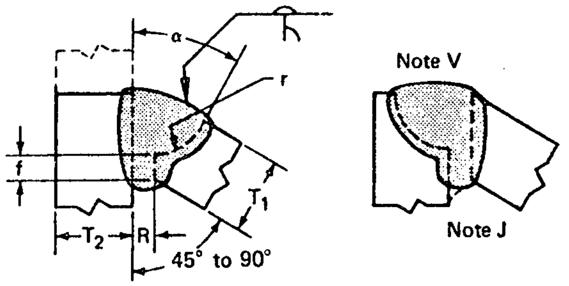
Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

*F = Flat, OH = Overhead.

Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints

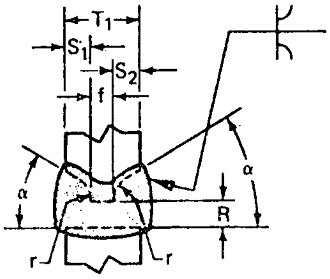
Single-J-groove weld (8)
T-joint (T)
Corner joint (C)



Tolerances	
As detailed	As fit up
R = +1/16,–0	+1/16,–1/8
α = +10°,–0°	+10°,–5°
f = +1/16,–0	Not limited
r = +1/4,–0	±1/16

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation				Permitted welding positions*	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle	Root face	Groove radius			
SMAW	TC-U8b	U	U	R = 0 to 1/8	α = 45°	f = 1/8	r = 3/8	All	–	C,J,V
				R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	F,OH	–	C,J,V
GMAW FCAW	TC-U8b-GF	U	U	R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	All	Not required	A,C,J,V

Double-J-groove weld (9)
Butt joint (B)



Tolerances	
As detailed	As fit up
R = +1/16,–0	+1/16,–1/8
α = +10°,–0°	+10°,–5°
f = +1/16,–0	Not limited
r = +1/4,–0	±1/16

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation				Permitted welding positions	Gas shielding for FCAW	Notes
		T_1	T_2	Root opening	Groove angle	Root face	Groove radius			
SMAW	B-U9	U, preferably 5/8 or thicker	–	R = 0 to 1/8	α = 45°	f = 1/8	r = 3/8	All	–	Br, C, M
GMAW FCAW	B-U-GF	U, preferably 5/8 or thicker	–	R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	All	Not required	A, Br, C, M

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note Br: Bridge application limits the use of these joints to the horizontal position

Note C: Gouge root before welding other side.

Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

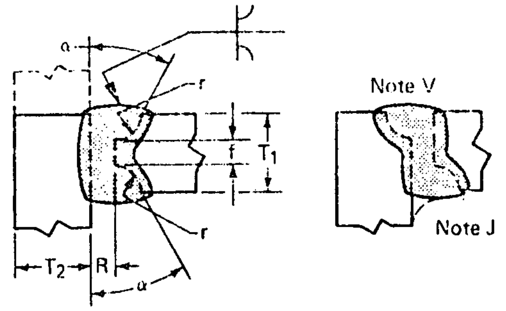
Note M: Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.

Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

* F = Flat, OH = Overhead.

Fig. 2. (continued)—Prequalified complete joint penetration groove welded joints

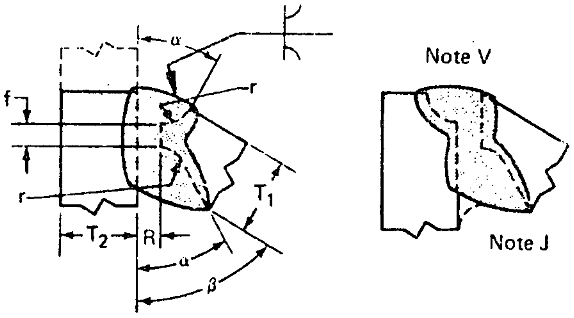
Double-J-groove weld (9)
T-joint (T)
Corner joint (C)



Tolerances	
As detailed	As fit up
R = +1/16,–0	+1/16,–1/8
α = +10°,–0°	+10°,–5°
f = +1/16,–0	Not limited
r = +1/4,–0	±1/16

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation				Permitted welding positions	Gas shielding for FCAW	Notes
		T₁	T₂	Root opening	Groove angle	Root face	Groove radius			
SMAW	TC-U9a	U, preferably 5/8 or thicker	U	R = 0 to 1/8	α = 45°	f = 1/8	r = 3/8	All	–	C, J, M, V
				R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	F,OH	–	C, J, M, V
GMAW FCAW	TC-U9a-GF	U, preferably 5/8 or thicker	U	R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	All	Not required	A, C, J, M, V

Double-J-groove weld (9)
T-joint(T)
Corner joint (C)



Tolerances	
As detailed	As fit up
R=+1/16,–0	+1/16,–1/8
α =+10°,–0°	+10°,–5°
f =+1/16,–0	Not limited
r =+1/4,–0	±1/16

Welding process	Joint designation	Base metal thickness (U = unlimited)		Groove preparation				Permitted welding positions*	Gas shielding for FCAW	Notes
		T₁	T₂	Root opening	Groove angle	Root face	Groove radius			
SMAW	TC-U9b	U, preferably 5/8 or thicker	U	R = 0 to 1/8	α = 45°	f = 1/8	r = 3/8	All	–	C, J, M, V
				R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	F,OH		
GMAW FCAW	TC-U9b-GF	U, preferably 5/8 or thicker	U	R = 0 to 1/8	α = 30°	f = 1/8	r = 3/8	All	Not required	A, C J, M, V

Note A: Not prequalified for gas metal arc welding using short circuiting transfer.

Note C: Gouge root before welding other side.

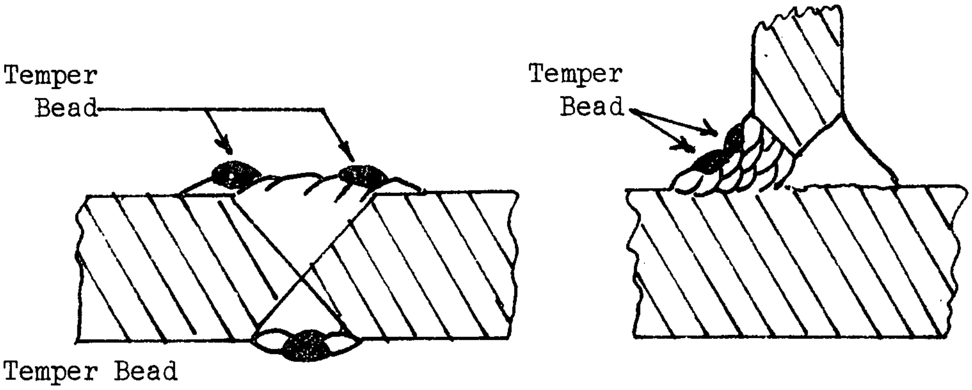
Note J: If fillet welds are used in buildings to reinforce groove welds in corner and T-joints, they shall be equal to 1/4 T_1 but need not exceed 3/8 in. Groove welds in corner and T-joints of bridges shall be reinforced with fillet welds equal to 1/4 T_1 but not more than 3/8 in.

Note M: Double-groove welds may have grooves of unequal depth, but the depth of the shallower groove shall be no less than one-fourth of the thickness of the thinner part joined.

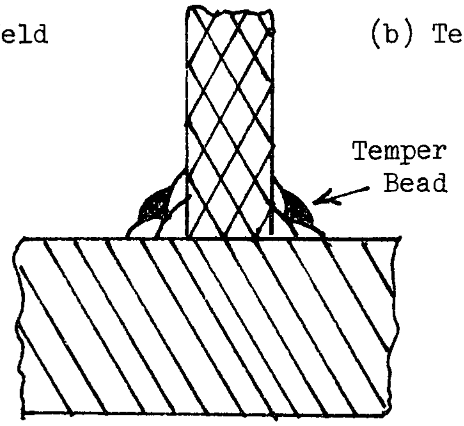
Note V: For corner joints, the outside groove preparation may be in either or both members, provided the basic groove configuration is not changed and adequate edge distance is maintained to support the welding operations without excessive edge melting.

* F = Flat, OH = Overhead.

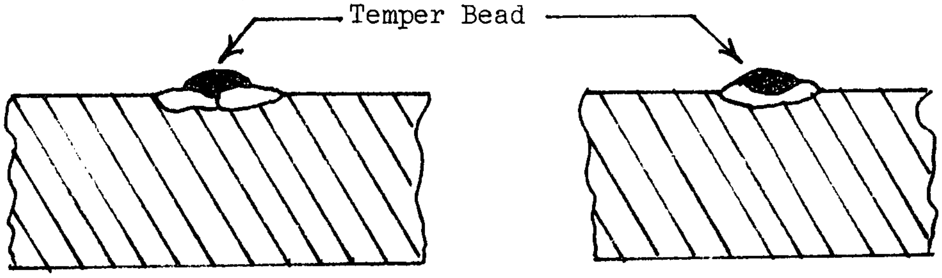
Fig. 2 (continued)—Prequalified complete joint penetration groove welded joints



(a) Butt Weld (b) Tee Weld



(c) Fillet



(d) Repair (e) Repair

TYPICAL TEMPER BEADS

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SA-U-1 **Rev.:** 1 **Date:** 5/9/80

Joint Design: Per Figure 2

B-U2-S
B-U3a-S
B-U3b-S
B-U3c-S
B-U7-S
C-U2-S
TC-U4a-S
TC-U4b-S
TC-U5-S

Base Metal: Type and Grade

A36
A53, Gr B
A242
A106 Gr B
A441
A500 Gr A&B
A501
A516
A529
A570
A572 Gr 42-50
A588
A606 TP 2 or TP 4
A607 Gr 45, 50, 55

Welding Conditions:

Increment	-	-
Current	275-575 A	300-600A
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	28-35 V	28-35 V
Transfer Mode	-	-
Travel Speed (IPM)	10 ipm min.	10 ipm min.
Electrode Type	EM12K	EM12K
Electrode Size	5/64"	3/32"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	F72EM12K	F72EM12K
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup to Work Distance	-	-
Contact Tube to Work Dist.	-	-
Preheat	→	
Interpass Temperature	500^{0}F max	
Post Weld Heat Treatment	None	
Welding Position	Flat	
Other		

Thickness	Min. Preheat
To 3/4"	None*
Over 3/4" - 1-1/2"	70^{0}F
Over 1-1/2" - 2-1/2"	150^{0}F
Over 2-1/2"	225^{0}F

*When base metal temperature is below 32^{0}F, preheat to 70^{0}F min. and maintain during welding.

Reference documents: P.S.1.C.1.2.

Prepared by:

Approved by: W. P. Jost

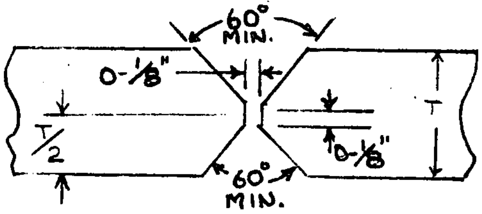
12239

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SA-U -2 Rev.: 0 Date: Aug. 25, 1980

Joint Design: Per Figure 2 and Sketch Below Base Metal: Type and Grade

- B-U2-S
- B-U3a-S
- B-U3b-S
- B-U3c-S
- B-U7-S
- C-U2-S
- TC-U4a-S
- TC-U4b-S
- TC-U5-S



- A36
- A53, Gr B
- A242
- A106, Gr B
- A441
- A500
- A501
- A529
- A570, All Grades
- A572, Grades 42-50
- A588
- A516, Grades 55-70

Welding Conditions:

Increment	All	All	
Current	275-550	360-600	
Pulse Rate	-	-	
Polarity	DCRP	DCRP	
Arc Voltage	31-36	32-36	
Transfer Mode	-	-	
Travel Speed (IPM)	9-16	9-19	
Electrode Type	EM12K	EM12K	
Electrode Size	5/64"	3/32"	
Filler Metal Type	-	-	
Filler Metal Size	-	-	
Flux Type	F72EM12K	F72EM12K	
Flux Particle Size	-	-	
Shielding Gas	-	-	
Shielding Gas Flow Rate	-	-	
Purging Gas	-	-	
Purging Gas Flow Rate	-	-	
Gas Cup Size	-	-	
Gas Cup to Work Distance	-	-	
Contact Tube to Work Dist.	1-1/2" max	1-1/2" max	
Preheat	→	Thickness	Min Preheat
Interpass Temperature	500° F max	to 3/4"	None*
Post Weld Heat Treatment	None	over 3/4" - 1-1/2"	70° F
Welding Position	Flat	over 1-1/2" - 2-1/2"	150° F
Other		over 2-1/2"	225° F

* When base metal is below 32°F, preheat to 70°F and maintain during welding

Reference documents: P.S. 1.C.1.2, PQR SA-U-2, PQR SA11-B-1

Prepared by: J D White

Approved by: W. P. Joest

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SA-U-3 Rev.: 0 Date: 9/24/80

Joint Design: Per Figure 2*

Base Metal: Type and Grade

A240, Tp 304, 304L
A666, Tp 304, 304L

B-U2-S*
B-U3a-S*
B-U3b-S*
B-U3c-S*
B-U7-S*
C-U2-S*
TC-U4a-S*
TC-U4b-S*
TC-U5-S*

*Thickness limited to 1" maximum

Welding Conditions:

Increment	-
Current	275-330 A
Pulse Rate	-
Polarity	DCRP
Arc Voltage	30-34 V
Transfer Mode	-
Travel Speed (IPM)	12 min.
Electrode Type	ER308L
Electrode Size	5/64"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	ARCOS S-50
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup to Work Distance	-
Contact Tube to Work Dist.	-
Preheat	60° F min.
Interpass Temperature	350° F max
Post Weld Heat Treatment	None
Welding Position	Flat
Other	

Reference documents: P.S. 1.C.1.2., PQR SA88-B-1

Prepared by: ____________

Approved by: W. P. Jost

E30268.04

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SA-U-4 Rev.: 0 Date: 6/15/81

Joint Design: Per Figure 2

B-U2-S
B-U3a-S
B-U3b-S
B-U3c-S
B-U7-S
C-U2-S
TC-U4a-S
TC-U4b-S
TC-U5-S

A572 GR 55 to →

Base Metal: Type and Grade

A36	A516
A53 Gr B	A529
A106 Gr B	A570
A242	A572 Gr 42,45,50,55
A441	A588
A500 Gr A&B	A606 Tp 2 or Tp 4
A501	A607 Gr 45,50,55

Welding Conditions:

Increment	-	-
Current	275-575A	300-600A
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	28-35V	28-35V
Transfer Mode	-	-
Travel Speed (IPM)	10 min	10 min
Electrode Type	EM12K	EM12K
Electrode Size	5/64"	3/32"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	F72EM12K	F72EM12K
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup to Work Distance	-	-
Contact Tube to Work Dist.	-	-

Preheat	→
Interpass Temperature	500° F
Post Weld Heat Treatment	None
Welding Position	Flat
Other	

Thickness	Min Preheat
To 3/4"	50° F
Over 3/4" - 1-1/2"	150° F
Over 1-1/2" - 2-1/2"	225° F
Over 2-1/2"	300° F

*When base metal temperature is below 32° F, preheat to 70° F min and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by:

Approved by: C.E. Roberts

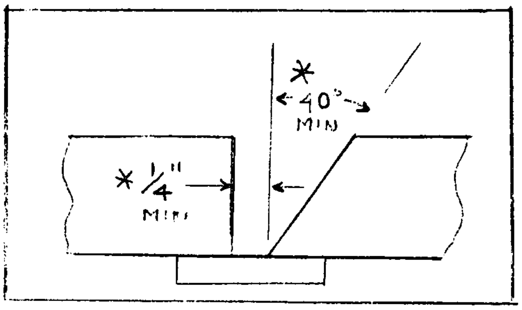
SAU4

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SA-U-5 Rev.: 0 Date: 6/26/81

Joint Design:

PER FIGURE →



* INCLUDES ALLOWABLE ASSY. TOLERANCE

Base Metal: Type and Grade

A36
A53 Gr B
A242
A106, Gr B
A441
A500 Gr A&B
A501
A516
A529
A570
A572 Gr 42-55
A588
A606 Tp 2 or Tp 4
A607 Gr 45, 50, 55

Welding Conditions:

Increment	-	-
Current	360-460	360-460
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	30-35	30-35
Transfer Mode	-	-
Travel Speed (IPM)	12-22	12-22
Electrode Type	EM12K	EM12K
Electrode Size	5/64"	3/32"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	F72EM12K	F72EM12K
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup to Work Distance	-	-
Contact Tube to Work Dist.	-	-

Preheat	→	Thickness	Min Preheat
Interpass Temperature	500° F max	To 3/4"	50° F
Post Weld Heat Treatment	None	Over 3/4" - 1-1/2"	150° F
Welding Position	Flat	Over 1-1/2" - 2-1/2"	225° F
Other		Over 2-1/2"	300° F

Reference documents: P.S. 1.C.1.2 PQR SA-U-5

Prepared by:

Approved by:

SMU5

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-1 Rev.: 9 Date: 7/1/82

Joint Design: Per Figure 1

B-P1a
B-P1b
B-P1c
B-P2
BC-P2
B-P3
B-P4
B-P2a *

BTC-P4
BTC-P5
BC-P6
B-P7
BTC-P8
BTC-P9
SJ-P1 - For included angles less than 45° use only 3/32 and 1/8" electrodes.

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501

A516
A529
A570
A572 Gr 42,45,50
A588
A505 TP 2 or TP 4
A607 Gr 45,50,55
A618 Gr II & III

Welding Conditions:

Increment	-	-	-	-	-
Current	75-115	100-145	130-205	170-275	275-375
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-	-
Travel Speed (IPM)	3 min	4 min	5 min	7 min	8 min
Electrode Type	E7018	E7018	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"	3/16"	1/4"

Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup to Work Distance	-
Contact Tube to Work Dist.	-
Preheat	
Interpass Temperature	500° F max
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

Thickness	Min. Temp
Up to 3/4	None**
Over 3/4 to 1-1/2	50° F
Over 1-1/2 to 2-1/2	150° F
Over 2-1/2	225° F

*For joint type B-P2a, max. electrode size is 5/32" dia.

**When the base metal is below 32° F, preheat to 70° F and maintain during welding.

Reference documents: P.S.1.C.1.2, PQR SM-P-1

Prepared by:

Reviewed by: J. R. Haueter

Approved by: W. P. Jost

E31054.18

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-2 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Per Figure 1

B-P1a
B-P1b
B-P1c
B-P2
BC-P2
B-P3
B-P4
BTC-P4
BTC-P5
BC-P6
B-P7
BTC-P8
BTC-P9

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A500 Grade A&B
A501
A516 Gr 55,60
A529
A570

Welding Conditions:

Increment	-	-	-	-	-
Current	50-80	80-120	120-160	140-215	225-320
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.	7 min.	8 min.
Electrode Type	E6010	E6010	E6010	E6010	E6010
Electrode Size	3/32"	1/8"	5/32"	3/16"	1/4"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	-				
Shielding Gas Flow Rate	-				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	-				
Gas Cup to Work Distance	-				
Contact Tube to Work Dist.	-				
Preheat					
Interpass Temperature	500°F				
Post Weld Heat Treatment	None				
Welding Position	F,H,V,OH				
Other					

Preheat →

Thickness	Min. Temp.
Up to 3/4	None*
Over 3/4 to 1-1/2	150°F
Over 1-1/2 to 2-1/2	225°F
Over 2-1/2	300°F

*When base metal is below 32°F, preheat to 70°F and maintain during welding.
E7010-A1 may be substituted for E6010.

Reference documents: P.S.1.C.1.2

Prepared by: W.P. Joest

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-3 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 1

B-P1a
B-P1b
B-P1c
B-P2
BC-P2
B-P3
B-P4
BTC-P4
BTC-P5
BC-P6
B-P7
BTC-P8
BTC-P9

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A500 Grade A&B
A501
A516 Grades 55, 60
A529
A570
A620**

Welding Conditions:

Increment	-	-	-
Current	50-80	80-120	120-160
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type	E6013	E6013	E6013
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat			
Interpass Temperature	500F max.		
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

Preheat →

Thickness	Min. Temp.
Up to 3/4	None*
Over 3/4 to 1-1/2	150°F
Over 1-1/2 to 2-1/2	225°F
Over 2-1/2	300°F

*When base metal is below 32°F, preheat to 70°F and maintain during welding.
**For lap fillet welds only.

Reference documents: P.S.1.C.1.2

Prepared by: W.P. Jost

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-4 Rev.: 3 Date: 6/1/81

Joint Design: Per Figure 1

B-P1a
B-P1b
B-P1c
B-P2
BC-P2
B-P3
B-P4
BTC-P4
BTC-P5
BC-P6
B-P7
BTC-P8
BTC-P9

Base Metal: ASTM Specifications

	A193 Gr B8 (304)	
Type 1	A240 or A666 - TP304,304L,316,or 316L	
to		
Type II	A36	A516
	A53 Gr. B	A529
	A106 Gr. B	A570
	A242	A572 Gr 42, 45 & 50
	A441	A588
	A500 Gr. A&B	A606 TP 2 or TP 4
	A501	A607 Gr 45, 50, 55

Welding Conditions:

Increment	-	-	-
Current	50-100	70-135	100-180
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23- 27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min	3 min	4 min
Electrode Type	E309-15 or 16	E309-15 or 16	E309-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	None*		
Interpass Temperature	350° F max		
Post Weld Heat Treatment	None		
Welding Position	F, H, V, OH		
Other			

*When base metal is below 32° F, preheat to 70° F and maintain during welding.
Weld thickness shall not exceed 3/4 inch.

Reference documents: P.S.1.C.1.2, PQR SM18-B-1

Prepared by:

Approved by: C. E. Roberts

SMP4

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-5 Rev.: 2 Date: 6/1/81

Joint Design: Per Figure 1

B-Pla
B-Plb
BP1c
B-P2
BC-P2
B-P3
B-P4
BTC-P4
BTC-P5
BC-P6
B-P7
BTC-P8
BTC-P9

Base Metal: ASTM Specifications

A240 or A666 - TP304,304L,316 or 316L
A276, TP 304,304L,316 or 316L

Welding Conditions:

Increment	-	-	-
Current	50-80	70-115	100-145
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min	3 min	4 min
Electrode Type	E308-15 or 16	E308-15 or 16	E308-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	None*		
Interpass Temperature	350° F max		
Post Weld Heat Treatment	None		
Welding Position	F, H, V, OH		
Other			

*When base metal is below 32° F, preheat to 70° F and maintain during welding.
Weld thickness shall not exceed 3/4 inch.

Reference documents: P.S.1.C.1.2 , PQR SM88-B-1

Prepared by:

Approved by: C.E Roberts

SMP5.3

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-6 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Per Figure 1

Base Metal: Type and Grade

A533 Gr B Cl 1

B-P1a
B-P1b
B-P1c
B-P2
BC-P2
B-P3
B-P4

BTC-P4
BTC-P5
BC-P6
B-P7
BTC-P8
BTC-P9

Notes:

1. Use stringer bead technique only. (Weave shall be kept to a minimum.)
2. Use temper beads on all welds; see Figure 3.
3. Electrodes shall be dry and shall be used directly from a heated oven.
4. Temper beads shall be deposited in weld metal and 1/2 bead away from surface beads in A-533 steel.

Welding Conditions:

Increment	–	–	–
Current	75-110	100-130	130-160
Pulse Rate	–	–	–
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27
Transfer Mode	–	–	–
Travel Speed (IPM)	3 min.	4 min.	5 min.
Electrode Type	E8018-C3	E8018-C3	E8018-C3
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	–		
Filler Metal Size	–		
Flux Type	–		
Flux Particle Size	–		
Shielding Gas	–		
Shielding Gas Flow Rate	–		
Purging Gas	–		
Purging Gas Flow Rate	–		
Gas Cup Size	–		
Gas Cup to Work Distance	–		
Contact Tube to Work Dist.	–		
Preheat	300°F min.		
Interpass Temperature	400°F max.		
Post Weld Heat Treatment	None		
Welding Position	H		
Other			

Preheat shall be maintained on the entire weld joint, both sides, until completion of welding. The preheat temperature shall be raised to 400-500°F immediately after completion of welding and maintained for six hours minimum.

Reference documents: P.S.1.C.1.2, PQR SM-P-6

Prepared by: W. P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-7 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Per Figure 1

Base Metal: Type

A-514 Steel
A-517

B-Pla
B-Plb
B-Plc
B-P2
BC-P2
B-P3
B-P4

BTC-P4
BTC-P5
BC-P6
B-P7
BTC-P8
BTC-P9

Notes:

1. User stringer bead technique only. (Weave shall be kept to minimum.)
2. Use temper beads on all welds; see Figure 3.
3. Electrodes shall be dry and shall be used directly from a heated oven.
4. Temper beads shall be deposited in weld metal and 1/2 bead away from surface beads in A-514 steel.
5. In welding joints involving lower strength base material welded to A-514 steel, electrodes conforming to the lower strength base material may be used and shall be EXX18 type. The welding conditions (including current, voltage, preheat, interpass temperature, electrode drying requirements, and temper bead requirements) specified for A-514 steel shall be used.

Welding Conditions:

Increment	–	–	–
Current	75-110	100-130	130-160
Pulse Rate	–	–	–
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27
Transfer Mode	–	–	–
Travel Speed (IPM)	3 min.	4 min.	5 min.
Electrode Type	E11018	E11018	E11018
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	–		
Filler Metal Size	–		
Flux Type	–		
Flux Particle Size	–		
Shielding Gas	–		
Shielding Gas Flow Rate	–		
Purging Gas	–		
Purging Gas Flow Rate	–		
Gas Cup Size	–		
Gas Cup to Work Distance	–		
Contact Tube to Work Dist.	–		
Preheat			
Interpass Temperature			
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

Thickness	Min. Preheat	Max. Interpass
To 3/4" incl	50°F	400°F
3/4" to 1-1/2"	125°F	400°F
1-1/2" to 2-1/2"	175°F	400°F
Over 2-1/2"	225°F	450°F

Preheat shall be maintained on the entire weld joint, both sides, until completion of welding. For base material over 3/4-inch in thickness, the preheat temperature shall be raised to 400-500°F immediately after completion of welding and maintained for two hours minimum.

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Jost

Approved by: Robert M Jessee

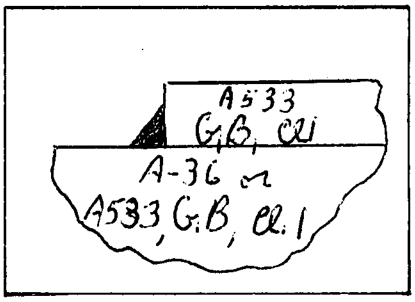
TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-8 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Fillet Welds Only

Base Metal: Type and Grade

A533 GR B, Cl 1
A36 ---



Notes:

1. Preheat shall be maintained, uninterrupted, until completion of welding.
2. Use temper bend technique against A533 material, (see figure 3).
3. Use stringer bends only. Weave shall be kept to an absolute minimum.
4. Electrodes to be used directly from portable heated containers.
5. This procedure is applicable to fabrication where procedures are to be qualified in accordance with ASME Section IX with AWS D1.1 fabrication requirements and no impact testing.

Welding Conditions:

Increment	-	-	-
Current	75-110	100-130	130-160
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23-25	23-25	23-25
Transfer Mode	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.
Electrode Type	E8018-C3	E8018-C3	E8018-C3
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	250°F min.		
Interpass Temperature	300°F max.		
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

Reference documents: P.S.1.C.1.2, PQR SM-P-6

Prepared by: W.P Jost

Approved by: Robert M Jessee

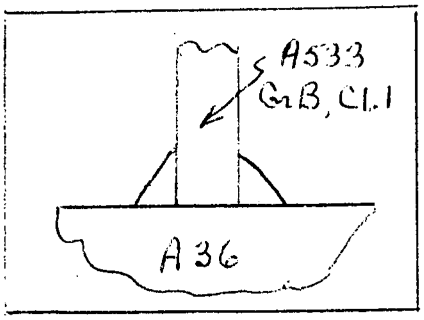
TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-9 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Fillet Welds Only

Base Metal: Type and Grade

A533	Gr B, Cl 1
A36	---



Notes:

1. Preheat shall be maintained, uninterrupted, until completion of welding.
2. Use temper bend technique against A533 material, (see Fig. 3).
3. Use stringer bends only. Weave shall be kept to an absolute minimum.
4. Electrodes to be used directly from portable heated containers.

*5. This procedure is applicable to fabrication where procedures are qualified in accordance with ASME Section IX with AWS D1.1 fabrication requirements. It is not qualified with notch toughness in the vertical position.

Welding Conditions:

Increment	-	-	-
Current	75-110	100-130	130-160
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23-25	23-25	23-25
Transfer Mode	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.
Electrode Type	E8018-C3	E8018-C3	E8018-C3
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	350°F min.		
Interpass Temperature	500°F max.		
Post Weld Heat Treatment	None		
Welding Position	F,H,V*,OH		
Other			

Reference documents: P.S.1.C.1.2, PQR SM-P-6

Prepared by: W. P. Jost

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-10 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Per Figure 1

Base Metal: Type and Grade

B-P1a	BTC-P4
B-P1b	BTC-P5
B-P1c	BC-P6
B-P2	B-P7
BC-P2	BTC-P8
B-P3	BTC-P9
B-P4	

		A 240, Typ. 304
A572 Gr 55 (Stainless Clad)	to	A 240, Typ. 316
		A 240, Typ. 304L
		A 240, Typ. 316L

Note: This procedure is applicable to joints in which the weld deposit will contact bare (unclad) steel on the A572 side of the joint.

Welding Conditions:

Increment			
Current	50-100	70-135	100-180
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type	E309-15 or 16	E309-15 or 16	E309-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat →			
Interpass Temperature	350°F max.		
Post Weld Heat Treatment	None		
Welding Position	H,V		
Other			

Thickness	Minimum Preheat
To 3/4"	50°F
Over 3/4" through 1-1/2"	150°F
Over 1-1/2" through 2-1/2"	225°F
Over 2-1/2"	300°F

Weld thickness shall not exceed thickness specified in Fig. 1 or 3/4" whichever is less.

Reference documents: P.S.1.C.1.2, PQR SM 18-B-1, PQR SM-U-6

Prepared by: W. P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-11 **Rev.:** 1 **Date:** 5/9/80

Joint Design: Per Figure 1

B-P1a	BTC-P4
B-P1b	BTC-P5
B-P1c	BC-P6
B-P2	B-P7
BC-P2	BTC-P8
B-P3	BTC-P9
B-P4	

Base Metal: Type and Grade

A572 Grade 55, 60, 65 } TO {

A36	A516
A53 Grade B	A529
A106 Grade B	A570
A242	A572 Gr 42-55
A441	A588
A500 Grade A&B	A606 TP 2 or TP 4
A501	A607 Gr 45, 50, 55
	A709 Gr 36
	*A519 Gr 1018 and 1026

Welding Conditions:

Increment	-	-	-	-	-
Current	75-115	100-145	130-205	170-275	275-375
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.	7 min.	8 min.
Electrode Type	E7018	E7018	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"	3/16"	1/4"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	-				
Shielding Gas Flow Rate	-				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	-				
Gas Cup to Work Distance	-				
Contact Tube to Work Dist.	-				
Preheat					
Interpass Temperature	500°F max.				
Post Weld Heat Treatment	None				
Welding Position	F, H, V, OH				
Other					

Thickness	Min. Preheat
To 3/4"	50°F
Over 3/4" thru 1-1/2"	150°F
Over 1-1/2" thru 2-1/2"	225°F
Over 2-1/2"	300°F

*When chemical analysis and minimum yield strength conform to requirements of A709 Grade 36.

Reference documents: P.S.1.C.1.2.

Prepared by:

Approved by: W. P. Jost

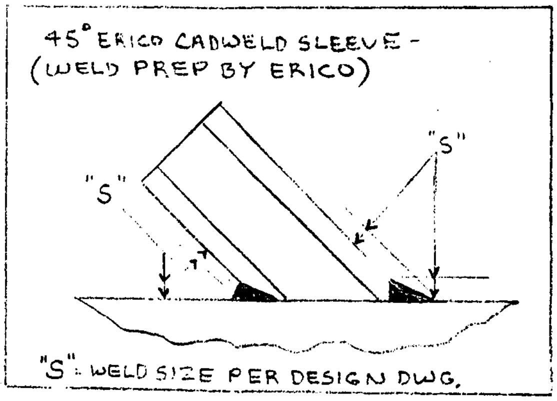
TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-P-13 Rev.: 0 Date: 4/21/81

Joint Design:

Per sketch →

Application Limited To C.F Brown Designed Structures.



Base Metal: Plate
A36
A441
A516
A572 Gr 42, 45 & 50

Cadweld Sleeve
A519 Gr 1018-Gr 1026

Welding Conditions:

Increment	Root	Rem	Rem
Current	75-115	100-145	130-205
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	-	-	-
Electrode Type	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		

Preheat		Thickness	Min. Temp.
Interpass Temperature	500° F max	Thru 3/4"	None
Post Weld Heat Treatment	None	Over 3/4" - 1-1/2"	50° F
Welding Position	H, V, OH	Over 1-1/2" - 2-1/2"	150° F
Other		Over 2-1/2"	225° F

Reference documents: P.S. 1.C.1.2, PQR SM-P-13

Prepared by:

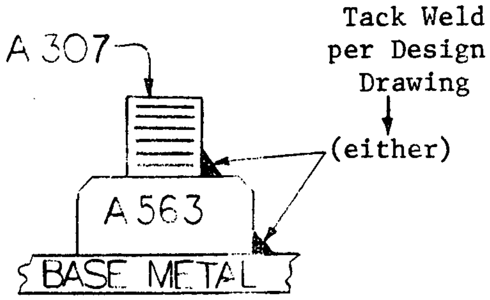
Approved by: C.E. Roberts

SMP13

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: *SM-P-14 Rev.: 0 Date: 12/11/81

Joint Design: Per Figure Below



A563 Nut Tack Welded to

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grades A&B
A501
A516
A529
A570
A575 Gr 42,45,50
A588
A505 TP 2 or TP 4
A607 Gr 45,50,55

A307 Bolt

Welding Conditions:

Increment	-	-	-
Current	75-115	100-145	130-205
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	3 min	4 min	5 min
Electrode Type	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	200°F min		
Interpass Temperature	500°F max		
Post Weld Heat Treatment	None		
Welding Position	F, H, V, OH		
Other			

*Use only when tack welds are specifically detailed on design drawings and are nonloaded connections (designed to prevent rotation of the nut).

Reference documents: P.S. 1.C.1.2, Test Report (MEDS) SME 811130 005.

Prepared by: James R. Haueter Reviewed by:

Approved by: C.E. Roberts

SMP14

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-L-1 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 2

B-L1a
C-L1a
B-L1b
TC-L1b

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	–	–	–	–	–
Current	75-115	100-145	130-205	170-275	275-375
Pulse Rate	–	–	–	–	–
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27	23-27
Transfer Mode	–	–	–	–	–
Travel Speed (IPM)	3 min.	4 min.	5 min.	7 min.	8 min.
Electrode Type	E7018	E7018	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"	3/16"	1/4"
Filler Metal Type	–				
Filler Metal Size	–				
Flux Type	–				
Flux Particle Size	–				
Shielding Gas	–				
Shielding Gas Flow Rate	–				
Purging Gas	–				
Purging Gas Flow Rate	–				
Gas Cup Size	–				
Gas Cup to Work Distance	–				
Contact Tube to Work Dist.	–				
Preheat	None*				
Interpass Temperature	500°F max.				
Post Weld Heat Treatment	None				
Welding Position	F,H,V,OH				
Other					

*When the base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W.P. Jost

Approved by: Robert M Grosse

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-L-2 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Per Figure 2

B-L1a
C-L1a
B-L1b
TC-L1b

Base Metal: ASTM Specifications

A240 or A666 TP 304, 304L, 316 or 316L

Welding Conditions:

Increment	-	-	-
Current	50-80	70-115	100-145
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type **	E308-15 or 16	E308-15 or 16	E308-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	None*		
Interpass Temperature	350°F max.		
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

*When base metal is below 32°F, preheat to 70°F and maintain during welding.
**When carbon steel backing is used, E309-15 or 16 shall be used for the root layer.

Reference documents: P.S.1.C.1.2, PQR SM 88-B-1

Prepared by: W.P. Joest

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-U-1　　Rev.: 6　　Date: 3/8/83

Joint Design: Per Figure 2

B-U2a
C-U2a
B-U2
C-U2
B-U3a
B-U3b
B-U4a
TC-U4c
B-U4
TC-U4a
TC-U4d
TC-U4b
B-U5b
B-U5a
TC-U5b
TC-U5c
TC-U5d
B-U6
C-U6
B-U7
B-U8
TC-U8a
TC-U8b
B-U9
TC-U9a
TC-U9b

Base Metal:

ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Gr A&B
A501
A515
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 GR 45,50,55
A633 GR A,B,C,D
A618 GR II & III

Welding Conditions:

Increment	-	-	-	-	-
Current	75-115	100-145	130-205	170-275	275-375
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.	7 min.	8 min.
Electrode Type	E7018	E7018	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"	3/16"	1/4"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	-				
Shielding Gas Flow Rate	-				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	-				
Gas Cup to Work Distance	-				
Contact Tube to Work Dist	-				
Preheat	→				
Interpass Temperature	500°F max.				
Post Weld Heat Treatment	None				
Welding Position	F,H,V,OH				
Other					

Thickness	Min. Temp.
Up to 3/4"	None*
Over 3/4" to 1-1/2"	50°F
Over 1-1/2" to 2-1/2"	150°F
Over 2-1/2"	225°F

*When the base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2, PQR SM11-B-9

Prepared by: 　　Reviewed by: W.P. Joest

Approved by: C.E. Roberts

E43067.07

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-U-1A   **Rev.:** 1   **Date:** 1-31-80

Joint Design: Per Figure 2

Base Metal: Type
A-514 Steel
A-517

B-U2a
C-U2a
B-U2
C-U2
B-U3a
B-U3b
B-U4a
TC-U4c
B-U4

B-U4a
TC-U4d
TC-U4b
B-U5b
B-U5a
TC-U5b
TC-U5c
TC-U5d
B-U6

C-U6
B-U7
B-U8
TC-U8a
TC-U8b
B-U9
TC-U9a
TC-U9b

Notes:

1. Use stringer bead technique only. (Weave shall be kept to minimum.)
2. Use temper beads on all welds; see Figure 3.
3. Electrodes shall be dry and shall be used directly from a heated oven.
4. Temper beads shall be deposited in weld metal and 1/2 bead away from surface beads in A-514 steel.
5. In welding of joints involving lower strength base material welded to A-514 steel, electrodes conforming to the lower strength base material may be used and shall be EXX18 type. The welding conditions (including current, voltage, preheat, interpass temperature, electrode drying requirements, and temper bead requirements) specified for A-514 steel shall be used.

Welding Conditions:

Increment	-	-	-
Current	75-110	100-130	130-160
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.
Electrode Type	E11018	E11018	E11018
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat			
Interpass Temperature			
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

Preheat / Interpass Temperature:

Thickness	Min. Preheat	Max. Interpass
To 3/4" incl	50°F	400°F
3/4" to 1-1/2"	125°F	400°F
1-1/2" to 2-1/2"	175°F	400°F
Over 2-1/2"	225°F	450°F

Preheat shall be maintained on the entire weld joint, both sides, until completion of welding. For base material over 3/4-inch in thickness, the preheat temperature shall be raised to 400-500°F immediately after completion of welding and maintained for two hours minimum.

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Jost

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-U-1B   Rev.: 6   Date: 6/1/81

Joint Design: Per Figure 2

B-U2a
C-U2a
B-U2
C-U2
B-U3a
B-U3b
B-U4a
TC-U4c
B-U4
B-U4a
TC-U4d
TC-U4b
B-U5b
B-U5a
TC-U5b
TC-U5c
TC-U5d
B-U6
C-U6
B-U7
B-U8
TC-U8a
TC-U8b
B-U9
TC-U9a
TC-U9b

Base Metal: Type and Grade

A572 Gr 55, 60, 65 to

A36
A53 Gr. B
A106 Gr. B
A242
A441
A500 Gr. A&B
A501
A516
A529
A570
A572 Gr 42,45,50,55
A588
A606 TP 2 or TP 4
A607 Gr. 45,50,55

Welding Conditions:

Increment	-	-	-	-	-
Current	75-115	100-145	130-205	170-275	275-375
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-	-
Travel Speed (IPM)	3 min	4 min	5 min	7 min	8 min
Electrode Type	E7018	E7018	E7018	D7018	E7018
Electrode Size	3/32"	1/8"	5/32"	3/16"	1/4"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	-				
Shielding Gas Flow Rate	-				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	-				
Gas Cup to Work Distance	-				
Contact Tube to Work Dist.	-				

		Thickness	Min. Preheat
Preheat			
Interpass Temperature	500° max	To 3/4"	50° F
Post Weld Heat Treatment	None	Over 3/4"- 1-1/2"	150° F
Welding Position	F, H, V, OH	Over 1-1/2" - 2-1/2"	225° F
Other		Over 2-1/2	300° F

Reference documents: P.S. 1.C.1.2

Prepared by:

Approved by: C.E. Roberts

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-U-2 Rev.: 4 Date: 3/4/81

Joint Design: Per Figure 2

B-U2a
C-U2a
B-U2
C-U2
B-U3a
B-U3b
B-U4a
TC-U4c
B-U4

B-U4a
TC-U4d
TC-U4b
B-U5b
B-U5a
TC-U5b
TC-U5c
TC-U5d
B-U6

C-U6
B-U7
B-U8
TC-U8a
TC-U8b
B-U9
TC-U9a
TC-U9b

Base Metal: ASTM Specifications

A240 TP 304, 304L
A660 316 or 316L
A479
A580

Welding Conditions:

Increment	-	-	-
Current	50-80	70-115	100-145
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type	E308-15 or 16	E308-15-16	E308-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	None*		
Interpass Temperature	350° F max.		
Post Weld Heat Treatment	None		
Welding Position	F, H. V, OH		
Other			

*When base metal is below 32° F, preheat to 70° F and maintain during welding.

Reference documents: P.S.1.C.1.2, PQR GT-SM88-0-2

Prepared by:

Approved by:

SMU2.03

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-U-3   Rev.: 4   Date: 6/1/81

Joint Design: Per Figure 2

B-U2a
C-U2a
B-U2
C-U2
B-U3a
B-U3b
B-U4a
TC-U4c
B-U4
B-U4a
TC-U4d
TC-U4b
B-U5b
B-U5a
TC-U5b
TC-U5c
TC-U5d
B-U6
C-U6
B-U7
B-U8
TC-U8a
TC-U8b
B-U9
TC-U9a
TC-U9b

Base Metal: ASTM Specifications

Type I
A240 or A666 TP 304, 304L
316 or 316L
to
Type II
A36
A53 Gr. B
A106 Gr. B
A242
A441
A500 Gr. A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-	-	-
Current	50-100	70-135	100-180
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min	3 min	4 min
Electrode Type	E309-15 or 16	E309-15 or 16	E309-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	None*		
Interpass Temperature	350° F max		
Post Weld Heat Treatment	None		
Welding Position	F, H, V, OH		
Other			

*When base metal is below 32° F, preheat to 70° F and maintain during welding.
Weld thickness shall not exceed 1-1/4 inches.

Reference documents: P.S.1.C.1.2, PQR SM-18-B-1

Prepared by:

Approved by: C E Roberts

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-U-4 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 2

Base Metal: ASTM Specifications

A572 Grade 65

B-U2a
C-U2a
B-U2
C-U2
B-U3a
B-U3b
B-U4a
TC-U4c
B-U4
B-U4a
TC-U4d
TC-U4b
B-U5b
B-U5a
TC-U5b
TC-U5c
TC-U5d
B-U6
C-U6
B-U7
B-U8
TC-U8a
TC-U8b
B-U9
TC-U9a
TC-U9b

Welding Conditions:

Increment	-	-	-	-	-
Current	75-115	100-145	130-205	170-275	275-375
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.	7 min.	8 min.
Electrode Type	E8018-C3	E8018-C3	E8018-C3	E8018-C3	E8018-C3
Electrode Size	3/32"	1/8"	5/32"	3/16"	1/4"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	-				
Shielding Gas Flow Rate	-				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	-				
Gas Cup to Work Distance	-				
Contact Tube to Work Dist.	-				
Preheat →					
Interpass Temperature	500°F max.				
Post Weld Heat Treatment	None				
Welding Position	F,H,V,OH				
Other					

Thickness	Min. Temp.
Up to 3/4	50°F
Over 3/4 to 1-1/2	150°F
Over 1-1/2 to 2-1/2	225°F
Over 2-1/2	300°F

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Jest

Approved by: Robert M. Jessee

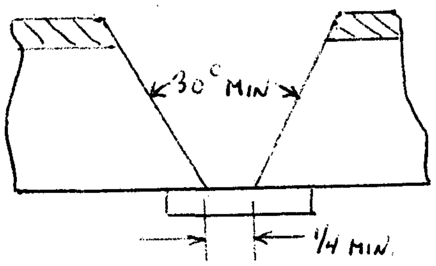
TENNESSEE VALLEY AUTHORITY

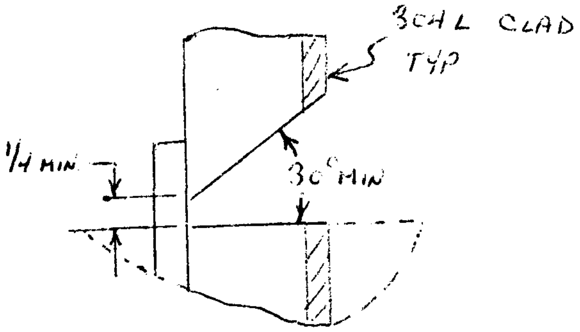
Detail Weld Procedure No.: SM-U-6 **Rev.:** 1 **Date:** 1-31-80

Joint Design:

Base Metal: Type and Grade

A572 Gr 55 to A572 Gr 55
A516 Gr 70





Welding Conditions:

Increment	–	–	–
Current	50-100	70-135	100-180
Pulse Rate	–	–	–
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	–	–	–
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type	E309-15 or 16	E309-15 or 16	E309-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	–		
Filler Metal Size	–		
Flux Type	–		
Flux Particle Size	–		
Shielding Gas	–		
Shielding Gas Flow Rate	–		
Purging Gas	–		
Purging Gas Flow Rate	–		
Gas Cup Size	–		
Gas Cup to Work Distance	–		
Contact Tube to Work Dist.	–		
Preheat →			
Interpass Temperature	350°F max.		
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

Thickness	Min. Preheat
To 3/4"	50°F
Over 3/4" thru 1-1/2"	150°F
Over 1-1/2" thru 2-1/2"	225°F
Over 2-1/2"	300°F

Reference documents: P.S.1.C.1.2, PQR-SM-U-6

Prepared by: W.P. Jost

Approved by: Robert M. Jessee

TVA 10565A (DED-6-74)

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-U-7 Rev.: 1 Date: 1/31/81

Joint Design: Per Figure 2

B-U2a
C-U2a
B-U2
C-U2
B-U3a
B-U3b
B-U4a
TC-U4c
B-U4
TC-U4a
TC-U4d
TC-U4b
B-U5b
B-U5a
TC-U5b
TC-U5c
TC-U5d
B-U6
C-U6
B-U7
B-U8
TC-U8a
TC-U8b
B-U9
TC-U9a
TC-U9b

Base Metal: Type and Grade

*Type 1	*Type 2
A572,Gr 55-+→	A240, Typ. 304 A240, Typ. 316 A240, Typ. 304L A240, Typ. 316L

Welding Conditions:

Layer No.	50-100	70-135	100-180
Current	DCRP	DCRP	DCRP
Polarity	22-26	23-27	23-27
Arc Voltage	2 Min.	3 Min.	4 Min.
Travel Speed	E309L-15 or 16	E309L-15 or 16	E309L-15 or 16
Electrode Type	3/32"	1/8"	5/32"
Electrode Size	-	-	-
Filler Metal Type	-	-	-
Filler Metal Size	-	-	-
Flux Type	-	-	-
Flux Partical Size	-	-	-
Shielding Gas	-	-	-
Shielding Gas Flow Rate	-	-	-
Purging Gas	-	-	-
Purging Gas Flow Rate	-	-	-
Gas Cup Size	-	-	-
Gas Cup To Work Distance	-	-	-
Preheat			
Interpass Temp.	350° F Max		
Post Weld Heat Treatment	None		
Welding Position	F, H, V, OH		
Other			

Thickness	Min. Preheat*
To 3/4"	60° F
Over 3/4" Through 1-1/2"	150° F
Over 1-1/2" Through 2-1/2"	225° F
Over 2-1/2"	300° F

*Applies to carbon steel member. Preheat for stainless steel member to be 60° F for any thickness.

Reference documents: P.S.1.C.1.2(a), PQR SM18-B-1, PQR SM-U-6

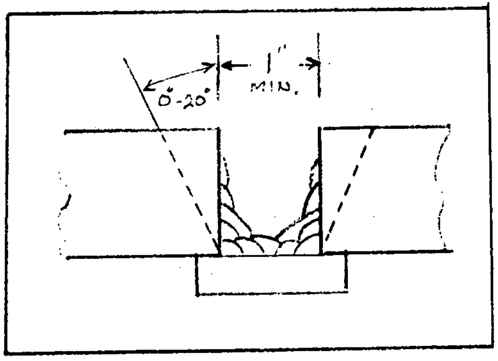
Prepared by:

Approved by:

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-U-8 Rev.: 0 Date: 5/7/81

Joint Design: Per Figure



Base Metal:

ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Gr A&B
A501

A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 GR 45,50,55
A633, GR A,B,C,D

Welding Conditions:

Increment	-	-	-	-	-
Current	75-115	100-145	130-205	170-275	275-375
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.	7 min.	8 min.
Electrode Type	E7018	E7018	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"	3/16"	1/4"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	-				
Shielding Gas Flow Rate	-				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	-				
Gas Cup to Work Distance	-				
Contact Tube to Work Dist.	-				
Preheat					
Interpass Temperature	500° F max.				
Post Weld Heat Treatment	None				
Welding Position	F, H, V, OH				
Other					

Thickness	Min. Temp.
Up to 3/4"	None*
Over 3/4" to 1-1/2"	50° F
Over 1-1/2" to 2-1/2"	150° F
Over 2-1/2"	225° F

*When the base metal is below 32° F, preheat to 70° F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by:

Approved by: C.E. Roberts

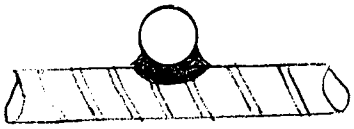
SMU8

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-RB-1 Rev.: 4 Date: 1/9/81

Joint Design: (TYP.)

Base Metal: A 615, A 616, A 617 to A 615, A 616, A 617, A 36



Welding Conditions:

Increment	-	-	-
Current	75-115	100-145	130-205
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	21-24	22-25	23-26
Transfer Mode	-	-	-
Travel Speed (IPM)	-	-	-
Electrode Type	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	500° F min.		
Interpass Temperature	1200° F max.		
Post Weld Heat Treatment	None		
Welding Position	F, H, V, OH		
Other	Limits of Applicability: (1) To be used only where specifically required by design drawings. (2) Bar size - No. 11 max. (3) Fillet welds only. (4) For bar sizes No. 10 and No. 11, carbon equivalent limited to 0.75 max as determined by the formula: carbon equivalent = $\%C + \frac{\%MN}{6}$. For smaller bars, carbon equivalent determination not necessary		

Reference documents: P.S.1.C.1.2

Prepared by:

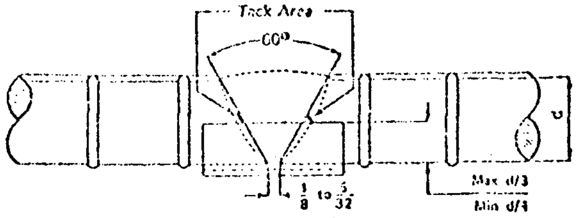
Approved by:

SMRB.1

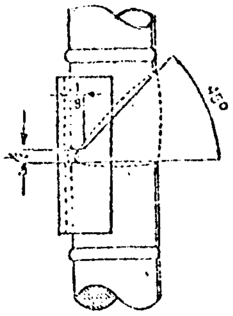
TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-RB-2 Rev.: 1 Date: 6/15/82

Joint Design: Per Figure Base Metal: A615 Grade 60



C – Single-V-groove Weld with split pipe back-up



D – Single-bevel groove Weld

Welding Conditions:

Increment	-	-
Current	75-100	110-140
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	23-25	23-25
Transfer Mode	-	-
Travel Speed (IPM)	-	-
Electrode Type	E9018 B3	E9018 B3
Electrode Size	3/32"	1/8"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	-	-
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup to Work Distance	-	-
Contact Tube to Work Dist.	-	-
Preheat	500°F min	
Interpass Temperature	800°F max	
Post Weld Heat Treatment	None	
Welding Position	*H, **V, **F, **OH	
Other		

*Use Detail D
**Use Detail C

1. This procedure to be used only for applications specified by EN DES.

2. This procedure limited to rebar size #11 and smaller.

Reference documents: P.S.1.C.1.2 PQR SM-RB-2

Prepared by: Reviewed by:

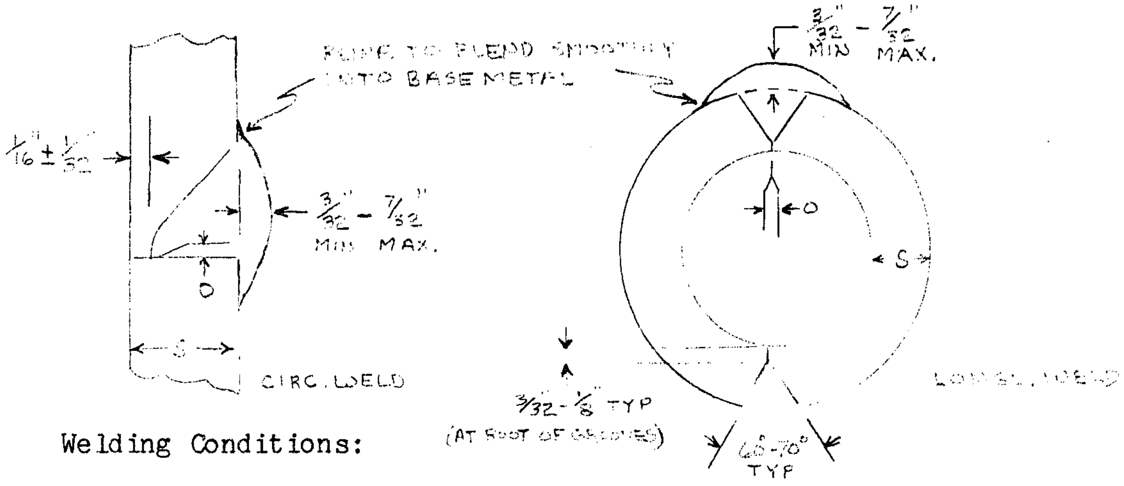
Approved by: C. E. Roberts

E42166.04

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM Cadweld Repair   Rev.: 1   Date: 10/30/81

Joint Design: Base Metal:



Welding Conditions:

Layer No.	Root	Rem	Rem
Current	75-115	75-115	100-145
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	22-26	23-27
Travel Speed	-	-	-
Electrode Type	E7018	E7018	E7018
Electrode Size	3/32"	3/32"	1/8"
Filler Metal Type	-	-	-
Filler Metal Size	-	-	-
Flux Type	-	-	-
Flux Particle Size	-	-	-
Shielding Gas	-	-	-
Shielding Gas Flow Rate	-	-	-
Purging Gas	-	-	-
Purging Gas Flow Rate	-	-	-
Gas Cup Size	-	-	-
Gas Cup to Work Distance	-	-	-

Preheat 60°F min.

Interpass Temperature 500°F max.

Post Weld Heat Treatment None

Welding Position All

Other Note 1: To maintain required I.D., it may be necessary to use halves from different sleeves cut slightly off center to compensate for material lost during the cut. When halves are fit together, lands and grooves in each half must be accurately aligned.

Note 2: Effective throat (E) for circ. welds = (S)-3/64"; for longitudinal welds (E) = (S)-5/64".

Reference documents: P.S. 1.C.1.2, PQR SM Cadweld Repair, SME 800715 001 (Results of proof test assemblies - all acceptable)

Prepared by: ____________   Reviewed by: W. P. Joost

Approved by: C. E. Roberts

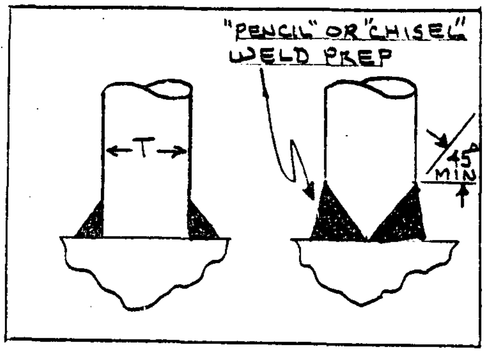
SMCR

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-SW-P-1 Rev.: 4 Date: 3/22/82

Notes:

1. Tack weld stud to hold in position during welding.
2. Fillet weld size shall be T/2 minimum.



Materials

Base

A36
A53 Gr B
A106 Gr B
A242
A441
A500 Gr A&B
A501

A516
A529
A570
A572 Gr 42, 45, 50
A588
A606 TP 2 or TP 4
A607 Gr 45, 50, 55

Stud

A108 Gr
1010
1015
1017
1020
Semi or Fully Killed

Welding Conditions:

Increment	-	-	-	-
Current	75-115	100-145	130-205	170-275
Pulse Rate	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.	7 min.
Electrode Type	E7018	E7018	E7018	E7018
Electrode Size	3/32"**	1/8"**	5/32"	3/16"
Filler Metal Type	-			
Filler Metal Size	-			
Flux Type	-			
Flux Particle Size	-			
Shielding Gas	-			
Shielding Gas Flow Rate	-			
Purging Gas	-			
Purging Gas Flow Rate	-			
Gas Cup Size	-			
Gas Cup to Work Distance	-			
Contact Tube to Work Dist.	-			
Preheat				
Interpass Temperature	400°F max.			
Post Weld Heat Treatment	None			
Welding Position	F, H, V, OH			

Thickness	Min. Preheat
To 3/4"	None*
3/4" to 1-1/2"	70°F
1-1/2" to 2-1/2"	150°F
Over 2-1/2"	225°F

*When base metal temperature is below 32°F, preheat to 70°F and maintain during welding.

**For use only on groove welded studs of all diameters and on fillet welded studs 7/16" or less in diameter.

Reference documents: P.S.1.C.1.2

Prepared by: James R Hauster

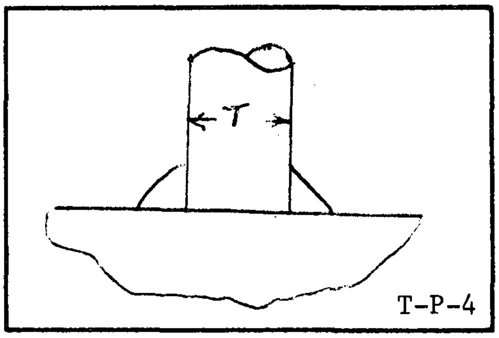
Reviewed by:

Approved by: C. E. Roberts

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-SW-P-2 **Rev.:** 1 **Date:** 1-31-80

Notes:
1. Tack weld stud to hold in position during welding.
2. Fillet weld size shall be T/2 minimum.



Materials

Base	Stud
304	304
316	

Welding Conditions:

Increment	-	-	-
Current	50-80	70-115	100-145
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type	E308-15 or 16	E308-15 or 16	E308-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	None*		
Interpass Temperature	350°F max.		
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

*When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2, PQR SM88-B-1

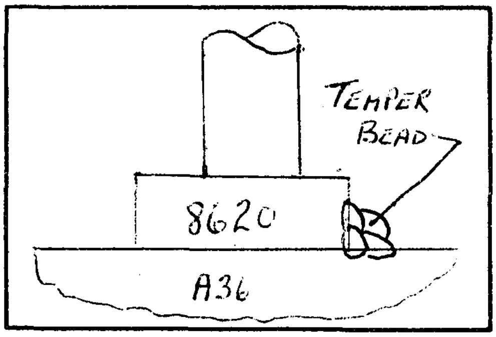
Prepared by: W.P. Joest

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-SW-P-3 **Rev.:** 1 **Date:** 1-31-80

Notes:
1. Tack weld stud to hold in position during welding.
2. Fillet weld size shall be 5/16" min.



Materials

Base	Stud
A36	A8620
A441	
A588	

Welding Conditions:

Increment	-	-
Current	75-115	100-145
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	23-27	23-27
Transfer Mode	-	-
Travel Speed (IPM)	3 min.	4 min.
Electrode Type	E7018	E7018
Electrode Size	3/32"	1/8"
Filler Metal Type	-	
Filler Metal Size	-	
Flux Type	-	
Flux Particle Size	-	
Shielding Gas	-	
Shielding Gas Flow Rate	-	
Purging Gas	-	
Purging Gas Flow Rate	-	
Gas Cup Size	-	
Gas Cup to Work Distance	-	
Contact Tube to Work Dist.	-	
Preheat	60°F min.	
Interpass Temperature	150°F max.	
Post Weld Heat Treatment	None	
Welding Position	F,V,OH	
Other	Temper beads shall be deposited in weld metal 1/2 bead away from surface beads in A8620 steel.	

Reference documents: P.S.1.C.1.2, PQR SW-5

Prepared by: W.P. Joest

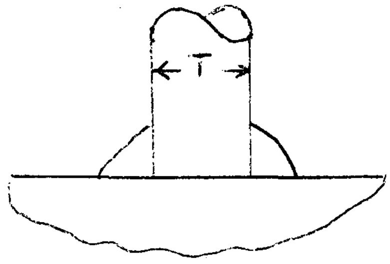
Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-SW-P-4 **Rev.:** 2 **Date:** 1-31-80

Joint Design:

This procedure covers any base material of Type 1 to any base material of Type 2 only.



JOINT DESIGN

Base Metal:

*Type 1	*Type 2	
A108 Grades 1010 to 1020	A240 or A666	Type 304, 304L, 316, or 316L

Welding Conditions:

Increment	-	-	-
Current	50-80	70-115	100-145
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	2 min.	3 min.	4 min.
Electrode Type	E309-15 or 16	E309-15 or 16	E309-15 or 16
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-		
Filler Metal Size	-		
Flux Type	-		
Flux Particle Size	-		
Shielding Gas	-		
Shielding Gas Flow Rate	-		
Purging Gas	-		
Purging Gas Flow Rate	-		
Gas Cup Size	-		
Gas Cup to Work Distance	-		
Contact Tube to Work Dist.	-		
Preheat	60°F min.		
Interpass Temperature	350°F max.		
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

Weld thickness shall not exceed 3/4-inch.
Tack weld stud to hold in position during welding.
Fillet weld size shall be T/2 minimum.

Reference documents: P.S.1.C.1.2, PQR SM18-B-1

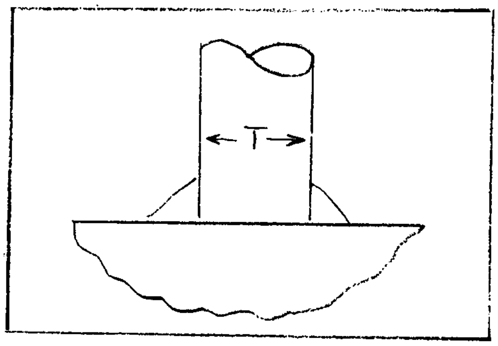
Prepared by: W.P. Joest

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-SW-P-5 Rev.: 0 Date: 1/27/81

Notes:
1. Tack weld stud to hold in position during welding.
2. Fillet wld size shall be T/2 minimum.



Materials

Base

A572, Gr 55, 60, 65

Stud

A108 Gr 1010-1020
Semi or fully killed

Welding Conditions:

Increment	-	-	-	-
Current	75-115	100-145	130-205	170-275
Pulse Rate	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP
Arc Voltage	23-27	23-27	23-27	23-27
Transfer Mode	-	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.	7 min.
Electrode Type	E7018	E7018	E7018	E7018
Electrode Size	3/32"*	1/8"*	5/32"	3/16"
Filler Metal Type				
Filler Metal Size	-			
Flux Type	-			
Flux Particle Size	-			
Shielding Gas	-			
Shielding Gas Flow Rate	-			
Purging Gas	-			
Purging Gas Flow Rate	-			
Gas Cup Size	-			
Gas Cup to Work Distance	-			
Contact Tube to Work Dist.	-			
Preheat →				
Interpass Temperature	400° F max			
Post Weld Heat Treatment	None			
Welding Position	F, H, V, OH			
Other				

Thickness	Min. Preheat
To 3/4"	50° F
Over 3/4" - 1-1/2"	150° F
Over 1-1/2" - 2-1/2"	225° F
Over 2-1/2"	300° F

*For use only on studs 7/16" or less in diameter.

Reference documents: P.S.1.C.1.2

Prepared by:

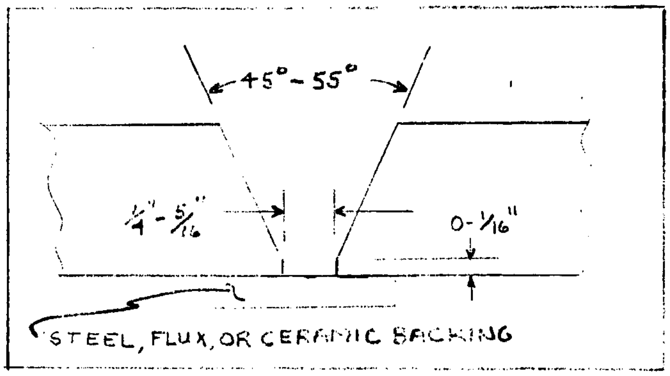
Approved by:

SMSWP.5

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-SA-U-1 Rev.: 0 Date: 3/5/81

Joint Design: Per Sketch



Base Metal:

ASTM Specifications

A36	A516
A53 Grade B	A529
A106 Grade B	A570
A242	A572 Gr 42,45,50
A441	A588
A500 Grade A&B	A606 TP 2 or TP 4
A501	A607 Gr 45,50,55

Welding Conditions:

Increment	Root	Root	Rem	Rem
Current	185-290	185-290	280-600	300-660
Pulse Rate	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP
Arc Voltage	25-29	25-29	28-39	28-39
Transfer Mode	Globular	Globular	-	-
Travel Speed (IPM)	4 min.	4 min.	7-20	7-20
Electrode Type	E70T-1	E70T-1	EM12K	EM12K
Electrode Size	.052"	1/16"	5/64"	3/32"
Filler Metal Type	-		-	
Filler Metal Size	-		-	
Flux Type	-		F72EM12K	
Flux Particle Size	-		-	
Shielding Gas	75A - 25CO$_2$		-	
Shielding Gas Flow Rate	30-40 CFH		-	
Purging Gas	-		-	
Purging Gas Flow Rate	-		-	
Gas Cup Size	3/4" max.		-	
Gas Cup to Work Distance	5/8" max.		-	
Contact Tube to Work Dist.	3/4" max.		1-1/2" max.	
Preheat →			Thickness	Min. Temp.
Interpass Temperature	500°F		Up to 3/4	50°F
Post Weld Heat Treatment	None		Over 3/4 to 1-1/2	150°F
Welding Position	F		Over 1-1/2 to 2-1/2	225°F
Other			Over 2-1/2	300°F

Note 1: When ceramic or flux backing is used, back side of weld must be examined to same requirements as the side from which welding is performed.

Reference documents: P.S.1.C.1.2 PQR GM-SA-U-1

Prepared by:

Approved by: C.E. Roberts

SMSAU.1

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-SD-P-1 Rev.: 3 Date: 2/24/81

Joint Design: Per Figure 1

BC-P2-GF
B-P3-GF
BTC-P4-GF
BTC-P5-GF
BC-P6-GF
B-P7-GF
BTC-P8-GF
BTC-P9-GF
SJ-P1-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-	-
Current	140-300	140-350
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	25-29	25-29
Transfer Mode	Globular	Globular
Travel Speed (IPM)	7 min	7 min
Electrode Type	E70S-3	E70S-3
Electrode Size	0.035	0.045
Filler Metal Type	-	
Filler Metal Size	-	
Flux Type	-	
Flux Particle Size	-	
Shielding Gas	CO_2	
Shielding Gas Flow Rate	23-35 CFH	
Purging Gas	-	
Purging Gas Flow Rate	-	
Gas Cup Size	3/4" max	
Gas Cup to Work Distance	5/8" max	
Contact Tube to Work Dist.	3/4" max	
Preheat		
Interpass Temperature	500° F max	
Post Weld Heat Treatment	None	
Welding Position	F, H, V, OH	
Other		

Thickness	Min. Temp.
Up to 3/4	None*
Over 3/4 to 1-1/2	70° F
Over 1-1/2 to 2-1/2	150° F
Over 2-1/2	225° F

*When base metal is below 32° F, preheat to 70° F and maintain during welding.

Reference Documents: P.S.1.C.1.2

Prepared by: C E Roberts

Approved by: W P Joest

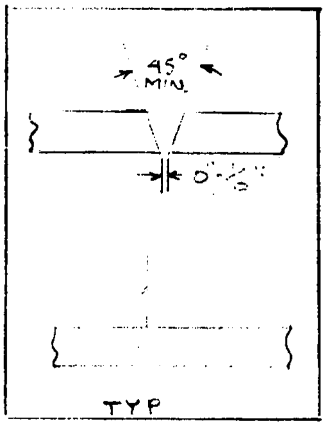
E31054.18

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-SD-P-2 Rev.: 2 Date: 9/3/81

Joint Design: Per sketch:

1. Base metal thickness or fillet weld size shall not exceed 1/4-inch.
2. Groove welds without backing or backgouging are considered partial penetration welds.
3. This procedure is applicable only to miscellaneous nonstructural welds.



Base Metal: ASTM Spec.

A36
A53
A106
A120
A500
A501
A570
A572 Grade 42, 45, & 50
A606 Type 2 or 4
A607 Grade 45, 50, & 55

Welding Conditions:

Increment	-
Current	80-160
Pulse Rate	-
Polarity	DCRP
Arc Voltage	17-22
Transfer Mode	short circuiting
Travel Speed (IPM)	4 min.
Electrode Type	E70S-3
Electrode Size	.035"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	CO_2
Shielding Gas Flow Rate	20-30 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	5/8" max.
Gas Cup to Work Distance	5/8" max.
Contact Tube to Work Dist.	5/8" max.
Preheat	None*
Interpass Temperature	500°F max.
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

*When base metal is below 32°F, preheat to 70°F, and maintain during welding.

Reference documents: P.S.1.C.1.2, PQR WS1133NR-1, GM11-0-6

Prepared by: J D White

Approved by: C.E. Roberts

GMSDP2

Detail Weld Procedure No.: GM-SD-L-1 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 2

B-L1a-GF
B-L1b-GF
TC-L1-GF

Base Metal:
ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A & B
A501
A516
A529
A570
A572 Gr 42, 45, & 50
A588
A606 TP 2 or TP 4
A607 Gr 45, 50, & 55

Welding Conditions:

Increment	-	-
Current	140-300	140-350
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	25-29	25-29
Transfer Mode	Globular	Globular
Travel Speed (IPM)	7 min.	7 min.
Electrode Type	E70S-3	E70S-3
Electrode Size	.035	.045
Filler Metal Type	-	
Filler Metal Size	-	
Flux Type	-	
Flux Particle Size	-	
Shielding Gas	CO_2	
Shielding Gas Flow Rate	25-35 CFH	
Purging Gas	-	
Purging Gas Flow Rate	-	
Gas Cup Size	3/4" max.	
Gas Cup to Work Distance	5/8" max.	
Contact Tube to Work Dist.	3/4" max.	
Preheat	None*	
Interpass Temperature	500°F	
Post Weld Heat Treatment	None	
Welding Position	F, H, V, OH	
Other		

*When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W.P. Jost

Approved by: Robert M. Isaacs

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-SD-U-1 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 2

B-U2a-GF
C-U2a
B-U2-GF
C-U2-GF
B-U3-GF
B-U4a-GF
TC-U4c-GF
B-U4-GF
TC-U4a-GF
TC-U4d-GF
TC-U4b-GF
B-U5-GF
TC-U5-GF
B-U6-GF
C-U6-GF
B-U7-GF
B-U8-GF
TC-U8a-GF
TC-U8b-GF
B-U9-GF
TC-U9a-GF
TC-U9b-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A & B
A501
A516
A529
A570
A572 Gr 42, 45, & 50
A588
A606 TP2 or TP4
A607 Gr. 45, 50, 55

Welding Conditions:

Increment	-	-
Current	140-300	140-350
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	25-29	25-29
Transfer Mode	Globular	Globular
Travel Speed (IPM)	7 min.	7 min.
Electrode Type	E70S-3	E70S-3
Electrode Size	.035	.045
Filler Metal Type	-	
Filler Metal Size	-	
Flux Type	-	
Flux Particle Size	-	
Shielding Gas	CO_2	
Shielding Gas Flow Rate	25-35 CFH	
Purging Gas	-	
Purging Gas Flow Rate	-	
Gas Cup Size	3/4" max.	
Gas Cup to Work Distance	5/8" max.	
Contact Tube to Work Dist.	3/4" max.	
Preheat →		
Interpass Temperature	500°F max.	
Post Weld Heat Treatment	None	
Welding Position	F, H, V, OH	
Other		

Thickness	Min. Temp.
Up to 3/4	None*
Over 3/4 to 1-1/2	70°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Jost

Approved by: Robert M. Isaacs

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-SD-U-2 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Per Figure 2

B-U2a-GF
C-U2a-GF
B-U2-GF
C-U2-GF
B-U3-GF
B-U4a-GF
TC-U4c-GF
B-U4-GF
TC-U4a-GF
TC-U4d-GF
TC-U4b-GF
B-U5-GF
TC-U5-GF
B-U6-GF
C-U6-GF
B-U7-GF
B-U8-GF
TC-U8a-GF
TC-U8b-GF
B-U9-GF
TC-U9a-GF
TC-U9b-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A & B
A501
A516
A529
A570
A572 Gr 42, 45, & 50
A588
A606 TP 2 or TP 4
A607 Gr 45, 50, & 55

Welding Conditions:

Increment	-
Current	140-300
Pulse Rate	-
Polarity	DCRP
Arc Voltage	25-29
Transfer Mode	Globular
Travel Speed (IPM)	7 min.
Electrode Type	E70S-3
Electrode Size	.035
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	75A -25CO$_2$
Shielding Gas Flow Rate	25-35 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/4" max.
Gas Cup to Work Distance	5/8" max.
Contact Tube to Work Dist.	3/4" max.
Preheat →	
Interpass Temperature	500°F
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

Thickness	Min. Temp.
Up to 3/4	None*
Over 3/4 to 1-1/2	70°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Joest

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-FC-P-1 Rev.: 4 Date: 2/24/81

Joint Design: Per Figure 1

BC-P2-GF
B-P3-GF
BTC-P4-GF
BTC-P5-GF
BC-P6-GF
B-P7-GF
BTC-P8-GF
BTC-P9-GF
SJ-P1-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-	-	-	-	-
Current	160-275	225-325	250-350	325-425	425-625
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	24-30	24-30	25-30	25-30	25-30
Transfer Mode	Globular	Globular	Globular	Globular	Globular
Travel Speed (IPM)	7 min	7 min	7 min	9 min	13 min
Electrode Type	E70T-1	E70T-1	E70T-1	E70T-1	E70T-1
Electrode Size	0.052"	1/16"	5/64"	3/32"	1/8"

Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	CO_2
Shielding Gas Flow Rate	30-40 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/4" max
Gas Cup to Work Distance	5/8" max
Contact Tube to Work Dist.	3/4" max

Preheat		Thickness	Min. Temp.
Interpass Temperature	500° F	Up to 3/4	None**
Post Weld Heat Treatment	None	Over 3/4 to 1-1/2	70° F
Welding Position	F, H, V*, OH*	Over 1-1/2 to 2-1/2	150° F
Other		Over 2-1/2	225° F

*0.052 and 1/16" electrodes only
**When base metal is below 32° F, preheat to 70° F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: C E Roberts

Approved by: W. P. Joest

E31054.18

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-FC-P-2 Rev.: 2 Date: 2/24/81

Joint Design: Per Figure 1

BC-P2-GF
B-P3-GF
BTC-P4-GF
BTC-P5-GF
BC-P6-GF
B-P7-GF
BTC-P8-GF
BTC-P9-GF
SJ-P1-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-
Current	140-300
Pulse Rate	-
Polarity	DCRP
Arc Voltage	22-28
Transfer Mode	Globular
Travel Speed (IPM)	7 min
Electrode Type	E70T-1 (all position electrode)
Electrode Size	0.052"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	75A - 25 CO_2
Shielding Gas Flow Rate	30-40 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/4" max
Gas Cup to Work Distance	5/8" max
Contact Tube to Work Dist.	3/4" max
Preheat	
Interpass Temperature	500° F max
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

Thickness	Min. Temp.
Up to 3/4	None*
Over 3/4 to 1-1/2	50° F
Over 1-1/2 to 2-1/2	150° F
Over 2-1/2	225° F

*When base metal is below 32° F, preheat to 70° F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: C. E. Roberts

Approved by: W. P. Jost

E31054.18

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-FC-L-1 **Rev.:** 3 **Date:** 1-31-80

Joint Design: Per Figure 2

B-L1a-GF
B-11b-GF
TC-L1-GF

Base Metal: ASTM Specifications

A36	A516
A53 Grade B	A529
A106 Grade B	A570
A242	A572 Gr,42,45,50
A441	A588
A500 Grade A&B	A606 TP 2 or TP 4
A501	A607 Gr 45,50,55

Welding Conditions:

Increment	-	-	-	-	-
Current	160-275	225-325	250-350	325-425	425-625
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	24-30	24-30	25-30	25-30	25-30
Transfer Mode	Globular	Globular	Globular	Globular	Globular
Travel Speed (IPM)	7 min.	7 min.	7 min.	9 min.	13 min.
Electrode Type	E70T-1	E70T-1	E70T-1	E70T-1	E70T-1
Electrode Size	.052"	1/16"	5/64"	3/32"	1/8"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	CO_2				
Shielding Gas Flow Rate	30-40 CFH				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	3/4" max.				
Gas Cup to Work Distance	5/8" max.				
Contact Tube to Work Dist.	3/4" max.				
Preheat →					
Interpass Temperature	500°F max.				
Post Weld Heat Treatment	None				
Welding Position	F,H,V*,OH*				
Other					

Thickness	Min. Temp.
Up to 3/4"	None**
Over 3/4 to 1-1/2	70°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*.052" and 1/16" electrodes
**When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W.P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-FC-L-2 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Per Figure 2

B-L1a-GF
B-L1b-GF
TC-L1-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501

A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-
Current	140-300
Pulse Rate	-
Polarity	DCRP
Arc Voltage	22-28
Transfer Mode	Globular
Travel Speed (IPM)	7 min.
Electrode Type	E70T-1 (all position electrode)
Electrode Size	.052"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	75A -25C_2
Shielding Gas Flow Rate	30-40 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/4" max.
Gas Cup to Work Distance	5/8" max.
Contact Tube to Work Dist.	3/4" max.
Preheat →	
Interpass Temperature	500°F max.
Post Weld Heat Treatment	None
Welding Position	F,H,V,OH
Other	

Thickness	Min. Temp.
Up to 3/4	None*
Over 3/4 to 1-1/2	50°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W.P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-FC-U-1 **Rev.:** 3 **Date:** 1-31-80

Joint Design: Per Figure 2

B-U2a-GF
C-U2a-GF
B-U2-GF
C-U2-GF
B-U3-GF
B-U4a-GF
TC-U4c-GF
B-U4-GF
TC-U4a-GF
TC-U4d-GF
TC-U4b-GF
B-U5-GF
TC-U5-GF
B-U6-GF
C-U6-GF
B-U7-GF
B-U8-GF
TC-U8a-GF
TC-U8b-GF
B-U9-GF
TC-U9a-GF
TC-U9b-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-	-	-	-	-
Current	160-275	225-325	250-350	325-425	425-625
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	24-30	24-30	25-30	25-30	25-30
Transfer Mode	Globular	Globular	Globular	Globular	Globular
Travel Speed (IPM)	7 min.	7 min.	7 min.	9 min.	13 min.
Electrode Type	E70T-1	E70T-1	E70T-1	E70T-1	E70T-1
Electrode Size	.052"	1/16"	5/64"	3/32"	1/8"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	CO_2				
Shielding Gas Flow Rate	30-40 CFH				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	3/4" max.				
Gas Cup to Work Distance	5/8" max.				
Contact Tube to Work Dist.	3/4" max.				
Preheat →					
Interpass Temperature	500°F max.				
Post Weld Heat Treatment	None				
Welding Position	F,H,V*,OH*				
Other					

Thickness	Min. Temp.
Up to 3/4"	None**
Over 3/4 to 1-1/2	70°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*.052" and 1/16" electrodes only
**When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W.P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-FC-U-2 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 2

B-U2a-GF
C-U2a-GF
B-U2-GF
C-U2-GF
B-U3-GF
B-U4a-GF
TC-U4c-GF
B-U4-GF
TC-U4a-GF
TC-U4d-GF
TC-U4b-GF
B-U5-GF
TC-U5-GF
B-U6-6F
C-U6-GF
B-U7-GF
B-U8-GF
TC-U8a-GF
TC-U8b-GF
B-U9-GF
TC-U9a-GF
TC-U9b-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-	-
Current	140-230	150-250
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	22-28	22-28
Transfer Mode	Globular	Globular
Travel Speed (IPM)	7 min.	7 min.
Electrode Type *	E70T-1	E70T-1
Electrode Size	.052"	1/16"
Filler Metal Type	-	
Filler Metal Size	-	
Flux Type	-	
Flux Particle Size	-	
Shielding Gas	75A -25CO_2	
Shielding Gas Flow Rate	30-40 CFH	
Purging Gas	-	
Purging Gas Flow Rate	-	
Gas Cup Size	3/4" max.	
Gas Cup to Work Distance	5/8" max.	
Contact Tube to Work Dist.	3/4" max.	
Preheat →		
Interpass Temperature	500°F max.	
Post Weld Heat Treatment	None	
Welding Position	F,H,V,OH	
Other		

Thickness	Min. Temp.
Up to 3/4	None**
Over 3/4 to 1-1/2	50°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*All position electrode
**When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W.P. Jost

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-FC-U-2A Rev.: 4 Date: July 1, 1981

Joint Design: Per Figure 2

B-U2a-GF
C-U2a-GF
B-U2-GF
C-U2-GF
B-U3-GF
B-U4a-GF
TC-U4c-GF
B-U4-GF
TC-U4a-GF
TC-U4d-GF
TC-U4b-GF
B-U5-GF
TC-U5-GF
B-U6-GF
C-U6-GF
B-U7-GF
B-U8-GF
TC-U8a-GF
TC-U8b-GF
B-U9-GF
TC-U9a-GF
TC-U9b-GF

Base Metal: Type and Grade

A572 Gr 55 To

A36
A53 Gr B
A106 Gr B
A242
A441
A500 Gr A & B
A501
A516
A529
A570
A572 Gr 42 - 55
A588
A606 TP2 or TP4
A607 Gr 45, 50, 55

Welding Conditions:

Increment	-	-
Current	140-300	140-300
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	22-28	22-28
Transfer Mode	Globular	Globular
Travel Speed (IPM)	7 min	7 min
Electrode Type	E70T-1*	E70T-1*
Electrode Size	0.052"	1/16"
Filler Metal Type	-	
Filler Metal Size	-	
Flux Type	-	
Flux Particle Size	-	
Shielding Gas	75A-25CO_2	
Shielding Gas Flow Rate	30-40 CFH	
Purging Gas	-	
Purging Gas Flow Rate	-	
Gas Cup Size	3/4" max	
Gas Cup to Work Distance	5/8" max	
Contact Tube to Work Dist.	3/4" max	
Preheat		
Interpass Temperature	500° F max.	
Post Weld Heat Treatment	None	
Welding Position	F, H, V, OH	
Other		

Thickness	Min. Temp.
Up to 3/4"	50° F
Over 3/4 to 1-1/2"	150° F
Over 1-1/2 to 2-1/2"	225° F
Over 2-1/2"	300° F

* With all-position capability

Reference documents: P.S.1.C.1.2

Prepared by:

Approved by:

GMFCU.2A

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM-FC-U-3 **Rev.:** 1 **Date:** 1-31-80

Joint Design: Per Figure 2 and Note 1

B-U2a-GF
C-U2a-GF
B-U2-GF
C-U2-GF
B-U3-GF
B-U4a-GF
TC-U4c-GF
B-U4-GF
TC-U4a-GF
TC-U4d-GF
TC-U4b-GF
B-U5-GF
TC-U5-GF
B-U6-GF
C-U6-GF
B-U7-GF
B-U8-GF
TC-U8a-GF
TC-U8b-GF
B-U9-GF
TC-U9a-GF
TC-U9b-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-
Current	200-250
Pulse Rate	-
Polarity	DCRP
Arc Voltage	20-22
Transfer Mode	Gobular
Travel Speed (IPM)	6 min.
Electrode Type	E70T-G*
Electrode Size	5/64"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup to Work Distance	-
Contact Tube to Work Dist.	-
Preheat	None**
Interpass Temperature	500°F max.
Post Weld Heat Treatment	None
Welding Position	F,H,V,OH
Other	

Note 1. This procedure is limited to a maximum of 3/4" weld thickness.

*Innershield or equivalent
**When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GMA-FC-P-1 **Rev.:** 3 **Date:** 1-31-80

Joint Design: Per Figure 1

BC-P2-GF
B-P3-GF
BTC-P4-GF
BTC-P5-GF
BC-P6-GF
B-P7-GF
BTC-P8-GF
BTC-P9-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP4
A607 Gr 45,50,55

Welding Conditions:

Increment	-	-	-	-	-
Current	140-300	225-325	250-350	325-425	425-625
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	22-28	24-30	25-30	25-30	25-30
Transfer Mode	Globular	Globular	Globular	Globular	Globular
Travel Speed (IPM)	7 min.	7 min.	7 min.	9 min.	13 min.
Electrode Type	E70T-1	E70T-1	E70T-1	E70T-1	E70T-1
Electrode Size	.052"	1/16"	5/64"	3/32"	1/8"

Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	CO_2
Shielding Gas Flow Rate	30-40 CFH***
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/4" max.
Gas Cup to Work Distance	5/8" max.
Contact Tube to Work Dist.	3/4" max.
Preheat	→
Interpass Temperature	500°F max.
Post Weld Heat Treatment	None
Welding Position	F,H,V*,OH*
Other	

Oscillation	Data
Width	0-5/8"
Frequency	0-115 cpm
Dwell	0-0.5 sec.

Thickness	Min. Temp.
Up to 3/4	None**
Over 3/4 to 1-1/2	70°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*.052" and 1/16" electrodes only

**When base metal is below 32°F, preheat to 70°F and maintain during welding.

***30 CFH min. for side delivery cup

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Jest

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GMA-FC-U-1 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 2

B-U2a-GF
C-U2a-GF
B-U2-GF
C-U2-GF
B-U3-GF
B-U4a-GF
TC-U4c-GF
B-U4-GF
TC-U4a-GF
TC-U4d-GF
TC-U4b-GF
B-U5-GF
TC-U5-GF
B-U6-GF
C-U6-GF
B-U7-GF
B-U8-GF
TC-U8a-GF
TC-U8b-GF
B-U9-GF
TC-U9a-GF
TC-U9b-GF

Base Metal: ASTM Specifications

A36
A53 Grade B
A106 Grade B
A242
A441
A500 Grade A&B
A501
A516
A529
A570
A572 Gr 42,45,50
A588
A606 TP 2 or TP 4
A607 Gr 45,50,55

Welding Conditions:

Increment	-	-	-	-	-
Current	140-300	225-325	250-350	325-425	425-625
Pulse Rate	-	-	-	-	-
Polarity	DCRP	DCRP	DCRP	DCRP	DCRP
Arc Voltage	22-28	24-30	25-30	25-30	25-30
Transfer Mode	Globular	Globular	Globular	Globular	Globular
Travel Speed (IPM)	7 min.	7 min.	7 min.	9 min.	13 min.
Electrode Type	E70T-1	E70T-1	E70T-1	E70T-1	E70T-1
Electrode Size	.052"	1/16"	5/64"	3/32"	1/8"
Filler Metal Type	-				
Filler Metal Size	-				
Flux Type	-				
Flux Particle Size	-				
Shielding Gas	CO_2				
Shielding Gas Flow Rate	30-40 CFH				
Purging Gas	-				
Purging Gas Flow Rate	-				
Gas Cup Size	3/4" max.				
Gas Cup to Work Distance	5/8" max.				
Contact Tube to Work Dist.	3/4" max.				
Preheat					
Interpass Temperature	500°F max.				
Post Weld Heat Treatment	None				
Welding Position	F,H,V*,OH*				
Other					

Oscillation	Data
Width	0-5/8"
Frequency	0-115 cpm
Dwell	0-0.5 sec.

Thickness	Min. Temp.
Up to 3/4	None**
Over 3/4 to 1-1/2	70°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*.052" and 1/16" electrodes
**When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GMA-FC-U-2 **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 2

- B-U2a-GF
- C-U2a-GF
- B-U2-GF
- C-U2-GF
- B-U3-GF
- B-U4a-GF
- TC-U4c-GF
- B-U4-GF
- TC-U4a-GF
- TC-U4d-GF
- TC-U4b-GF
- B-U5-GF
- TC-U5-GF
- B-U6-GF
- C-U6-GF
- B-U7-GF
- B-U8-GF
- TC-U8a-GF
- TC-U8b-GF
- B-U9-GF
- TC-U9a-GF
- TC-U9b-GF

Base Metal: ASTM Specifications

- A36
- A53 Grade B
- A106 Grade B
- A242
- A441
- A500 Grade A&B
- A501
- A516
- A529
- A570
- A572 Gr 42,45,50
- A588
- A606 TP 2 or TP 4
- A607 Grade 45,50,55

Welding Conditions:

Increment	-
Current	170-240
Pulse Rate	-
Polarity	DCRP
Arc Voltage	22-28
Transfer Mode	Globular
Travel Speed (IPM)	7 min.
Electrode Type	E70T-1 (all position electrode)
Electrode Size	.052"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	75A -25CO_2
Shielding Gas Flow Rate	30-50 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/4" max.
Gas Cup to Work Distance	5/8" max.
Contact Tube to Work Dist.	3/4" max.
Preheat →	
Interpass Temperature	500°F max.
Post Weld Heat Treatment	None
Welding Position	F,H,V,OH
Other	

Oscillation	Data
Width	0.5/8"
Frequency	0-115 cpm
Dwell	0-0.5 sec.

Thickness	Min. Temp.
Up to 3/4	None*
Over 3/4 to 1-1/2	50°F
Over 1-1/2 to 2-1/2	150°F
Over 2-1/2	225°F

*When base metal is below 32°F, preheat to 70°F and maintain during welding.

Reference documents: P.S.1.C.1.2

Prepared by: W. P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GMA-FC-U-2A **Rev.:** 2 **Date:** 1-31-80

Joint Design: Per Figure 2

Base Metal: ASTM Specifications

A572 Grade 55

B-U2a-GF
C-U2a-GF
B-U2-GF
C-U2-GF
B-U3-GF
B-U4a-GF
TC-U4c-GF
B-U4-GF
TC-U4a-GF
TC-U4d-GF
TC-U4b-GF
B-U5-GF
TC-U5-GF
B-U6-GF
C-U6-GF
B-U7-GF
B-U8-GF
TC-U8a-GF
TC-U8b-GF
B-U9-GF
TC-U9a-GF
TC-U9b-GF

Welding Conditions:

Increment	-
Current	175-240
Pulse Rate	-
Polarity	DCRP
Arc Voltage	22-28
Transfer Mode	Globular
Travel Speed (IPM)	7 min.
Electrode Type	E70T-1 (all position electrode)
Electrode Size	.052"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	75A -25CO_2
Shielding Gas Flow Rate	30-50 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/4" max.
Gas Cup to Work Distance	5/8" max.
Contact Tube to Work Dist.	3/4" max.
Preheat →	
Interpass Temperature	500°F max.
Post Weld Heat Treatment	None
Welding Position	F,H.V,OH
Other	

Oscilliation	Date
Width	0-5/8"
Frequency	0-115 cpm
Dwell	0-0.5 sec.

Thickness	Min. Temp.
Up to 3/4	50°F
Over 3/4 to 1-1/2	150°F
Over 1-1/2 to 2-1/2	225°F
Over 2-1/2	300°F

Reference documents: P.S.1.C.1.2

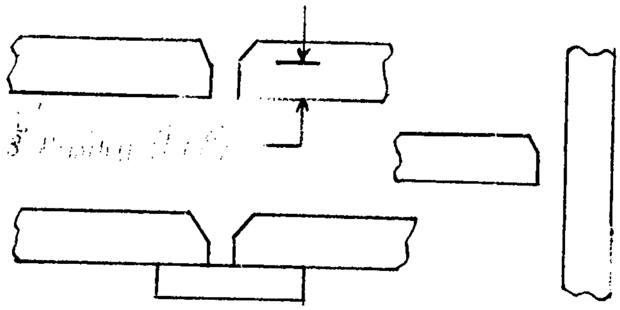
Prepared by: W.P. Jost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT-P-1 Rev.: 2 Date: 6/1/81
For handrail welding

Joint Design:



Base Metal:
A36
A53
A106
A500
A501
A120

Welding Conditions:

Layer No.	All
Current	60-130
Polarity	DCSP
Arc Voltage	10-14
Travel Speed (IPM)	3/4 IPM min
Electrode Type	E WTH-2
Electrode Size	3/32"
Filler Metal Type	E70S-6 or E70S-3
Filler Metal Size	1/16", 3/32", or 1/8"
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	15-25 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	1/2" max
Gas Cup to Work Distance	1/2" max
Preheat	None
Interpass Temperature	500° F max
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

Welders shall be qualified to test GT-6-0-1-L or GT-6-0-1/2-40 of G-29M.

Reference documents: 1.C.1.2, PQR GT11-0-1

Prepared by:

Approved by: C.E. Roberts

GTP1

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: AW-SW-P-1 Rev.: 3 Date: 9/5/80

Note 1:
Remove Arc shield after weld is completed.

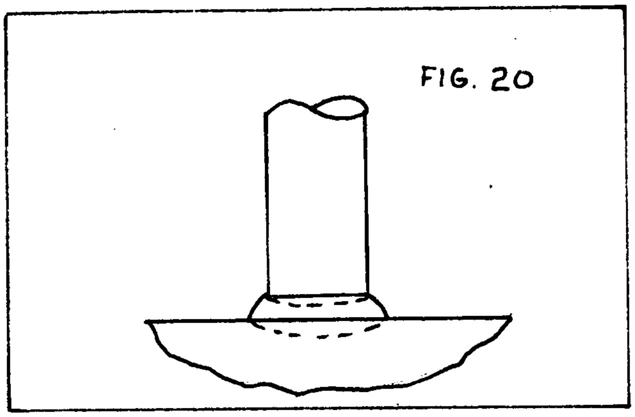


FIG. 20

Materials

Base	Stud
A36	A 108 Gr
A53, Gr B	1010
A242	1015
A106, Gr B	1017
A441	1020
A500	Semi or
A501	Fully
A514	Killed
A529	
A570, Gr D, E	
A572	
A588	
A516	
A108 Studs	

Welding Conditions:

Stud Dia.	Current* (Amps)	Time* (Cycles)	Lift ± 1/32" (Arc Length)	Plunge (Burn-Off)	Total Travel
3/16"	300	7	1/16"	1/8"	3/16"
1/4"	400	10	1/16"	1/8"	3/16"
5/16"	500	15	1/16"	1/8"	3/16"
3/8"	600	15	1/16"	1/8"	3/16"
7/16"	700	25	1/16"	1/8"	3/16"
1/2"	900	30	3/32"	5/32"	1/4"
5/8"	1200	40	3/32"	5/32"	1/4"
3/4"	1600-1800	50-70	1/8"	3/16"-5/16"	5/16"-7/16"
7/8"	1800-2000	60-80	1/8"	3/16"-5/16"	5/16"-7/16"
1"	2000-2200	70-90	1/8"	3/16"-5/16"	5/16"-7/16"

* ± 10%

Preheat	0° F min. For temperature below 32° F, see section 16.8 of P.S. 1.C.1.2
Interpass Temperature	-
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

Reference documents: P.S. 1.C.1.2

Prepared by:

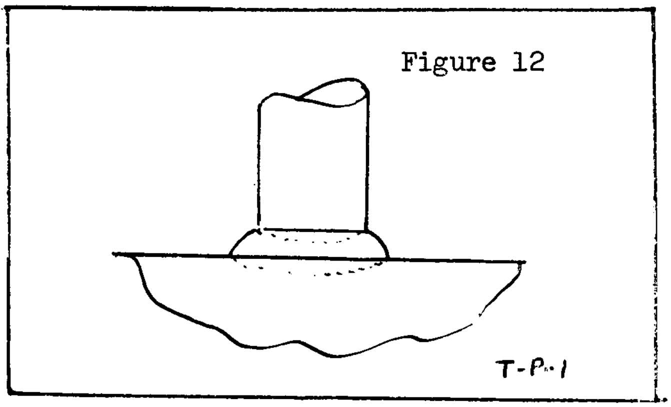
Approved by:

E30249.12

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: AW-SW-P-2 Rev.: 0 Date.: 7-31-74

Note 1.
Remove arc shield after weld is completed.



WELD JOINT DESIGN

Materials

Base	Stud
304 SS	304 SS
316 SS	

Welding Conditions:

Stud Dia.	Current* (Amps)	Time* (Cycles)	Left (Arc Length)	Plunge (Burn-off)	Total Travel
3/16"	300	7	1/16"	1/8"	3/16"
1/4"	400	10	1/16"	1/8"	3/16"
5/16"	500	15	1/16"	1/8"	3/16"
3/8"	600	15	1/16"	1/8"	3/16"
7/16"	700	25	1/16"	1/8"	3/16"
1/2"	900	30	3/32"	5/32"	1/4"
5/8"	1200	40	3/32"	5/32"	1/4"
3/4"	1600	50	1/8"	3/16"	5/16"
7/8"	1800	70	1/8"	3/16"	5/16"
1"	2000	70	1/8"	3/16"	5/16"

Preheat	32° F Min.
Interpass Temp.	-
Post Weld Heat Treatment	None
Welding Position	F,H,V,OH
Other	

*±10%

Reference documents: P.S.1.C.1.2(a)

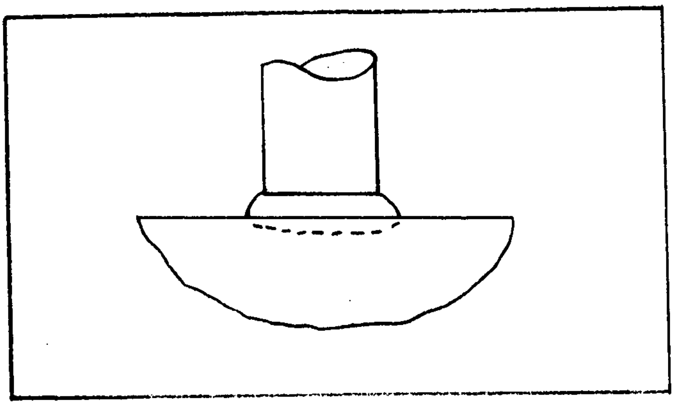
Prepared by: Robert M. Jessee

Approved by:

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: AW-SW-P-3 Rev.: 2 Date: 6/1/81

Note 1: Remove arc shield after weld is completed.



Materials

Base	Stud
304 SS	A-108 Gr
304L SS	1010
316 SS	1015
	1020
	Semi or Fully Killed

Welding Conditions:

Stud Dia.	Current* (Amps)	Time* (Cycles/Sec)	Lift (Arc Length ± 1/32)	Plunge (Burn-Off ± 1/32)	Total Travel ± 1/32
3/16"	300	7/.12	1/16"	1/8"	3/16"
1/4"	400	10/.16	1/16"	1/8"	3/16"
5/16"	500	15/.25	1/16"	1/8"	3/16"
3/8"	600	20/.33	1/16"	1/8"	3/16"
7/16"	700	25/.41	1/16"	1/8"	3/16"
1/2"	900	30/.50	3/32"	5/32"	1/4"
5/8"	1200	40/.63	3/32"	5/32"	1/4"
3/4"	1600	50/.73	1/8"	3/16"	5/16"
7/8"	1800	72/1.20	1/8"	3/16"	5/16"
1"	2000	75/1.30	1/8"	3/16"	5/16"

Polarity	Straight (Stud Negative)
Preheat	32° F min
Interpass Temperature	None
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

*± 10%

Reference Documents: P.S. 1.C.1.2(a) PQR (Herron-1974-19)

Prepared by: L D White

Approved by: C E Roberts

AWSWP3

TVA 10565A (DED-6-74)

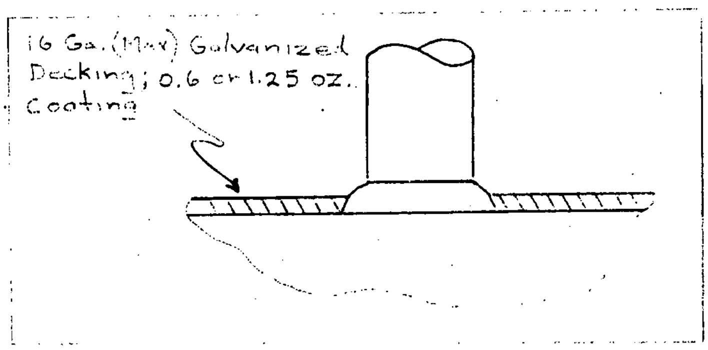
TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: AW-SW-P-4 **Rev.:** 2 **Date:** August 2, 1979

Joint Design:

Note 1. Remove arc shield after weld is completed.

Note 2. Decking to be in firm contact with backing structure.



Base Metal:

Base	Stud
A 36	A-108 Gr
A 53 Gr B	1010
A 242	1015
A 106 Gr B	1017
A 441	1020
A 500	Semi or
A 514	fully
A 529	killed
A 570	
A 572	
A 588	
A 516	

Welding Conditions: (Unless noted, parameters specified are applicable to 0.6 ounce or 1.25 ounce galvanized coatings)

Stud Dia.	Current* (Amps)	Time* (Cycles)	Lift (Arc Length)	Plunge (Burn-Off)	Total Travel
1/2"	1100	40	3/32"	1/2"	19/32"
5/8"	1500	55	3/32"	1/2"	19/32"
3/4"	2000	65 (Note 3)	1/8"	1/2"	5/8"
7/8"	2200	75	1/8"	1/2"	5/8"
1"	2500	85	1/8"	1/2"	5/8"

Note 3. 96 cycles* for 1.2 ounce coatings.

Preheat	32 F Min.
Interpass Temp.	-
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

*±10%

Reference documents: P.S.1.C.1.2

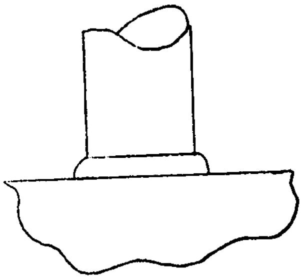
Prepared by: J Dewhite

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: AW-SW-P-5 Rev.: 1. Date: 10/5/81

Figure 20



WELD JOINT DESIGN T-P-1

Materials

Base	Stud **
A 36	304 SS
A 53 Gr B	309 SS
A 242	
A 106 Gr B	
A 441	
A 500	
A 501	
A 514	
A 529	
A 570 Gr D, E	
A 572	
A 588	
A 516	

Welding Conditions:

Stud Dia.	Current* (Amps)	Time* (Cycles/Sec)	Lift (Arc Length)	Plunge (Burn-Off)	Total Travel
1/4"	450	18/.3	1/16"	1/8"	3/16"
3/8"	710	26/.43	1/16"	3/16"	1/4"
1/2"	1000	36/.6	3/32"	3/16"	9/32"
5/8"	1350	48/.8	3/32"	3/16"	9/32"

Preheat	32° F min
Interpass Temp.	-
Post Weld Heat Treatment	None
Welding Position	F.H.V.OH
Other	

*± 10%

**Annealed studs shall be used.

Reference Documents: P.S. 1.C.1.2(a); Herron J3003, J3003A, J3003B, and J3003C

Prepared by:

Approved by: C E Roberts

AWSWP5

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: July 29, 1980 W. P. Q. R. No. SA-U-2

Welding Process: Submerged Arc Manual Semi-Automatic [✓ Automatic]

Mtl. Type and Spec. A36 To A36 P-No. 1 To P-No. 1

Thickness (and Dia. if Pipe) 2" thick plate Thickness Range Qualified unlimited Thru

WELDING MATERIALS

Filler Metal F-No. A-No.
Electrode F-No. 6 A-No. 1
Spec. or Analysis: SFA 5.17 Ty EM12K

Flux: F72-EM12K
Other Additives:

WELDING PROCEDURE

Position Qualified: Flat (G)
Qualifying For: Flat
Single or Multiple Pass: Multiple
Number of Arcs: Single
Preheat Temp. 60° F min
Interpass Temp. 500° F max
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: Hobart HB-20 wire
Hobart H700 Flux

Type Current: DCRP
Joint Configuration: Double Vee

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
1	5/64"	275	32	12
2	5/64"	440-460	35	10
3-5	5/64"	480-550	35	10
6-14	5/64"	275-480	33-35	10-15

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
	Width	Thickness				
Round	0.5025	-	0.198	13,700	69,200	Ductile-BM
Round	0.5041	-	0.199	13,900	69,800	"
Round	0.5013	-	0.197	13,800	70,100	"
Round	0.4988	-	0.195	13,900	71,300	"

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	1G1	Acceptable
Side	1G2	Acceptable
Side	1G3	Acceptable
Side	1G4	Acceptable

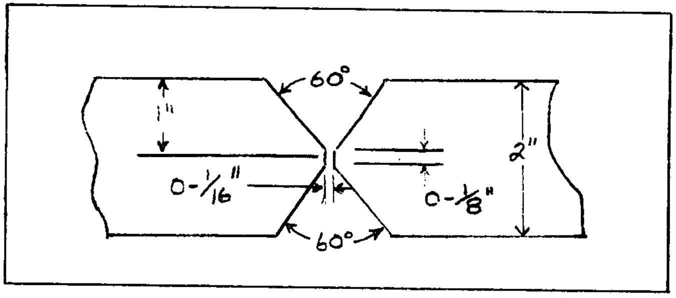
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic		Weld Acceptable

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Hartsville Nuclear Plant
Welder T. F. Reischman Symbol IADI
Test No.: WPQT-80-16
Testing Lab Singleton Materials Engineering Lab.

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the ~~ASME~~ AWS Code.

By Walter P. Joest

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: June 26 1981

WPQR No. SA-U-5

DWP No. SA-U-5 Rev. 0

Welding Process: Submerged Arc Manual Semiautomatic [✓ Automatic]

Mtl. Type and Spec. A572 Gr 55 To A572 Gr 55 P-No. NA To P-No. NA

Thickness (and Dia. if Pipe) Plate 1-1/4 inch Thickness Range Qualified 3/16" - U

WELDING MATERIALS

Filler Metal F-No. A-No.

Electrode F-No. 6 A-No. 1

Spec. or Analysis: SFA-5.17 EM12K

Flux: F72-EM12K

Other Additives:

WELDING PROCEDURE

Position Qualified: Flat 1(G)

Qualifying For:

Single or Multiple Pass: Multiple

Number of Arcs: One

Preheat Temp. 70° F min

Interpass Temp. 500° F min

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls. Lincoln L-61 Electrode with 860 Flux

Type Current: DCRP

Joint Configuration: Single Bevel See sketch below

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (In/Min)
1-3	3/32	400	32	12-14
Rem	3/32	425	32.5	16-22

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Spec. No.	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character and Location of Failure
		Width	Thickness				
Trans	P73	0.9975	1.1205	1.118	86,400	77,300	Ductile (Wm)
Trans	P74	0.9946	1.1201	1.114	85,000	76,300	Ductile (Wm)

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	P161	Acceptable
Side	P162	Acceptable
Side	P163	Acceptable
Side	P164	Acceptable

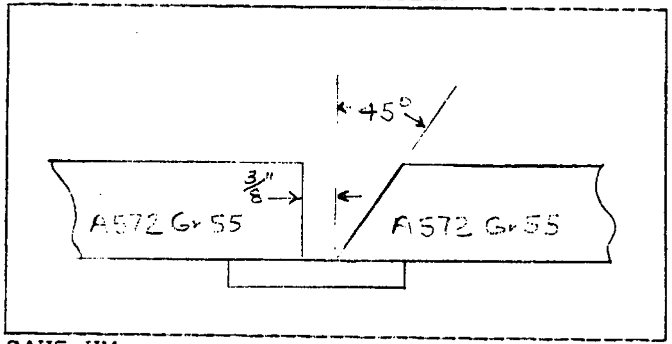
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic	Final	Acceptable
(with backing removed)		

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



SAU5.HM

Dept. Conducting Test QC - Welding PBN

Welder Haskel A. McClain Symbol I-028

Testing No. WPQT-81-25

Testing Lab. Singleton Materials Eng. Lab.

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

BY

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: 2/24/81
WPQR No. SM-P-1
DWP No.
Welding Process: Shielded Metal - Arc Manual Semiautomatic Automatic
Mtl. Type and Spec. A-36 To A-36 S-No. To P-No.
Thickness (and Dia. if Pipe) 3/8" Plate Thickness Range Qualified Unlimited

WELDING MATERIALS

Filler Metal F-No. 1 A-No. 4
Electrode F-No. A-No.
Spec. or Analysis: SFA 5.1, E7018
Flux:
Other Additives:

WELDING PROCEDURE

Position Qualified: F, H, V, OH (G)
Qualifying For: All Positions
Single of Multiple Pass: Multipass
Number of Arcs: One
Preheat Temp. 60° F
Interpass Temp. 500° F
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

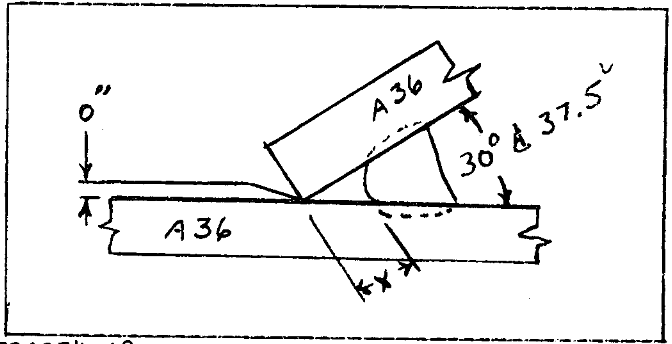
Trade Name Filler Mtls.
Type Current: DCRP
Joint Configuration: 30° and 37.5° Vee, Zero root opening

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Position
All	1/8	110-135	23-24	F,H,V,OH

Macrosections were examined per AWS D1.1, Section 5.0, and showed a maximum lack of penetration at the root of the welds as follows:

Number of Macros	Welding Position	Included Angle	Lack of Penetration (X)
6	Flat	30°	1/4"
6	Horizontal	30°	5/16"
6	Vertical	30°	5/16"
6	Overhead	30°	5/16"
6	Flat	37.5°	3/16"
6	Horizontal	37.5°	1/4"
6	Vertical	37.5°	1/4"
6	Overhead	37.5°	1/4"

WELD JOINT DESIGN



Dept. Conducting Test Bellefonte Nuclear Plt.
Welder B. Dawson Symbol FADY
Testing No.
Testing Lab. Bellefonte Nuclear Plant

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS D1.1.

BY C.E. Roberts

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: June 11, 1976 W. P. Q. R. No. SM-P-6

Welding Process: Shielded Metal Arc [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A533 Gr B, Cl. 1 To A533 Gr. B, Cl. 1 P-No. 3 To P-No. 3

Thickness (and Dia. if Pipe) 6 Thickness Range Qualified 3/16" Thru Unlimited

WELDING MATERIALS

Filler Metal F-No. NA A-No.

Electrode F-No. 4 A-No. -

Spec. or Analysis: E8018-C3

Flux: None

Other Additives: None

WELDING PROCEDURE

Position Qualified: Horizontal 2 (G)

Qualifying For: Horizontal

Single or Multiple Pass: Multiple

Number of Arcs: One

Preheat Temp. 300° Min.

Interpass Temp. 400° Max.

Post Weld Heat Treatment: 400°-500° for 6 hours immediately after welding. (No testing was performed for 72 hours minimum after low temperature heat treatment)

Trade Name Filler Mtls: Lincoln E8018 C3

Type Current: DCRP

Joint Configuration: Single V

FOR INFORMATION ONLY

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
1	1/8"	100-130	24	-
REM	5/32"	130-160	25	-

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
	Width	Thickness				
Transverse					84,400	Outside Weld
Transverse					83,000	Outside Weld

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	S1	Acceptable
Side	S2	Acceptable
Side	S3	Acceptable
Side	S4	Acceptable

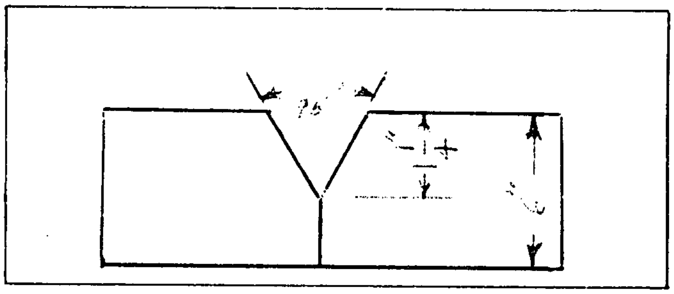
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic		

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear
Weld	-20 F	90,77,93	87	72,61,74	66,54,76
Haz	-20 F	61,50,53	55	57,42,39	46,25,43

WELD JOINT DESIGN



Dept. Conducting Test W.B.N.P.

Welder William Pittman Symbol 3P

Test No.: NA

Testing Lab W.B.N.P. - Bend Tests
SML - Tensile Tests

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the ASME Code.

By

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: April 21, 1981
WPQR No. SM-P-13
DWP No. SM-P-1

Welding Process: SMAW [✓ Manual] Semiautomatic Automatic
Mtl. Type and Spec. A519 (Gr 1018-1026) To A36 P-No. N/A To P-No. N/A
Thickness (and Dia. if Pipe) ______ Thickness Range Qualified ______

WELDING MATERIALS

Filler Metal F-No. ____ A-No. ____
Electrode F-No. 4 A-No. 1
Spec. or Analysis: SFA 5.1, Ty E7018
Flux: ______
Other Additives: ______

WELDING PROCEDURE

Position Qualified: H, V, OH (G)
Qualifying For: H, V, OH
Single of Multiple Pass: Multiple
Number of Arcs: Single
Preheat Temp. 60° F min
Interpass Temp. 500° F max
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls. ______
Type Current: DCRP
Joint Configuration: Single V Partial Pen. Weld

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (In/Min)
1	3/32"	85-95	23-27	-
Rem	1/8"	125-130	23-27	-

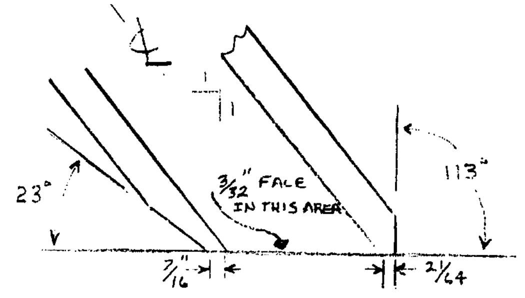
Macrosections were examined per AWS D1.1, Section 5, and showed the following effective throat:

Specimen No.	Position of Welding	Effective Throat of Weld*
CW-0-1	Overhead	0.699"
CW-V-1	Vertical	0.713"
CW-V-2	Vertical	0.783"
CW-H-1	Horizontal	0.670"

*Average of eight (8) measurements from sections equally spaced around circumference of calweld sleeve

Required effective throat - 9/16" (0.562") mininum

WELD JOINT DESIGN



WELD PREP-AS SUPPLIED BY ERICO PRODUCTS

SMP13.JW

Dept. Conducting Test Hartsville Nuclear Plant
Welder J. Wallin Symbol AAAE
Testing No. SM-P-13
Testing Lab. Sectioning and Measurement by Hartville Welding QC

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

BY C E Roberts

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: August 15, 1979 W. P. Q. R. No. SM-U-6

Welding Process: SMAW [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A572 Gr. 55 To A572 P-No. N/A To P-No. N/A

Thickness (and Dia. if Pipe) 1-1/2" Plate - 304L s/s Clad Thickness Range Qualified - Thru Unlimited

WELDING MATERIALS

Filler Metal F-No. - A-No. -
Electrode F-No. 5 A-No. 8
Spec. or Analysis: SFA 5.4 E309-16

Flux: None
Other Additives: None

WELDING PROCEDURE

Position Qualified: Horizontal 2 (G)
Qualifying For: Horizontal
Single or Multiple Pass: Multiple
Number of Arcs: Single
Preheat Temp. 60° F min.
Interpass Temp. 350° F max.
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: Stoody E390L-16
Type Current: DCRP
Joint Configuration: See Sketch

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
All	1/8	105-120	24-26	3.5 min.

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
	Dia.	Thickness				
Transv. Rd	0.500		0.196	17,400	88,800	Ductile - B.M.
Transv. Rd	0.501		0.197	18,000	91,400	Ductile - B.M.
Chemical Analysis of Weld Deposit: 0.034% C, 19.24% Cr, 9.82% Ni						

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	FB-5	Acceptable
Side	FB-6	Acceptable
Side	FB-7	Acceptable
Side	FB-8	Acceptable

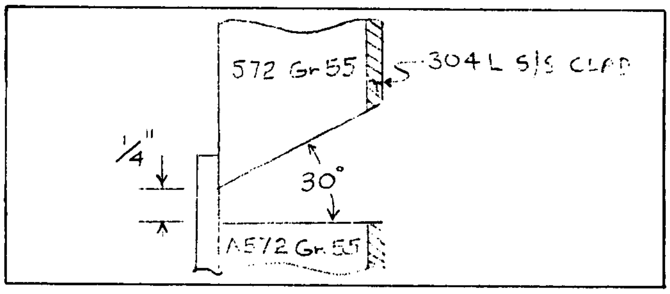
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant	Surf.	Acceptable
Ultrasonic		
Radiographic	Weld	Acceptable

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Hartsville Nuclear Plant
Welder J. M. Garrison Symbol AAAA
Test No.: WPQT 79-122
Testing Lab SME-K

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

By Robert M Jessee

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: August 15, 1979 W. P. Q. R. No. SM-U-6

Welding Process: SMAW [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A572 Gr. 55 To A572 Gr. 55 P-No. N/A To P-No. N/A

Thickness (and Dia. if Pipe) 1-1/2" Pl. - 304L S/S Clad Thickness Range Qualified - Thru Unlimited

WELDING MATERIALS

Filler Metal F-No. - A-No. -

Electrode F-No. 5 A-No. 8

Spec. or Analysis: SFA5.4, E309-16

Flux: None

Other Additives: None

WELDING PROCEDURE

Position Qualified: Vertical (Upward) 3 (G)

Qualifying For: Vertical

Single or Multiple Pass: Multiple

Number of Arcs: Single

Preheat Temp. 60° F min.

Interpass Temp. 350° F max

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: Stoody E309L-16

Type Current: DCRP

Joint Configuration: See Sketch

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
Root	1/8	100-110	24-26	2.5 min
Root	1/8	105-115	24-26	2.5 min

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
	Dia.	Thickness				
Transv-Rd.	0.5035		0.199	17,800	89500	Ductile - B.M.
Transv-Rd.	0.5045		0.200	17,900	89500	Ductile - B.M.
Chemical Analysis of Weld Deposit: 0.034% C, 23% Cr, 11.62% Ni						

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	FB-1	Acceptable
Side	FB-2	Acceptable
Side	FB-3	Acceptable
Side	FB-4	Acceptable

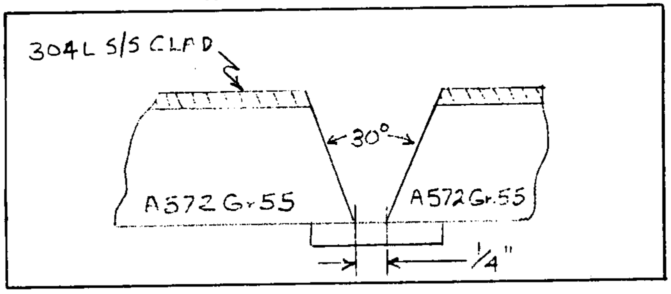
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant	Surf.	Acceptable
Ultrasonic		
Radiographic	Weld	Acceptable

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Hartsville Nuclear Plant

Welder J. M. Garrison Symbol AAAA

Test No.: WPQT-79-126

Testing Lab SME-K

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

By Robert M.

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: 5/7/81
WPQR No. SM-U-8
DWP No. SM-U-8, Rev. 0
Welding Process: SMAW Manual Semiautomatic Automatic
Mtl. Type and Spec. A516 Gr 70 To A516 Gr 7 P-No. N/A To P-No. N/A
Thickness (and Dia. if Pipe) 1-1/2" thk Plate Thickness Range Qualified 3/16"-unlim.

WELDING MATERIALS

Filler Metal F-No. ______ A-No. ______
Electrode F-No. 4 A-No. 1
Spec. or Analysis:
Flux:
Other Additives:

WELDING PROCEDURE

Position Qualified: Flat (G)
Qualifying For: Flat
Single of Multiple Pass: Multiple
Number of Arcs: Single
Preheat Temp. 60° F
Interpass Temp. 500° F max
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls.
3/32" and 5/32" - Westinghouse
1/8", 3/16", and 1/4" - Airco
Type Current: DCRP
Joint Configuration: See sketch

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (In/Min)
1,2,5&6	1/8"	120-140	24-25	4-5
3-4	3/32"	85-100	23-24	3-4
7-13	5/32"	165-185	24-25	6-7
14-17	3/16"	240-265	25-26	6-7
18-27	1/4"	320-355	25-26	7-8

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Specimen No.	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character and Location of Failure
Transv.	H142	0.195	14,100	72,300	Duct - BM
Transv.	H143	0.191	14,000	73,300	Duct - BM
Transv.	H144	0.192	14,200	74,000	Duct - BM
Transv.	H145	0.195	15,100	77,400	Duct - BM

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	H77	Acceptable
Side	H78	Acceptable
Side	H79	Acceptable
Side	H80	Acceptable

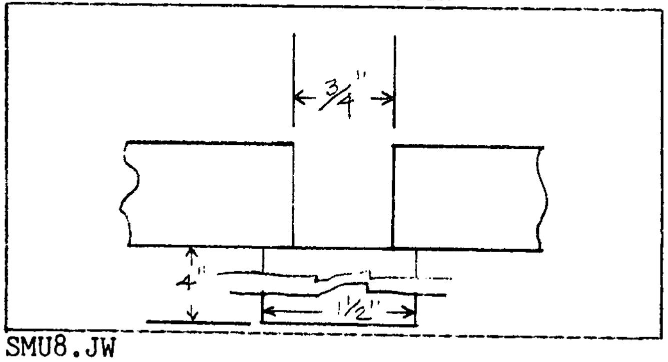
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic	Weld	Acceptable

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg of 3	Lateral Expansion	% Shear
BM	-20° F	18 19.5 18	18.5	17.5 19 17	42 50 42
WM	-20° F	105.5 115.0 129.0	116.3	76 85.5 85.5	44 52 58
HAZ	-20° F	33.5 34.0 37.0	34.8	28 28 31.5	60 62 77

WELD JOINT DESIGN



SMU8.JW

Dept. Conducting Test Hartsville Nuclear Plant
Welder J. Wallin Symbol AAAE
Test No.
Testing Lab. Singleton Materials Eng. Lab

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

BY C. E. Roberts

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: 7-23-74

W. P. Q. R. No. SW-5

Welding Process: SMA [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A36 To A8620 P-No. 1 To P-No. -

Thickness (and Dia. if Pipe) NA Thickness Range Qualified NA Thru

WELDING MATERIALS

Filler Metal F-No. A-No.
Electrode F-No. 4 A-No. 1
Spec. or Analysis: SFA 5.1, E7018

Flux:
Other Additives:

WELDING PROCEDURE

Position Qualified: Horizontal Pipe 5(G)
Qualifying For: OH, V, F
Single or Multiple Pass: Multiple
Number of Arcs: One
Preheat Temp. 60° F Min
Interpass Temp. 150° F Max
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: McKay

Type Current: DCRP
Joint Configuration: Fillet

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
ALL	3/32	75-115	24	-

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
	Width	Thickness				

GUIDED BEND TESTS

Type	Specimen No.	Results

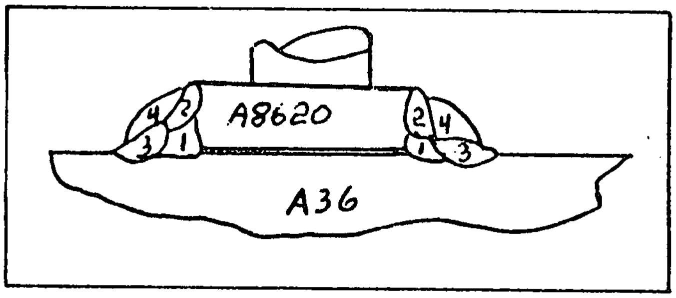
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle	Root & Final-Acceptable	
Visual	Final	Acceptable
Macro	4 Sections-8 Surfaces	
Examined-Complete penetration to Root-		
-No defects		

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test SNP
Welder Biggs, Gary Symbol G3
Test No.:
Testing Lab SNP

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the ASME Code.

By Robert L Harris

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: 7/29/80

W. P. Q. R. No. SM Cadweld Repair Circumferential Weld

Welding Process: SMAW [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A519, Gr1018-1026 To A519G-1018-1026 P-No. 1 To P-No. 1

Thickness (and Dia. if Pipe) 9/16" nom. wall x 3-3/4" O.D. Thickness Range Qualified 9/32" thru 1-1/8"

WELDING MATERIALS

Filler Metal F-No. A-No.
Electrode F-No. 4 A-No. 1
Spec. or Analysis: SFA 5.1, E7018
Flux:
Other Additives:

WELDING PROCEDURE

Position Qualified: Vert Pipe Pos. 2(G)
Qualifying For: Flat, Horizontal
Single or Multiple Pass: Multiple
Number of Arcs: Single
Preheat Temp. 60 F
Interpass Temp. 500 F max
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: Airco 7018 MR

Type Current: DCRP
Joint Configuration: Single "J" Bevel Partial Penetration Weld

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
1	3/32"	90	23	3
2-4	1/8"	120	24	5
5-7	1/8"	125	24	6
8-10	1/8"	120	24	7
11-13	1/8"	120	24	7.5
14-16	1/8"	120	24	7

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
	Width	Thickness				
Transv	0.740"	0.3374"	0.250	22,000	88,000	Ductile - W.M.
Transv	0.740"	0.3375"	0.250	22,100	88,400	Ductile - W.M.

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	P17	Acceptable
Side	P18	Acceptable
Side	P19	Acceptable
Side	P20	Acceptable

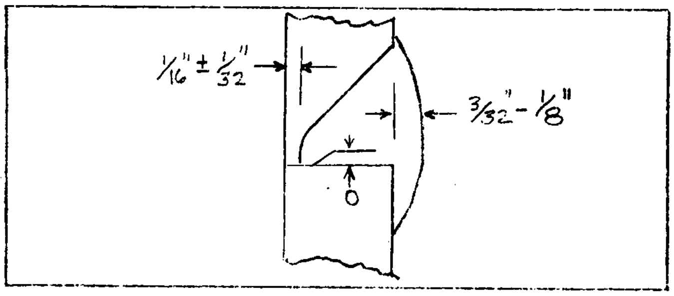
Effective Throat Measurement

Sample no.	Throat Measurement (In.)
P17	5/8" (0.625)
P18	17/32" (0.531)
P19	9/16" (0.562)
P20	19/32" (0.593)

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Phipps Bend Nuc. Plant
Welder C. J. Stapleton Symbol I-003
Test No.: WPQT-80-10, SME 80 0501 001
Testing Lab Singleton Matls. Eng. Lab.

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

By Walter P. Joest

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: 7/29/80

W. P. Q. R. No. SM-Cadweld Repair Circumferential Weld

Welding Process: SMAW [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A519, Gr1008-1026 To A519, Gr1008-1026 P-No. 1 To P-No. 1

Thickness (and Dia. if Pipe) 9/16" Nom. Wall X 3-3/4" od Thickness Range Qualified 9/32 Thru 1-1/8"

WELDING MATERIALS

Filler Metal F-No. A-No.

Electrode F-No. 4 A-No. 1

Spec. or Analysis: SFA 5.1, E7018

Flux:

Other Additives:

WELDING PROCEDURE

Position Qualified Horiz. Pipe Pos. 5 (G)

Qualifying For: F, OH, V (Upward Progression)

Single or Multiple Pass: Multiple

Number of Arcs: Single

Preheat Temp. 60 F

Interpass Temp. 500 F max.

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: Airco 7018 MR

Type Current: DCRP

Joint Configuration: Single "J" Bevel Partial Penetration Weld

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
1-4	3/32	85	23	3
5-7	3/32	85	23	3.5
8-10	3/32	90	23	4.5
11-14	3/32	90	23	5
15-16	3/32	90	23	5
17-19	3/32	90	23	5.5

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
	Width	Thickness				
Transv	0.751"	0.3663"	0.275	24,200	88,000	Ductile-WM
Transv	0.716"	0.3662"	0.262	23,200	88,500	Ductile-WM

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	P21	Acceptable
Side	P22	Acceptable
Side	P23	Acceptable
Side	P24	Acceptable

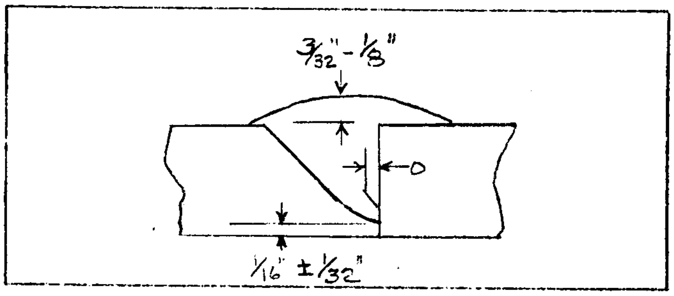
Effective Throat Measurements

Sample No.	Throat Measurement (In.)
P21	19/32" (0.593)
P22	19/32" (0.593)
P23	9/16" (0.562)
P24	9/16" (0.562)

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Phipps Bend Nuc. Plant

Welder C. J. Stapleton Symbol I-003

Test No.: WPQT-80-10, SME 80 0501 001

Testing Lab Singleton Matls. Eng. Lab

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

By Walter P. Joest

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: 7/29/80

W. P. Q. R. No. SM-Cadweld Repair Longitudinal Weld

Welding Process: SMAW [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A519 Gr 1018-1026 To A519 Gr 1018-1026 P-No. 1 To P-No. 1

Thickness (and Dia. if Pipe) 9/16" nom wall X 3-3/4" od Thickness Range Qualified 9/32" Thru 1-1/8"

WELDING MATERIALS

Filler Metal F-No. A-No.

Electrode F-No. 4 A-No. 1

Spec. or Analysis: SFA 5.1, E7018

Flux:

Other Additives:

WELDING PROCEDURE

Position Qualified: Flat and Overhead 1G and 4(G)

Qualifying For: Flat and Overhead

Single or Multiple Pass: Multiple

Number of Arcs: Single

Preheat Temp. 60° F min.

Interpass Temp. 500° F max

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: AIRCO 7018 MR

Type Current: DCRP

Joint Configuration: Single Vee Partial Penetration Weld

	Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
Flat	1	3/32"	95	23	3-4
	Rem	1/8"	135	24	5-7
Overhd	1	3/32"	95	23	3-4
	Rem	1/8"	135	24	5-7

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure
	Width	Thickness				

GUIDED BEND TESTS

Type	Specimen No.	Results

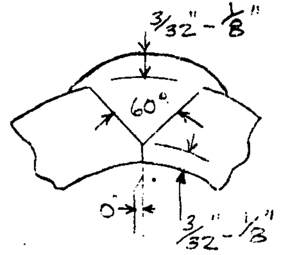
Effective Throat Measurement (Inches)

Flat Pos.	Overhead Pos.
1. 0.555	1. 0.466
2. 0.499	2. 0.477
3. 0.465	3. 0.464
4. 0.452	4. 0.452
5. 0.432	5. 0.467
Avg = 0.481	Avg. = 0.465

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Phipps Bend Nuclear Plant

Welder Alonzo Cline Symbol I-034

Test No.: 7-17-80-2

Testing Lab Singleton Materials Eng. Lab

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the ~~ASME~~ AWS Code.

By Walter P. Joest

TVA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: 7/29/80

W. P. Q. R. No. SM Cadweld Repair Longitudinal Weld

Welding Process: SMAW [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A519. Gr 1018-1026 To A519 GR 1018-1026 P-No. 1 To P-No. 1

Thickness (and Dia. if Pipe) 9/16" Nom. wall X 3-3/4" od Thickness Range Qualified 9/32" thru 1-1/8"

WELDING MATERIALS

Filler Metal F-No. A-No.

Electrode F-No. 4 A-No. 1

Spec. or Analysis: 5FA5.1 E7018

Flux:

Other Additives:

WELDING PROCEDURE

Position Qualified: Horizontal 2 (G)

Qualifying For: Horizontal

Single or Multiple Pass: Multiple

Number of Arcs: Single

Preheat Temp. 60° F min.

Interpass Temp. 500° F max.

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: Airco 7018 M.R.

Type Current: DCRP

Joint Configuration: Single Vee Partial Penetration Weld

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
1	3/32"	95	24	3-5
Rem	3/32"	95	24	6
Rem	1/8"	135	23	6-7

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions Width	Thickness	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure

GUIDED BEND TESTS

Type	Specimen No.	Results

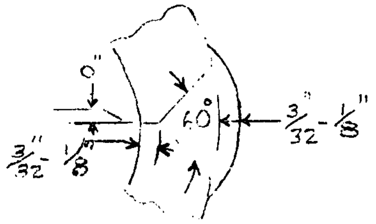
Effective Throat Measurement (Inches)
10 Locations - 5 each Longl. Weld

1. 0.464	6. 0.489	
2. 0.468	7. 0.453	
3. 0.453	8. 0.453	Avg. = 0.465
4. 0.489	9. 0.467	
5. 0.440	10. 0.474	

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Phipps Bend Nuclear Plant

Welder Alonzo Cline Symbol I-034

Test No.: 7-17-80-1

Testing Lab Singleton Materials Eng. Lab

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the ~~ASME~~ AWS Code.

By Walter P. Joest

T VA 10560 (DED-4-74)

Tennessee Valley Authority

WELDING PROCEDURE QUALIFICATION RECORD

Date: 7/29/80

W. P. Q. R. No. SM-Cadweld Repair Longitudinal Weld

Welding Process: SMAW [✓ Manual] Semi-Automatic Automatic

Mtl. Type and Spec. A519 GR 1018-1026 To A519 Gr 1018-1026 P-No. 1 To P-No. 1

Thickness (and Dia. if Pipe) 9/16" nom. wall X 3-3/4" od Thickness Range Qualified 9/32" thru 1-1/8"

WELDING MATERIALS

Filler Metal F-No. A-No.

Electrode F-No. 4 A-No. 1

Spec. or Analysis:

Flux:

Other Additives:

WELDING PROCEDURE

Position Qualified: Vertical 3(G)

Qualifying For: Vertical

Single or Multiple Pass: Multiple

Number of Arcs: Single

Preheat Temp. 60° F min.

Interpass Temp. 500° F max.

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls: AIRCO 7018

Type Current: DCRP

Joint Configuration: Single Vee Partial Penetration Weld

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (Inches/Min.)
All	3/32"	90	24	3-6

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimensions Width	Thickness	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character And Location of Failure

GUIDED BEND TESTS

Type	Specimen No.	Results

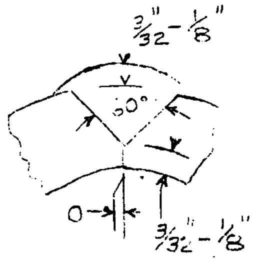
Effective Throat Measurement (Inches)
10 Locations - 5 each Longl. Weld

1. 0.446"	6. 0.445	
2. 0.456"	7. 0.475	
3. 0.470"	8. 0.448	Avg. = 0.456
4. 0.460"	9. 0.442	
5. 0.464	10. 0.457	

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg. of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Phipps Bend Nuclear Plant

Welder Alonzo Cline Symbol I-034

Test No.: 7-17-80-2

Testing Lab ~~Singleton Materials Eng. Lab~~

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the XXXX Code.
AWS

By Walter P. Joest

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: August 7, 1981

WPQR No. SM-RB-2

DWP No. SM-RB-2 Revision 0

Welding Process: SMAW Manual Semiautomatic Automatic

Mtl. Type and Spec. A615 GR 60 To A615 Gr 60 P-No. N/A To P-No. N/A

Thickness (and Dia. if Pipe) 1.375 Dia #11 Rebar Thickness Range Qualified Sizes ≤ #11

WELDING MATERIALS

Filler Metal F-No. ____ A-No. ____

Electrode F-No. 4 A-No. 4

Spec. or Analysis: E9018 B3

SFA-5.5

Flux:

Other Additives:

WELDING PROCEDURE

Position Qualified: H, V 2, 3(G)

Qualifying For: H, V

Single of Multiple Pass: Multiple

Number of Arcs: Single

Preheat Temp. 500° F

Interpass Temp. 800° F max

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls. Westinghouse

Type Current: DCRP

Joint Configuration: Single V groove and single bevel groove with 1/8" root opening. See sketch below.

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (In/Min)
1-12	3/32"	98	23	3.0/min
13-20	1/8"	120	24	2.5/min

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Code Diameter	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character and Location of Failure
Round	RB-D1* 1.410	1.56	161,600	103,600	Ductile - BM
Round	RB-D2* 1.410	1.56	160,400	102,800	Ductile - BM
Round	RB-C1** 1.410	1.56	162,000	103,800	Ductile - BM
Round	RB-C2** 1.410	1.56	164,000	105,100	Ductile - BM
*2G Pos.	**3G Pos.				

GUIDED BEND TESTS

Type	Specimen No.	Results

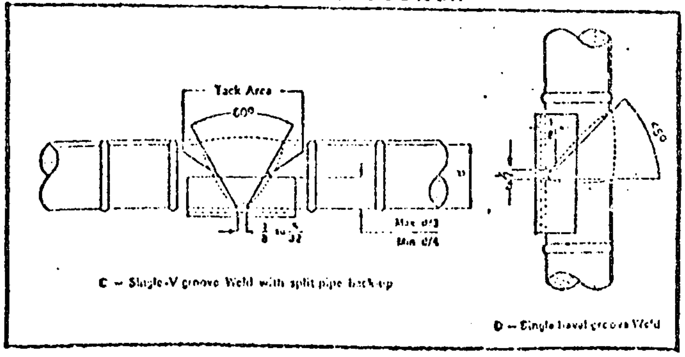
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic		
2 Macros***	Weld	Acceptable

CHARPY V NOTCH IMPACT TESTS ***1 ea - 2G and 3G Pos.

Location	Temp.	Ft/Lb Value	Avg of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



C – Single-V groove Weld with split pipe back-up

D – Single bevel groove Weld

Dept. Conducting Test Bellefonte Nuclear Plt

Welder Billy D. Roden Symbol IABA

Testing No. WPQT-81-28

Testing Lab. Singleton Materials Eng. Lab

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

BY W. P. Joest

SMBB2.BR

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: June 23, 1982

WPQR No. SM-RB-2

DWP No. SM-RB-2

Welding Process: SMAW Manual Semiautomatic Automatic

Mtl. Type and Spec. A615 Gr 70 Rebar To same S-No. N/A To P-No. N/A

Thickness (and Dia. if Pipe) Thickness Range Qualified No. 11 Bar

WELDING MATERIALS

Filler Metal F-No. A-No.

Electrode F-No. 4 A-No. 4

Spec. or Analysis:

SFA 5.5, Ty E-9018 B3

Flux:

Other Additives:

WELDING PROCEDURE

Position Qualified: 1G and 4G (G)

Qualifying For: Flat and Overhead

Single of Multiple Pass: Multiple

Number of Arcs: Single

Preheat Temp. 500 degrees F minimum

Interpass Temp. 800 degrees F maximum

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls. Westinghouse

Type Current: DCRP

Joint Configuration: Single V-Groove

See Sketch Below

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (In/Min)
1-12	3/32"	100	23	3.0
13-20	1/8"	120	24	2.5

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Code	Dia.	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character and Location of Failure
Full Section	0-1	1.410	1.56	122,400	78,500	BM
Full Section	0-2	1.410	1.56	161,400	103,500	BM
Full Section	F-1	1.410	1.56	162,200	104,000	BM
Full Section	F-2	1.410	1.56	166,600	106,800	BM

GUIDED BEND TESTS

Type	Specimen No.	Results

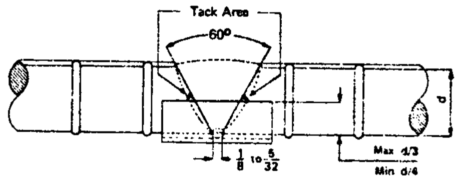
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic		
Macro (1 ea. pos.) Weld		Acceptable

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Bellefonte Nuclear Plant

Welder Billy D. Roden Symbol IABA

Testing No. CSB 820618 303

Testing Lab. Singleton Materials Engineering Laboratory

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

BY C. E. Roberts

E42174.01

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: 3/5/81
WPQR No. GM-SA-U-1
DWP No. GM-SA-U-1
Welding Process: GM/SA Manual Semiautomatic (GM) Automatic (SA)
Mtl. Type and Spec. SA516 Gr 70 To SA516 GR 70 P-No. 1 To P-No. 1
Thickness (and Dia. if Pipe) 1-1/2" Plate Thickness Range Qualified Unlimited

WELDING MATERIALS

Filler Metal F-No. A-No.
Electrode F-No. 6 A-No. 1
Spec. or Analysis:
GM (Flux Core):SFA5.20 Ty E70T-1
SA:SFA5.17 Ty EM12K
Flux: SFA5.17 Ty F72-EM12K
Other Additives:
Ground Ceramic Backing Utilized

WELDING PROCEDURE

Position Qualified: Flat 1 (G)
Qualifying For: Flat
Single of Multiple Pass: Multiple
Number of Arcs: Single
Preheat Temp. 60°F
Interpass Temp. 500°F Max.
Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls.
GMA - Unicore
SA - Hobart
Type Current:
Joint Configuration:
Single Vee

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (In/Min)
1&2	.052" (GMA)	205-265	26-28	4 min
3-15	5/64" (SA)	280-600	28-38	8 min

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Width	Thk.	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character and Location of Failure
Flat	1.068"	0.4708"	0.5028	41000	81500	Duct - BM
Flat	1.040"	0.4713"	0.4902	39800	81200	Duct - BM

GUIDED BEND TESTS

Type	Specimen No.	Results
Side	H73	Acceptable
Side	H74	Acceptable
Side	H75	Acceptable
Side	H76	Acceptable

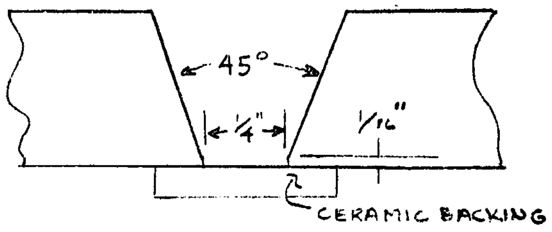
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic	Weld	Acceptable

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Hartsville Nuc Plant
Welder J. G. Wallin Symbol AAAE
Testing No. WPQT-81-5
Testing Lab. Singleton Matls Eng Lab

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the AWS Code.

BY C. E. Roberts

GMSAU.JW

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: September 1, 1981

WPQR No. GM11-0-6

DWP No.

Welding Process: Gas Metal Arc Manual [✓ Semiautomatic] Automatic

Mtl. Type and Spec. SA-36 To SA-36 P-No. 1 To P-No. 1

Thickness (and Dia. if Pipe) 3/8" Plate Thickness Range Qualified 1/16"-.413"

WELDING MATERIALS

Filler Metal F-No. A-No.

Electrode F-No. 6 A-No. 1

Spec. or Analysis: SFA 5.18, Type E70S-6

Flux:

Other Additives:

Shielding Gas - 75% Argon - 25% CO_2

Flow Rate - 28 cfh

WELDING PROCEDURE

Position Qualified: Vertup(Root downhill) 3(G)

Qualifying For: F,V,H,OH

Single or Multiple Pass: Multiple

Number of Arcs: One

Preheat Temp. 60°F

Interpass Temp. 500°F

Post Weld Heat Treatment: None

FOR INFORMATION ONLY

Trade Name Filler Mtls.

Hobart "HB28," .035"

Type Current: DCRP

Joint Configuration: Single "V," 75° Incl Angle

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (In/Min)
All	.035"	108	18	5

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Dimension		Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character and Location of Failure
	Width	Thickness				
Trans	0.998"	0.331"	0.330	24,050	72,900	Ductile - BM
Trans	1.003"	0.323"	0.324	23,750	73,300	Ductile - BM

GUIDED BEND TESTS

Type	Specimen No.	Results
Face	B69	Acceptable
Face	B70	Acceptable
Root	B71	Acceptable
Root	B72	Acceptable

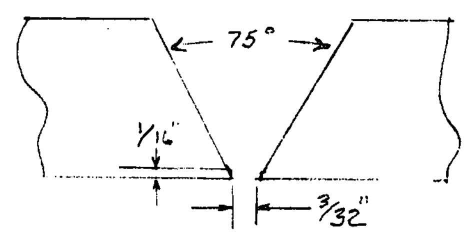
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant		
Ultrasonic		
Radiographic		

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test BNP

Welder Quattlebaum Symbol FAHN

Testing No. WPQT-77-11

Testing Lab. Singleton

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested in accordance with requirements of the ASME Code.

BY C. E. Roberts

WPQT77.11

Process Specification: 1.C.2.2(R1)
Date: 3/4/83
Sheet: 1 of 4

WELDER PERFORMANCE QUALIFICATION

(This specification is technically identical with Process Specification 1.C.2.2(a) with addenda 1-4.)

1.0 SCOPE

1.1 This process specification defines the requirements for welder performance qualification in accordance with the requirements of AWS D1.1, Rev 2-74 Code for Welding in Building Construction.

1.2 Performance qualification tests are intended to determine the ability of welders to deposit sound welds in accordance with a qualified welding procedure.

2.0 REQUIREMENTS

2.1 Each welder shall be required to pass a performance qualification test prior to welding on components or assemblies which are fabricated in accordance with AWS D1.1, 2-74 Code.

2.2 All tests shall be conducted in accordance with the conditions specified on the test description.

2.3 A record of all qualification tests, including those which failed to meet requirements, shall be kept on file and shall include the test conditions and results.

2.4 Welders who pass qualification tests for groove welds shall be qualified for groove welds within the limits of the test description and for fillet welds of any thickness. The groove weld test on plate qualifies welders for groove welds on pipe only to the extent shown in Table 5.23 of AWS D1.1.

2.5 Welders who pass qualification tests for fillet welds shall be qualified for fillet welds only, in all thicknesses within the limits of the test description.

3.0 RETESTS

3.1 A welder who fails to meet requirements of a test may be retested under the following conditions:

(a) An immediate retest may be made which shall consist of two test welds of each type and for each position on which tests failed to meet requirements.

(b) A complete retest may be made when the welder has had additional training or practice for a minimum of 2 hours.

4.0 RENEWAL OF QUALIFICATION

4.1 Renewal of qualification of a performance test shall be required under the following conditions:

(a) When the welder has not used the welding process (manual shielded metal arc, gas tungsten arc, etc.) for a period of 6 months or more.

(b) When there is specific reason to question the welder's ability to produce welds that meet specification requirements.

4.2 Renewal of qualification under 4.1(a) need only be made in the 3/8-inch thickness.

5.0 TEST DESCRIPTION

5.1 Each test description shall define the requirements to be followed in performance of tests in accordance with a qualified welding procedure.

5.2 Each test description shall specify the mechanical tests and/or other test required in order to pass the test.

6.0 ACCEPTANCE STANDARDS

6.1 Mechanical Tests

6.1.1 Mechanical tests shall be performed in accordance with Paragraph 5.27 of AWS D1.1-Rev 2-74.

6.1.2 The convex surface of bend test specimens shall be examined for the appearance of cracks or other open defects. Any specimen in which a crack or other open defect is present after bending, exceeding 1/8 inch measured in any direction, is not acceptable.

6.2 Radiographic Tests

6.2.1 Welds as revealed by radiography in accordance with AWS D1.1-Rev 2-72, Sec 6, Part II, shall be free from overlap, craters, and cracks and undercut in excess of 0.010 inch. One (1) inch of weld at each end of the test assembly need not be evaluated.

6.2.2 Limitations of porosity and fusion-type defects is based on Figure 9.25.2.1 of AWS D1.1-Rev 2-74. The greatest dimension of any porosity or fusion-type defect that is 1/16-inch or larger in greatest dimension shall not exceed the size or dimensions of Defect-B indicated in Figure 9.25.2.1 for the effective throat thickness or weld size involved. The distance from any porosity or fusion-type defect described above to another such defect, to an edge shall not be less than the minimum clearance allowed -C, indicated by Fig 9.25.2.1 for the size of defect under examination. The limitations given by Figure 9.25.2.1 for 1-1/2 inch joint or weld throat thickness shall apply to all joints or weld throats of greater thickness.

6.2.3 Independent of the requirements of 6.2.2, the sum of the greatest dimensions of porosity and fusion-type defects less than 1/16-inch in greatest dimension shall not exceed 3/8-inch in any linear inch of weld.

7.0 Applicability of Process Specification 1.M.2.2 Welder Qualification.

7.1 Welders qualified to test descriptions of Process Specification 1.M.2.2 with 5- or 6-inch diameter 3/4-inch wall thickness pipe in the 2G and 5G or 6G positions by side bend tests or by radiography which meets the requirements of section 6.2 of this specification are qualified to weld with the welding process and filler metal classification used in qualification test in all positions on material from 3/16-inch to unlimited thickness on plate or pipe with 4-inch or greater diameter on single welded joints with backing or double welded joints and on fillet welds on unlimited thickness material.

Welders who qualified to Process Specification 1.M.2.2 tests which use one welding process for the root and another process for the remainder of the weld are qualified to this specification as described above for the welding process and filler metal classification used for the remainder of the test weld.

7.2 Some of the applicable test descriptions and the filler metals they qualify for are as follows:

Process Specification 1.M.2.2 Test Description	Filler Metal Qualified
SM-4-B-3-H	AWS A5.1 or A5.5 F1 through F4
GT-SM-6-4-C-3-H	
GT-SM-6-4-0-3-H	
SM-5-B-3-H	AWS A5.4, F5
GT-SM-7-5-C-3-H	
GT-SM-7-5-0-3-H	
GM(FC)-6-B-3-H	AWS A5.20, F6
GT-GM(FC)-6-6-0-3-H	
GM-GM(FC)-6-6-0-3-H	

7.3 Welders qualified to test descriptions of Process Specification 1.M.2.2 in the 2G and 5G or the 6G position by bend tests or by radiography which meets the requirements of section 6.2 of this specification are qualified to the requirements of this specification. They are qualified to weld fillet welds on unlimited thickness material with the welding process and filler metal classification used in qualification testing.

7.4 Welders qualified to test descriptions utilizing the gas metal-arc solid wire process (GM-SD) are qualified for that process using the globular or spray transfer mode only unless stated otherwise on the specific test description.

Prepared by J R White 4/14/83

Reviewed by Robert M. Jesser 4/14/83

Approved by C E Roberts 4/14/83

Process Specification: 1.C.2.2(a)
Date: 4/8/80
Sheet: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No.: SA-6-U Rev. 0 Date: 4/8/80

1. Welding Process: Automatic Submerged Arc

2. Electrode Type: EM12K

3. Flux Type: F72EM12K

4. Base Material: Carbon steel plate, 1-inch minimum thickness by 15-inch minimum length.

5. Welding Positions: Flat

6. Joint Design: Single V with backing, 20° included angle, 5/8" root opening

7. Welding Procedure: SA-U-1

8. Tests: Side bends or radiographic examination per AWS D1.1, part 5

9. Limits of Qualification:

9.1 This test shall qualify a welding operator for welding on plate with electrodes of SFA 5.17, F6 classification in the flat position singled welded joints with backing, and on double welded joints from 3/16 inch to unlimited thickness and fillet welds of any size in the flat (1F) and horizontal (2F) position.

9.2 The following welding procedures may be used with this qualification within the thickness range specified:

SA-U-1

Prepared by: J. D White

Approved by: Robert M Jusse

PERFORMANCE QUALIFICATION TEST

Test No.; SM-4-H Rev. 0 Date: 7-31-74

1. Welding Process: Manual Shielded Metal Arc

2. Electrode Type: EXX15, 16, or 18

3. Base Material: A36 (2) 1" x 3" x 6" (rolling direction of the plate shall be transverse to the direction of welding)

4. Welding Positions: V, OH

5. V Weld Progression: Vertical up

6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing or 3/8" x 3" x 6" for radiographic testing

7. Welding Procedure: SM-U-1

8. Mechanical Tests: 2 side bends per AWS D1.1-72 Rev 2-74 Code, Chapter 5 or radiographic test

9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.1 or AWS A5.5 Specification, F1 through F4 Classification, in all positions, on single welded joints with backing and double welded joints, and on fillet welds, in unlimited thickness.

9.2 The following welding procedures may be used with this specification:

SM-L-1
SM-U-1
SM-P-1
SM-U-1A

SM-SW-P-1
SM-RB-1

PERFORMANCE QUALIFICATION TEST

Test No.: SM-4-L Rev. 0 Date: 7-31-74

1. Welding Process: Manual Shielded Metal Arc

2. Electrode Type: EXX15, 16, or 18

3. Base Material: A36 (a) 3/8" th x 3" w x 6" lg (rolling direction of the plate shall be transverse to the direction of welding)

4. Welding Positions: V, OH

5. V Weld Progression: Vertical up

6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing or 3/8" x 3" x 6" for radiographic testing

7. Welding Procedure: SM-U-L

8. Mechanical Tests: 1 face bend, 1 root bend per AWS D1.1, Rev 2-74. Chapter 5 or radiographic tests

9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.1 or AWS A5.5 Specification, F1 through F4 classification, in all positions, on single welded joints with backing and double welded joints, up to and including 3/4 inch thickness, and fillet welds of any thickness.

9.2 The following welding procedures may be used with this qualification:

SM-L-1
SM-P-1
SM-U-1
SM-U-1A

SM-SW-P-1
SM-RB-1

PERFORMANCE QUALIFICATION TEST

Test No.: SM-4-4-L   Rev. 0   Date: 11/21/77

1. Welding Process: Manual Shielded Metal Arc
2. Electrode Type: EXX15, 16, or 18
3. Base Material: Carbon Steel Pipe, 2 inch schedule 80 or 3 inch schedule 40
4. Welding Positions: 2G + 5G or 6G
5. V Weld Progression: Vertical up
6. Weld Joint Design: 60° included angle, 1/4 inch nominal root opening with backing ring.
7. Welding Procedure: SM-U-1
8. Mechanical Tests: 2 face bends, 2 root bends per AWS D1.1, Chapter 5 or radiographic tests.
9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.1 or AWS A5.5 Specification, F1 through F4 classification, in all positions, on single welded joints with backing and double welded joints, from .063 inch through .674 inch thickness, and fillet welds of any thickness on plate or pipe 4 inch diameter and under. (Not applicable to T, K, and Y connections.)

9.2 The following welding procedures may be used with this qualification:

SM-P-1
SM-P-2
SM-P-3
SM-P-6
SM-L-1
SM-U-1
SM-U-1A
SM-RB-1
SM-SW-P-1

Prepared by:

Approved by: Robert M [illegible]

Process Specification: 1.C.2.2
Date: 3/25/80
Sheet: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No. SM-4-Down   Revision 0   Date: 3/25/80

1. Welding Process: Manual Shielded Metal Arc

2. Electrode Type: EXX15, 16, or 18

3. Base Material: A36 (a) 3/8" th x 3" w x 6" lg (rolling direction of the plate shall be transverse to the direction of welding)

4. Welding Positions: V

5. V Weld Progression: Vertical up except that one bead at each toe of the reinforcement shall be welded with downward progression (see Figure 1)

6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6"

7. Welding Procedure: SM-U-1

8. Mechanical Tests: 2 face bends (perform bends with reinforcement intact)

9. Limits of Qualification:

   9.1 This test shall qualify a welder for welding with electrodes of AWS A5.1 specification; E7018 or E8018 classification, with vertical downward progression for thepurpose of undercut correction as permitted in P.S. 1.C.1.2

   9.2 This test shall be used only as a supplementary qualification test to extend welder qualification to include vertical downward correction of undercut. The welder shall also be qualified by other test(s) permitted by Process Specification 1.C.2.2 to weld with E7018 or E8018 electrodes.

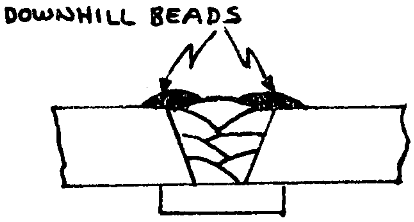


FIG. I

PS1C22

Prepared by

Approved by Robert M

PERFORMANCE QUALIFICATION TEST

Test No.; SM-4-Special-1 Rev. 0 Date: 11/21/77

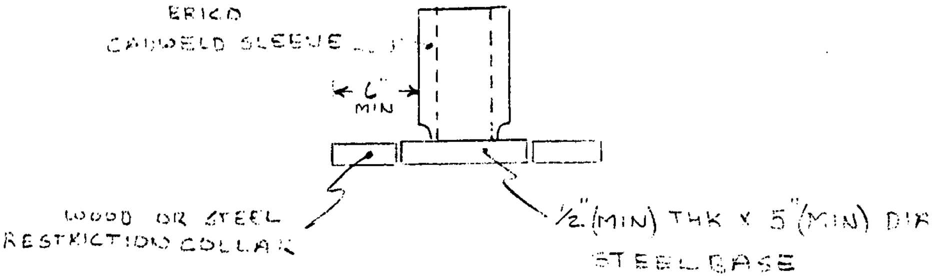
1. Welding Process: Manual Shielded Metal Arc
2. Electrode Type: EXX15, 16, or 18
3. Base Material: Erico cadweld sleeve, carbon steel base plate (see sketch below).
4. Welding Positions: Position to be welded in production
5. V Weld Progression: Vertical up
6. Weld Joint Design: See sketch below.
7. Welding Procedure: SM-P-1 (see note below)
8. Tests: 3 macroetch specimens approximately 120^{0} apart. Specimens shall exhibit complete pentration to the root.
9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.1 or AWS A5.5 Specification, F1 through F4 classification for welding cadweld sleeves to structural members.

9.2 The following welding procedures may be used with this specification:

SM-P-1

Note: Welder must have SM-4-L or SM-4-H qualification before performing this test.



TEST ASSY (TYP)

Prepared by:

Approved by: Robert M

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: SM-5-H   Revision: 2   Date: 6-15-81

1. Welding Process: Manual Shielded Metal Arc
2. Electrode Type: E308-15 (E309-15 will be used for carbon steel)
3. Base Material: A-240 Type 304 or 316 or carbon steel (A36). Plate 3/8" th x 3" x 6" lg. (rolling direction of the plate shall be transverse to the welding direction.
4. Welding Positions: V, OH
5. V Weld Progression: Vertical Up
6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing or 3/8" x 3" x 6" for radiographic testing.
7. Welding Procedure: SM-U-2 for stainless steel. (SM-U-3 for carbon steel.)
8. Mechanical Tests: 2 side bends per AWS D1.1-Rev. 1-76, Chapter 5, or radiographic tests.
9. Limits of Qualification:

    9.1 This test shall qualify a welder for welding with electrodes of AWS A5.4 Specification, F5 Classification, in all positions, on single welded joints with backing and on double welded joints and fillet welds of any thickness.

    9.2 The following welding procedures may be used with this qualification:

    SM-L-2
    SM-P-4
    SM-P-5
    SM-SW-P-2
    SM-SW-P-4
    SM-U-2

Prepared by:

Approved by: C E Roberts

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: SM-5-L Revision: 2 Date: 6-1-81

1. Welding Process: Manual Shielded Metal Arc
2. Electrode Type: E308-15 (E309-15 will be used for carbon steel)
3. Base Material: A-240 Type 304 or 316 or carbon steel (A36). Plate 3/8" th x 3" x 6" lg. (rolling direction of the plate shall be transverse to the welding direction.
4. Welding Positions: V, OH
5. V Weld Progression: Vertical Up
6. Weld Joint Design: 45^{o} included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing or 3/8" x 3" x 6" for radiographic testing.
7. Welding Procedure: SM-U-2 for stainless steel. (SM-U-3 for carbon steel.)
8. Mechanical Tests: 1 face bend, 1 root bend per AWS D1.1-Rev. 2-74, Chapter 5, or radiographic tests.
9. Limits of Qualification:

   9.1 This test shall qualify a welder for welding with electrodes of AWS A5.4 Specification, F5 Classification, in all positions, on single welded joints with backing and on double welded joints, up to and including 2T thickness, and fillet welds of any thickness.

   9.2 The following welding procedures may be used with this qualification:

   SM-L-2
   SM-P-4
   SM-P-5
   SM-SW-P-2
   SM-SW-P-3

Prepared by: J D White

Approved by: C. E. Roberts

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: SM-5-L(a) Revision: 1 Date: 6-1-81

1. Welding Process: Manual Shielded Metal Arc
2. Electrode Type: E309-15 or E309-16
3. Base Material: A-36 Plate 3/8" th x 3" x 6" lg. (rolling direction transverse to the welding direction).
4. Welding Positions: V, OH
5. V Weld Progression: Vertical Up
6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing or 3/8" x 3" x 6" for radiographic testing.
7. Welding Procedure: SM-U-3
8. Mechanical Tests: 1 face bend, 1 root bend or radiographic tests per AWS D1.1, Chapter 5.
9. Limits of Qualification:

   9.1 This test shall qualify a welder for welding with electrodes of AWS A5.4 Specification, F5 Classification, in all positions, on single welded joints with backing and on double welded joints, up to and including 2T thickness, and fillet welds of any thickness.

   9.2 The following welding procedures may be used with this qualification:

   SM-P-4
   SM-P-5
   SM-L-2
   SM-SW-P-2
   SM-SW-P-4

Prepared by:
Approved by: C E Roberts

Process Specification: 1.C.2.2(a)
Date: 1/13/77
Page: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No.: SM-5-U   Rev. 0   Date: 1/13/77

1. Welding Process: Manual Shielded Metal Arc
2. Electrode Type: E308-15 (E309-15 will be used for carbon steel)
3. Base Material: A-240 Type 304 or 316 or carbon steel (A36) plate 1" th x 3" w x 6" lg (rolling direction of the plate shall be transverse to the welding direction
4. Welding Positions: V, OH
5. V Weld Progression: Vertical Up
6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing or 3/8" x 3" x 6" for radiographic testing.
7. Welding Procedure: SM-U-2 for stainless steel.
8. Mechanical Tests: 2 side bends per AWS D1.1-Rev. 1-76, Chapter 5, or radiographic tests.
9. Limits of Qualifications:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.4 Specification, F5 Classification, in all positions, on single welded joints with backing and double welded joints and fillet welds of any thickness.

9.2 The following welding procedures may be used with this qualification:

SM-L-2
SM-P-4
SM-P-5
SM-SW-P-2
SM-SW-P-4
SM-U-2

Prepared by ______________________

Approved by ______________________

Process Specification: 1.C.2.2

Sheet: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No.: GM-FC-6-L(1) Revision 1 Date: 1/31/80

1. Welding Process: Gas Metal Arc - Flux Cored
2. Electrode: E70T-1
3. Base Material: A36 (2) 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)
4. Welding Position: Vertical
5. Weld Progression: Vertical up
6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing
7. Welding Procedure: GM-FC-U-1
8. Mechanical Tests: 1 face bend and 1 root bend or radiographic tests per AWS D1.1.
9. Limits of Qualification

    9.1 This test shall qualify a welder for welding with electrodes of AWS A5.20 Specification, F6 Classification, flat, horizontal, and vertical positions, on single welded joints with backing and double welded joints, up to and including 3/4-inch thickness, and fillet welds of any thickness.

    9.2 The following welding procedures may be used with this qualification:

    GM-FC-U-1 GM-FC-U-2
    GM-FC-L-1 GM-FC-L-2
    GM-FC-P-1 GM-FC-P-2

Prepared by: W. P. Joest

Approved by:

Process Specification: 1.C.2.2

Sheet: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No.: GM-FC-6-L(2) Revision 1 Date: 1/31/80

1. Welding Process: Gas Metal Arc - Flux Cored

2. Electrode: E70T-1

3. Base Material: A36 (2) 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Overhead

5. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing

6. Welding Procedure: GM-FC-U-1

7. Mechanical Tests: 1 face bend and 1 root bend or radiographic tests per AWS D1.1

8. Limits of Qualification

   8.1 This test shall qualify a welder for welding with electrodes of AWS A5.20 Specification, F6 Classification, flat and overhead positions, on single welded joints with backing and double welded joints, up and including 3/4-inch thickness, and fillet welds of any thickness.

   8.2 The following welding procedures may be used with this qualification:

GM-FC-U-1	GM-FC-U-2
GM-FC-L-1	GM-FC-L-2
GM-FC-P-1	GM-FC-P-2

Prepared by: W. P. Joest

Approved by: R. M. [illegible]

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: GM-FC-6-L(3) Rev. 0 Date: 9-13-76

1. Welding Process: Gas Metal Arc - Flux Cored

2. Electrode: E70T-1

3. Base Material: A36 (2) 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Vertical

5. V Weld Progression: Vertical Up

6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing

7. Welding Procedure: GM-FC-U-2

8. Mechanical Tests: 1 face bend, 1 root bend per AWS D1.1, Rev. 2-74, Chapter 5 or radiographic tests

9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.20 Specification, F6 Classification, flat, horizontal, and vertical positions, on single welded joints with backing and double welded joints, up to and including 3/4-inch thickness, and fillet welds of any thickness.

9.2 The following welding procedures may be used with this qualification:

GM-FC-U-1
GM-FC-U-1
GM-FC-U-1
GM-FC-U-2
GM-FC-L-2
GM-FC-P-2

Prepared by W P [illegible]

Approved by Robert M. [illegible]

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: GM-FC-6-L(4) Rev. 0 Date: 9-13-76

1. Welding Process: Gas Metal Arc - Flux Cored

2. Electrode: E70T-1

3. Base Material: A36 (2) 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Overhead

5. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing.

6. Welding Procedure: GM-FC-U-2

7. Mechanical Tests: 1 face bend, 1 root bend per AWS D1.1-Rev. 2-74, Chapter 5 or radiographic tests

8. Limits of Qualification

8.1 This test shall qualify a welder for welding with electrodes of AWS A5.20 Specification, F6 Classification, flat and overhead positions, on single welded joints with backing and double welded joints, up to and including 3/4-inch thickness, and fillet welds of any thickness.

8.2 The following welding procedures may be used with this qualification:

GM-FC-U-1
GM-FC-L-1
GM-FC-P-1
GM-FC-U-2
GM-FC-L-2
GM-FC-P-2

Prepared by

Approved by

PERFORMANCE QUALIFICATION TEST

Test No.: GM-FC-6-H(1) Rev. 1 Date: 1-31-80

1. Welding Process: Gas Metal Arc - Flux Cored

2. Electrode: E70T-1

3. Base Material: A36(2) 1" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Vertical

5. Weld Progression: Vertical up

6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing

7. Welding Procedure: GM-FC-U-1

8. Mechanical Tests: Two side bends per AWS D1.1 Chapter 5 or radiographic tests

9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.20 Specification, F6 Classification, flat, horizontal, and vertical positions, on single welded joints with backing and double welded joints, and fillet welds, in unlimited thickness.

9.2 The following welding procedures may be used with this qualification:

GM-FC-U-1	GM-FC-U-2
GM-FC-L-1	GM-FC-L-2
GM-FC-P-1	GM-FC-P-2

Prepared by W. P. Frost

Approved by Robert M. Jessee

PERFORMANCE QUALIFICATION TEST

Test No.: GM-FC-6-H(2)   Rev. 1   Date: 1-31-80

1. Welding Process: Gas Metal Arc - Flux Cored

2. Electrode: E70T-1

3. Base Material: A36 (2) 1" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Overhead

5. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing

6. Welding Procedure: GM-FC-U-1

7. Mechanical Tests: 2 side bends per AWS D1.1 Chapter 5 or radiographic tests

8. Limits of Qualification:

8.1 This test shall qualify a welder for welding with electrodes of AWS A5.20 Specification, F6 Classification, flat horizontal and overhead position, on single welded joints with backing and double welded joints, and fillet welds, in unlimited thickness.

8.2 The following welding procedures may be used with this qualification:

GM-FC-U-1
GM-FC-L-1
GM-FC-P-1

GM-FC-U-2
GM-FC-L-2
GM-FC-P-2

Prepared by W. P. Jost

Approved by Robert M. Jesse

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: GM-FC-6-H(3) Rev. 0 Date: 9-13-76

1. Welding Process: Gas Metal Arc - Flux Cored

2. Electrode: E70T-1

3. Base Material: A36(2) 1" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Vertical

5. V Weld Progression: Vertical up

6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing

7. Welding Procedure: GM-FC-U-2

8. Mechanical Tests: 2 Side bends per AWS D1.1-Rev. 2-74, Chapter 5 or radiographic tests

9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.20 Specification, F6 Classification, flat, horizontal, and vertical positions, on single welded joints with backing and double welded joints, and fillet welds, in unlimited thickness.

9.2 The following welding procedures may be used with this qualification:

GM-FC-U-1
GM-FC-L-1
GM-FC-P-1
GM-FC-U-2
GM-FC-L-2
GM-FC-P-2

Prepared by D P Jost

Approved by Robert M.

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: GM-FC-6-H(4) Rev. 0 Date: 9-13-76

1. Welding Process: Gas Metal Arc - Flux Cored

2. Electrode: E70T-1

3. Base Material: A36 (2) 1" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Overhead

5. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing

6. Welding Procedure: GM-FC-U-2

7. Mechanical Tests: 2 Side bends per AWS D1.1-Rev. 2-74 Chapter 5 or radiographic tests

8. Limits of Qualification:

8.1 This test shall qualify a welder for welding with electrodes of AWS A5.20 Specification, F6 Classification, flat and overhead position, on single welded joints with backing and double welded joints, and fillet welds, in unlimited thickness.

8.2 The following welding procedures may be used with this qualification:

GM-FC-U-1 GM-FC-U-2
GM-FC-L-1 GM-FC-L-2
GM-FC-P-1 GM-FC-P-2

Prepared by W. P. Frost

Approved by Robert M Jesse

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-6-L(1) Rev. 0 Date: 7-31-74

1. Welding Process: Gas Metal Arc - Solid Wire

2. Electrode: E70S-3

3. Base Material: A36 (2) 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Vertical

5. V Weld Progression: Vertical up

6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing.

7. Welding Procedure: GM-SD-U-1

8. Mechanical Tests: 1 face bend, 1 root bend per AWS D1.1-Rev. 2-74, Chapter 5 or radiographic tests

9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.18 Specification, F6 classification, flat, horizontal, and vertical positions, on single welded joints with backing and double welded joints, up to and including 3/4-inch thickness, andfillet welds of any thickness.

9.2 The following welding procedures may be used with this qualification:

GM-SD-U-1
GM-SD-L-1
GM-SD-P-1

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-6-L(2) Rev.0 Date: 7-31-74

1. Welding Process: Gas Metal Arc - Solid Wire

2. Electrode: E70S-3

3. Base Material: A36 (2) 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Overhead

5. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing.

6. Welding Procedure: GM-SD-U-1

7. Mechanical Tests: 1 face bend, 1 root bend per AWS D1.1-Rev. 2-74, Chapter 5 . or radiographic tests

8. Limits of Qualification:

8.1 This test shall qualify a welder for welding with electrodes of AWS A5.18 Specification, F6 classification, flat, horizontal, and overhead positions, on single welded joints with backing and double welded joints, up to and including 3/4-inch thickness, and fillet welds of any thickness.

8.2 The following welding procedures may be used with this qualification:

GM-SD-U-1
GM-SD-L-1
GM-SD-P-1

Process Specification: 1.C.2.2
Date: 12/22/82
Sheet: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-6-L(3) Revision 1 Date: 12/22/82

1. Welding Process: Gas Metal Arc - Solid Wire

2. Electrode: E70S-3

3. Base Material: A36 (2) 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding).

4. Welding Position: Overhead and Vertical (upward progression)

5. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing.

6. Welding Procedure: GM-SD-P-2

7. Mechanical Tests: 1 face bend and 1 root bend per AWS-D1.1. Chapter 5 or radiographic tests.

8. Limits of Qualification

   8.1 This test shall qualify a welder for making fillet welds not exceeding 1/4" nominal size with electrodes of AWS A5.18 Specification, F6 classification, in the flat, horizontal, vertical, and overhead positions using the short-circuiting transfer mode only.

   8.2 The following welding procedure may be used with this qualification:

   GM-SD-P-2

Prepared by:
Reviewed by: W.P. Joest
Approved by: C.E. Roberts

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-6-L(4) Rev. 1 Date: 1-31-80

1. Welding Process: Gas Metal Arc - Solid Wire

2. Electrode: E70S-3

3. Base Material: A36 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Overhead and Vertical (upward progression)

5. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing.

6. Welding Procedure: GM-SD-U-2

7. Mechanical Tests: 1 face bend and 1 root bend per AWS-D1.1 Chapter 5 or radiographic tests

8. Limits of Qualification:

8.1 This test shall qualify a welder for welding with electrodes of AWS A5.18 Specification, F6 classification, in all positions, on single-welded joints with backing and double-welded joints in unlimited thickness, and fillet welds of any thickness.

8.2 The following welding procedure may be used with this qualification:

GM-SD-U-2

Prepared by W. P. Jost

Approved by Robert M Jesse

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-6-H(1) Rev. 0 Date: 7-31-74

1. Welding Process: Gas Metal Arc - Solid Wire

2. Electrode: E70S-3

3. Base Material: A36 (2) 1" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Vertical

5. V Weld Progression: Vertical up

6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing.

7. Welding Procedure: GM-SD-U-1

8. Mechanical Tests: 1 face bend, 1 root bend per AWS D1.1-Rev. 2-74, Chapter 5 or radiographic tests

9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.18 Specification, F6 classification, flat, horizontal, and vertical positions, on single welded joints with backing and double welded joints, and fillet welds, in unlimited thickness.

9.2 The following welding procedures may be used with this qualification:

GM-SD-U-1
GM-SD-L-1
GM-SD-P-1

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-6-H(2) Rev. 0 Date: 7-31-74

1. Welding Process: Gas Metal Arc - Solid Wire

2. Electrode: E70S-3

3. Base Material: A36 (2) 1" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)

4. Welding Position: Overhead

5. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing.

6. Welding Procedure: GM-SD-U-1

7. Mechanical Tests: 1 face bend, 1 root bend per AWS D1.1-Rev. 2-74, Chapter 5 or radiographic tests

8. Limits of Qualification:

8.1 This test shall qualify a welder for welding with electrodes of AWS A5.18 Specification, F6 classification, flat, horizontal, and overhead positions, on single welded joints with backing and double welded joints, and fillet welds, in unlimited thickness.

8.2 The following welding procedures may be used with this qualification:

GM-SD-U-1
GM-SD-L-1
GM-SD-P-1

Process Specification: 1.C.2.2(a)

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-6-H - Pipe Rev. 0 Date: 12/4/78

1. Welding Process: Gas Metal Arc-Solid Wire
2. Electrode Type: E7DS-3
3. Base Material: Carbon Steel Pipe, 6 inch schedule 80 or 8 inch schedule 120
4. Welding Positions: 2G + 5G or 6G
5. V Weld Progression: Vertical up
6. Weld Joint Design: 60° included angle, 1/4 inch nominal root opening with backing ring.
7. Welding Procedure: GM-SD-U-2
8. Mechanical Tests: 2 side bends for 2G position, 4 side bends for 5G and 6G positions per AWS D1.1, Chapter 5 or radiographic tests.
9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.18 Specification, F6 classification, in all positions, on single welded joints with backing and double welded joints, from 0.187 inch through unlimited thickness, and fillet welds of any thickness on plate or pipe 4 inch diameter and greater. (Not applicable to T, K, and Y connections.)

9.2 The following welding procedures may be used with this qualification:

GM-SD-U-2

Prepared by: J D White

Approved by: Robert M. Jessee

Process Specification: 1.C.2.2

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-6-4-L Revision: 0 Date: 9/10/81

1. Welding Process: Gas Metal Arc-Solid Wire
2. Electrode Type: E70S-3
3. Base Material: Carbon Steel Pipe, 2 inch, schedule 80 or 3 inch schedule 40.
4. Welding Positions: 2G + 5G or 6G
5. V Weld Progression: Vertical Up
6. Weld Joint Design: 60^{o} included angle, 1/8" inch nominal root opening.
7. Welding Procedure: GM-SD-P-2
8. Mechanical Tests: 1 face bend and 1 root bend for 2G position, 2 face bends and 2 root bends for 5G and 6G positions per AWS D1.1, Chapter 5, or radiographic tests.
9. Limits of Qualification:

9.1 This test shall qualify a welder for welding with electrodes of AWS A5.18 Specification, F6 Classification, in all positions, on single welded joints and on double welded joints, from 0.063 inch through 0.674 thickness, and fillet welds of any thickness on plate or pipe 4 inch diameter and smaller. (Not applicable to T, K, and Y connections.)

9.2 The following welding procedure may be used with this qualification within the thickness range specified::

GM-SD-P-2 (1/16" - 1/4")

Prepared by:

Approved by: C.E Roberts

PERFORMANCE QUALIFICATION TEST

Test No.: GMA-FC-6-H(Vert) Revision 0 Date: 1/8/80

1. Welding Process: Gas Metal Arc - Flux Cored
2. Electrode: E70T-1
3. Base Material: A36 (2) 1" th x 6" w x 15" lg (rolling direction of plate shall be transverse to the direction of welding)
4. Welding Position: Vertical
5. Weld Joint Design: 20^0 included angle, 5/8" root opening, backing strip 3/8" x 1-1/2" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing
6. Welding Procedure: GMA-FC-U-1 or GMA-FC-U-2
7. Mechanical Tests: 2 side bends per AWS D1.1, Chapter 5 or radiographic tests
8. Limits of Qualification:

8.1 This test shall qualify a welding operator for welding with electrodes of AWS A5.20 Specification, F6 Classification, in the vertical position on single welded joints with backing and double welded joints, and fillet welds, in unlimited thickness.

8.2 The following welding procedures may be used with this qualification:

GMA-FC-U-1	GMA-FC-U-2
GMA-FC-P-1	GMA-FC-U-2a

Prepared by

Approved by W.P. Joest

PERFORMANCE QUALIFICATION TEST

Test No.: GMA-FC-6-H(Horiz)   Revision 0   Date: 1/8/80

1. Welding Process: Gas Metal Arc - Flux Cored
2. Electrode: E70T-1
3. Base Material: A36 (2) 1" th x 6" w x 15" lg (rolling direction or plate shall be transverse to the direction of welding)
4. Welding Position: Horizontal
5. Weld Joint Design: 20^0 included angle, 5/8" root opening, backing strip 3/8" x 1-1/2" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing
6. Welding Procedure: GMA-FC-U-1 or GMA-FC-U-2
7. Mechanical Tests: 2 side bends per AWS D1.1, Chapter 5 or radiographic tests
8. Limits Of Qualification:

   8.1 This test shall qualify a welding operator for welding with electrodes of AWS A5.20 Specification, F6 Classification, in the horizontal position, on single welded joints with backing and double welded joints, and fillet welds, in unlimited thickness.

   8.2 The following welding procedures may be used with this qualification:

   GMA-FC-U-1   GMA-FC-U-2
   GMA-FC-P-1   GMA-FC-U-2a

Prepared by:

Approved by:

PERFORMANCE QUALIFICATION TEST

Test No.: GMA-FC-6-H(Flat) Revision 0 Date: 1/8/80

1. Welding Process: Gas Metal Arc - Flux Cored
2. Electrode: E70T-1
3. Base Material: A36 (2) 1" th x 6" w x 15" lg (rolling direction of plate shall be transverse to the direction of welding)
4. Welding Position: Flat
5. Weld Joint Design: 20^{0} included angle, 5/8" root opening, backing strip 3/8" x 1-1/2" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing
6. Welding Procedure: GMA-FC-U-1 or GMA-FC-U-2
7. Mechanical Tests: 2 side bends per AWS D1.1, Chapter 5 or radiographic tests
8. Limits of Qualification:

8.1 This test shall qualify a welding operator for welding with electrodes of AWS A5.20 Specification, F6 Classification, in the flat position, on single welded joints, with backing and double welded joints, and fillet welds, in unlimited thickness.

8.2 The following welding procedures may be used with this qualification:

GMA-FC-U-1	GMA-FC-U-2
GMA-FC-P-1	GMA-FC-U-2a

Prepared by:

Approved by: W.P. Jost

Process Specification: 1.C.3.1(R1)
Date: March 4, 1983
Sheet: 1 of 1

PEENING PROCEDURE

1.0 PURPOSE AND SCOPE

1.1 This procedure defines the requirements for performing peening operations approved by the Engineer (EN DES) in accordance with the AWS Structural Welding Code D1.1.

1.2 Peening in accordance with this procedure is intended to control distortion caused by welding, by judiciously peening each weld bead.

2.0 PERSONNEL

2.1 Personnel shall be familiar with the requirements of this specification prior to production peening.

3.0 PEENING TOOLS

3.1 Hammer - Peening shall be performed using a pneumatic hammer, similar to a Chicago Pneumatic No. 2 or heavier, capable of deforming each weld bead sufficiently to relieve shrinkage stress and control distortion.

3.2 Tool - A wide, blunt tool of the configuration shown shall be used.

3.3 Air pressure 85 to 95 lb/in^2 (approximately).

4.0 SEQUENCE OF OPERATIONS

4.1 Peening shall not be performed on the first 3/8-inch of weld deposit, the final layer, or the base metal at the edges of the weld.

4.2 Peen each layer until the deposited bead begins to flake or as necessary to achieve the desired movement between the parts being welded.

4.3 Peening will be done with the long dimension of the tool, parallel with the axis of the welded joint in order to spread the weld metal and counteract the shrinkage.

Prepared by: 4/18/83
Reviewed by: W.P. 4/18/83
Approved by: C.E. 4/18/83

PEENING PERFORMANCE QUALIFICATION TEST

1.0 PURPOSE AND SCOPE

1.1 This procedure defines the requirements for qualification of personnel to perform peening operations approved by the Engineer (EN DES) in accordance with the AWS Structural Welding Code D1.1.

1.2 Performance qualification is intended to determine the ability of personnel to judiciously peen a weld deposit and control residual stresses and/or distortion caused by welding.

2.0 REQUIREMENTS

2.1 Personnel performing peening operations shall be required to pass a performance qualification test prior to performing production peening. Several men may qualify on one test assembly provided each man peens two layers.

2.2 Performance tests shall be conducted by a person designated as the Test Supervisor. The Test Supervisor shall determine that all requirements of the performance test are followed.

2.3 A record of all qualification tests, including those which have been terminated or otherwise failed to meet requirements shall be kept on file and shall include the test condition results (record form attached).

3.0 TEST DESCRIPTION

3.1 Welding Procedure: Process Specification 1.C.1.2(R2)-SM-U-1

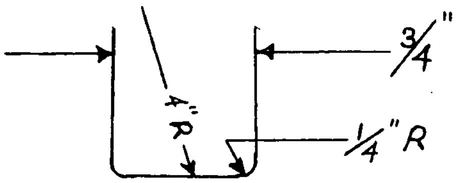
3.2 Base Material: Use two closure plates modified per sketch 1 for each test assembly.

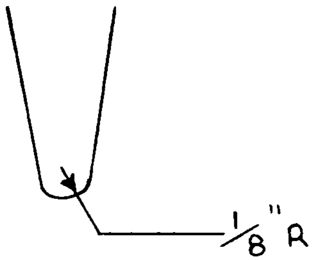
3.3 Welding and Peening Position: Vertical

3.4 Weld Joint Design: See sketch 1

3.5 Peening Procedures:

3.5.1 Peening Tool Design





3.5.2 Sequence of Operations

3.5.2.1 Do not peen the weld until the weld throat is at least 3/8-inch in depth and the free plate has started to produce angular distortion.

3.5.2.2 Peen all subsequent layers (after slag removal). This peening is to be performed uniformly along the weld until the angular distortion has been corrected as observed by holding a straight edge against and across the back of the two plates at the top, middle, and bottom as indicated (see sketch 1).

Prepared by: W. P. Jost 4-18-83
Reviewed by: 4-18-83
Approved by: C. E. Roberts 4/18/83

Process Specification: 1.C.4.1 (R1)
Date: 3/4/83
Sheet: 3 of 4

TENNESSEE VALLEY AUTHORITY

PEENING PERFORMANCE QUALIFICATION RECORD

Name ____________ Badge No. ____________ Stamp No. ____________

Welding Process ____________ Manual _____ Semi-Automatic _____ Automatic _____

Welder _____ Welding Operator _____ Welding Procedure No. ____________ Rev _____

Position of test plate or pipe ____________ Qualifying for ____________

Mtl. Spec. ____________ To ____________ P No. ________ to P No. ________

Diameter and/or thickness ____________ Range Qualified ____________

GROOVE WELDS
Guided Bend Tests

Type	Position and Specimen No.	Results

Department conducting test ____________

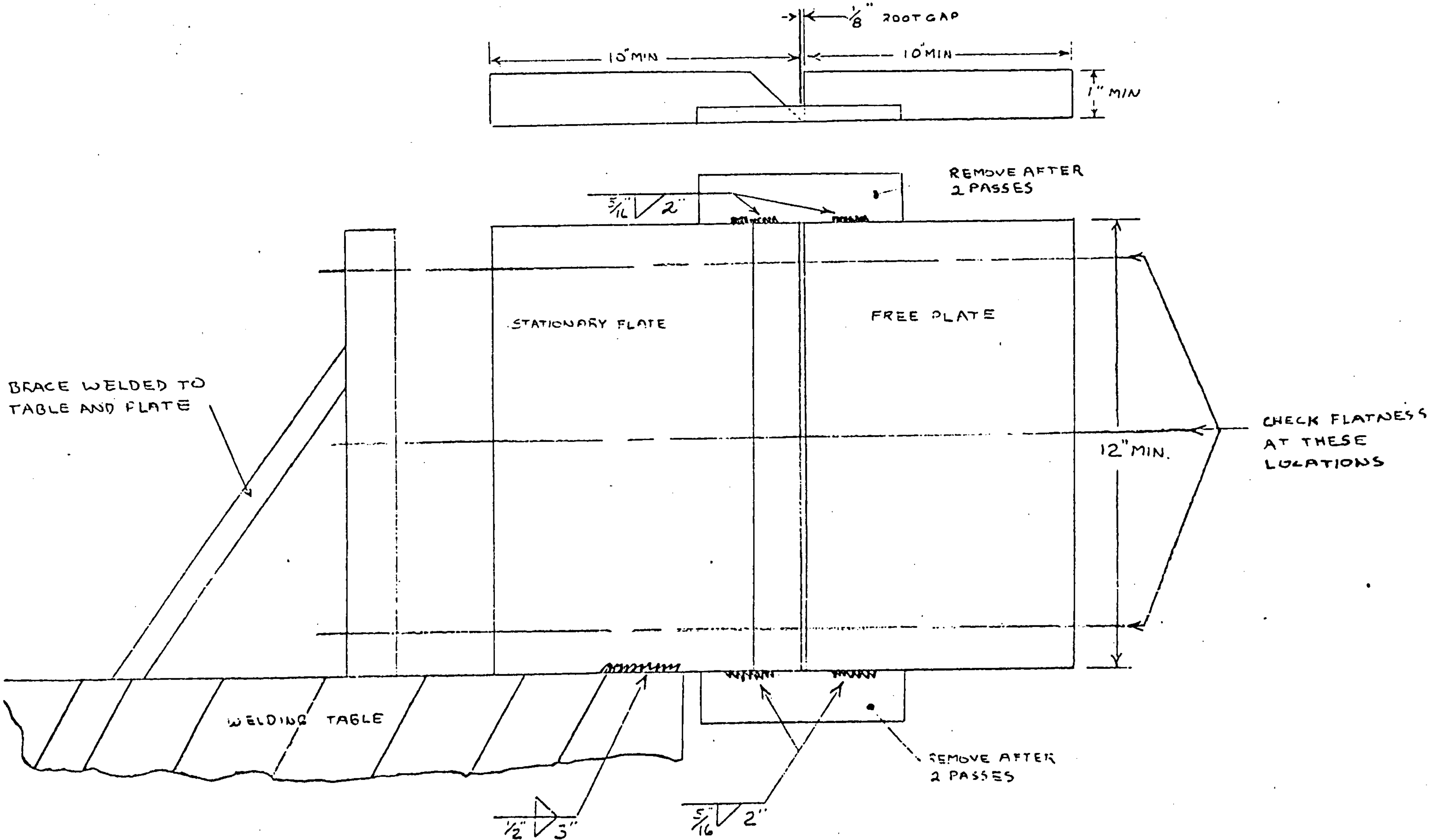
Test No. ____________

Testing Lab. ____________

☐ We certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of P.S. 1.C.3.1

Date ____________ By ____________

SKETCH 1
WELD PEENING TEST ASSY.



Process Specification: 2.C.1.1 (R0)
Date: 3/4/83
Sheet: 1 of 3

TENNESSEE VALLEY AUTHORITY
SPECIFICATION FOR POSTWELD HEAT TREATMENT OF AWS WELDMENTS

1.0 GENERAL

1.1 Scope

This specification defines the requirements for postweld heat treatment, in accordance with AWS D1.1, 1979 revision.

2.0 METHOD OF POSTWELD HEAT TREATMENT

Postweld heat treatment shall be accomplished by one of the following methods:

2.1 Heating in a Furnace

2.1.1 The item shall be heat treated in a closed furnace whenever practical.

2.1.2 The assembly may be heated in more than one heat if the overlap of the heated sections as at least 5 feet. The cross-section where the assembly projects from the furnace shall not intersect a structural discontinuity.

2.2 Heating the Assembly Outside the Furnace

2.2.1 The assembly may be heated outside the furnace when adequate temperature indicating and recording devices are used to aid in the control and maintenance of temperature in the assembly. Prior to this operation, the portion of the assembly to be heated shall be fully enclosed with insulating materials.

2.2.2 When local heating of a portion of an assembly is performed, the portion heated must be free to expand and contract without damaging nonheated portions of the assembly and adjacent components.

2.3 Heat Treating Quenched and Tempered Steel

2.3.1 Weldments in A514, A517, and A709, grades 100 and 100W steels shall not be stress relieved without the consent of EN DES.

3.0 HEATING AND COOLING

3.1 Heating

3.1.1 The temperature of the furnace shall not exceed 600°F at the time the welded assembly is placed in it.

3.1.2 Above 600°F the rate of heating shall not be more than 400°F per hour divided by the maximum metal thickness of the thicker part in inches, but in no case more than 400°F per hour. During the heating period, variation in temperature throughout the portion of the part being heated shall be no greater than 250°F within 15-foot interval of length.

3.1.3 After a maximum temperature of 1100°F is reached on quenched and tempered steels, or a mean temperature range between 1100 and 1200°F is reached on other steels, the temperature of the assembly shall be held within the specified limits for a time not less than specified in Table 1, based on weld thickness. When the specified stress relief is for dimensional stability, the holding time shall be not less than specified in Table 1, based on the thickness of the thicker part. During the holding period there shall be no difference greater than 150°F between the highest and lowest temperature throughout the portion of the assembly being heated.

Table 1 - Minimum Holding Time

1/4 In. (6.4 mm) or Less	Over 1/4 In. (6.4 mm) through 2 In. (51 mm)	Over 2 In. (51 mm)
15 min	1 hr/in.	2 hrs plus 15 min for each additional in. over 2 in. (51 mm)

3.2 Alternative Heating

3.2.1 Alternatively, when it is impractical to postweld heat treat to the temperature limitations stated in section 3.1 welded assemblies may be stress relieved at lower temperatures for longer periods of time as given in Table 2.

Table 2 - Alternative Stress Relief Heat Treatment

Decrease in Temperature Below Minimum Specified Temperature		Minimum Holding Time at Decreased Temperature, Hours per Inch of Thickness
°F	°C	
50	10	2
100	38	3
150	66	5
200	93	10

3.3 Cooling

3.3.1 Above 600°F cooling shall be done in a closed furnace or cooling chamber at a rate no greater than 500°F per hour divided by the maximum metal thickness of the thicker part in inches, but in no case more than 500°F per hour. From 600°F the assembly may be cooled in still air.

4.0 EQUIPMENT

4.1 Heating Devices

4.1.1 Heating shall be by electric inductance, electric resistance, or gas-fired equipment. The flame of gas-fired equipment shall not impinge on items being heated.

4.1.2 The furnace or heating device atmosphere shall be controlled to prevent excessive oxidation of the heat-treated item. Inert gas shall be used to prevent oxidation of critical items.

4.2 Temperature Measurements

4.2.1 Temperature shall be determined using thermocouples attached to the surface of the heated zone of the item. The temperature indicating and recording device (when required) shall be calibrated in accordance with the OEDC Quality Assurance Program.

4.2.2 The temperature of the heated zone shall be determined at a minimum of two locations. These locations shall be the anticipated hottest and coldest locations (e.g., for horizontal assembly at the top and bottom of the assembly).

Prepared by: 4/4/83

Reviewed by: W. P. Joest 4/14/83

Approved by: C. E. Roberts 4/14/83

Process Specification: 3.C.1.1 (R1)
Date: 3/4/83
Sheet: 1 of 5

TENNESSEE VALLEY AUTHORITY

SPECIFICATION FOR LIQUID PENETRANT EXAMINATION SOLVENT REMOVABLE METHOD

1.0 SCOPE

1.1 This process specification defines the requirements for Liquid Penetrant Examination to be used when examining welded joints in accordance with the American Welding Society, Structural Welding Code D1.1 (except bridges).

1.2 This specification may also be used for examination of other components or welds when specified by Division of Engineering Design. (This specification is technically identical with Process Specification 3.C.1.1(a) with Addenda 1-3).

2.0 DESCRIPTION OF METHOD

2.1 Liquid penetrant examination is a method of non-destructive examination which provides for the detection of discontinuities which are open to the surface, in both ferrous and non-ferrous materials.

2.2 Typical discontinuities detectable by this method of examination are cracks, seams, laps, cold shuts, laminations, slag and porosity.

2.3 A liquid penetrant is applied to the surface to be examined and allowed to enter openings or discontinuities which may exist. The excess penetrant is then removed, followed by drying of the part. A developer is then applied, which is wetted or otherwise affected by the penetrant material entrapped in the openings of discontinuities. The entrapped penetrant material may then be seen directly due to the contrast in color between the penetrant material and surrounding developer.

3.0 METHOD

3.1 A color contrast penetrant of the solvent removable type only shall be used under the provisions and requirements of this specification.

3.2 All penetrant materials shall be analyzed for sulfur and halogens by evaporating a 100-gram sampled of the material for 3 hours at 90 to 100°C or its boiling point, whichever is lower.

3.2.1 The material shall be acceptable if the residue does not exceed 0.005 gram.

3.2.2 If the residue exceeds 0.005 gram, it shall be analyzed for sulfur and halogens (ASTM D129-64 and D808-63). The total sulfur or halogen content of the residue shall not exceed 1 percent.

3.2.3 Certification of test results of each batch of penetrant material shall be filed by contract or project for future reference.

3.3 Penetrant materials of other types, such as water washable type, shall not be intermixed with the solvent removable type. All penetrant materials for a particular examination shall be supplied by the same manufacturer.

4.0 METHOD REQUIREMENTS

4.1 Surface Preparation

4.1.1 Surfaces may be examined in the as-welded, as-rolled, as-cast, or as-forged condition providing that surface irregularities will not mask the indications resulting from unacceptable defects. In such cases, grinding or machining may be necessary to provide an acceptable surface for examination.

4.1.2 Prior to liquid penetrant examination, the surface to be examined and the adjacent area within at least one inch of the area to be examined shall be dry and free of dirt, lint, scale, welding slag or flux, spatter, oil or other extraneous matter that might obscure surface openings or otherwise interfere with the examination. Cleaning solvent shall meet the requirements of section 3.2.

4.2 Drying

4.2.1 Drying of surfaces to be examined may be done by normal evaporation or by the use of forced warm air. Prior to the drying operation, the surface to be examined shall be wiped with a clean, lint-free, dry cloth or absorbent paper and the excess cleaning solvent shall be allowed to evaporate for a minimum of 5 minutes.

4.3 Temperature

4.3.1 The temperature of the surfaces to be examined shall be a minimum of 60°F and a maximum of 125°F (90°F maximum if possible) throughout the examination. Local heating or cooling is permissible in order to maintain the specified temperature range.

4.4 Application of Penetrant

4.4.1 Penetrant may be applied by dipping, spraying, or brushing, but not by immersion. If applied by spraying with the use of compressed air, filters shall be installed in the compressed air lines to prevent the inclusion of dirt, oil, or water that may have collected in the air lines.

4.5 Penetration Time

4.5.1 After application of penetrant, a minimum of 10 minutes shall elapse prior to initiation of penetrant removal.

4.6 Removal of Excess Penetrant

4.6.1 After the specified penetration time has elapsed, excess penetrant shall be removed with clean, dry cloths or absorbent paper. Care shall be taken to remove as little penetrant as possible from openings or discontinuities. This operation shall be repeated until most traces of penetrant have been removed from the surfaces.

4.6.2 A clean, dry cloth or absorbent paper shall then be moistened with solvent and remaining traces of penetrant removed by wiping lightly. Excess solvent should not be used for this operation in order to prevent the removal of penetrant from discontinuities. Flushing of the surface with solvent shall be prohibited.

4.7 Drying

4.7.1 Drying of the surface being examined shall be accomplished by normal evaporation for a minimum of 5 minutes.

4.8 Application of Developer

4.8.1 Liquid developer shall be applied by spraying on the examination surface and shall be applied within 10 minutes after removal of excess penetrant.

4.8.2 Prior to application of the developer, the solution shall be agitated to ensure dispersal of the particles in suspension.

4.8.3 The developer shall be applied in such a manner that will produce a fairly uniform white coating. Surface discontinuities will be evident in areas where the penetrant bleeds out in a deep red color. Indications of a light pink color may indicate either inadequate or excessive cleaning. Care shall be taken in the application of the developer so as not to apply a coating so thin that dye will not be drawn out of discontinuities, or so thick that pooling will result and mask indications.

5.0 EXAMINATION

5.1 The true size and nature of discontinuities are difficult to evaluate if the dye diffuses excessively in the developer; therefore, it is good practice to observe the surface being examined during application of the developer in order to detect the nature of certain indications which tend to bleed out profusely.

5.2 Final interpretation and evaluation of indications shall be made after a minimum of 7 minutes has elapsed after application of the developer, and within 30 minutes after application of developer.

5.3 If the surface being examined is of sufficient area to preclude complete examination within the prescribed time, the area shall be examined in suitable increments.

5.4 Adequate lighting shall be provided in the examination area to prevent loss of sensitivity in the examination.

5.5 Examination of ASTM A514 and A517 steels shall be performed not less than 48 hours after completion of welding.

6.0 EVALUATION OF INDICATIONS

6.1 Mechanical discontinuities will be indicated by bleeding out of the penetrant, resulting in either non-relevant or relevant indications. All indications shall be evaluated in terms of the acceptance standards.

6.2 Non-relevant Indications

6.2.1 Any indication which is believed to be non-relevant shall be regarded as unacceptable until the indication is eliminated by surface conditioning or evaluated by other non-destructive means and demonstrated to be non-relevant. For example, localized surface imperfections such as machining marks or other surface conditions may produce indications similar to those of relevant indications and which may or may not be relevant. Broad areas of pigmentation which would mask indications of discontinuities are not acceptable.

6.3 Relevant Indications

6.3.1 Relevant indications are those which result from mechanical discontinuities.

7.0 ACCEPTANCE CRITERIA

A weld shall be acceptable by liquid penetrant examination if it shows that:

7.1 The weld has no cracks.

7.2 Thorough fusion exists between weld metal and base metal.

7.3 The sum of diameters of piping porosity does not exceed 3/8-inch in any linear inch of weld nor does it exceed 3/4-inch in any 12-inch length of weld.

8.0 DEFECT REMOVAL AND REPAIR

8.1 Defects which are not acceptable shall be removed and the defect area reexamined to assure complete removal.

8.2 Whenever a defect is removed and repair by welding is not required, the area shall be blended into the surrounding surface so that no notches, crevices or corners exist.

8.3 Whenever a defect is removed and repair by welding is required, the area shall be cleaned of all penetrant materials for a distance of at least one inch surrounding the defect area. Welding shall be performed in accordance with a qualified procedure by qualified welders. Completed repairs shall be reexamined to the original requirements.

9.0 POST-EXAMINATION CLEANING

9.1 After completion of all examinations, including those of repaired areas, the examined area shall be cleaned by wiping with clean dry cloth or paper, followed by wiping with cloth or paper saturated with acetone or isopropyl alcohol.

10.0 RECORDS

10.1 A record shall be made of all examinations.

10.2 Recommended record forms are included in attachments A and B.

Prepared by 4/15/83
Reviewed by Robert M [illegible] 4/15/83
SNT-TC-1A, Level III
Approved by C E Roberts 4/18/83

Process Specification: 3.C.1.1 (R1)
Date: 3/4/83
Attachment A

RECORD OF LIQUID PENETRANT EXAMINATION

Examination Procedure No. ____________________________

Penetrant Type ____________________ Brand Name ______________

Penetrant Remover ____________________ Brand Name ______________

Developer ____________________ Brand Name ______________

Part Temperature ____________________ Weld Joint No. ______________

Drying Time ____________________ Location ______________

Penetrating Time ____________________

Developing Time ____________________

Results of Examination:

Extent of Repair:

Weld Procedure No. ________

Results of Examination after Repair:

Date of Examination:

By ____________________________

SNT-TCIA Level ______________

DE03:PS3C11.1

ATTACHMENT B

Card F W

PENETRANT EXAMINATION
QCI N101 R ___
QCI N102 R ___

A MATERIAL BRAND & TYPE ______________________

B INDICATIONS NOTED ______ . ______________________

C RESULTS ______________________ ACC ________ REJ ______

COMMENTS ____

____

____

INSPECTOR ______________________ LEVEL ____________ DATE ________

TVA 103

Card F

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Weld No.	T															

R/E - F	TEST CODE		REJ. CD.	INCHES	
17	18	19	20	21	22
.	P	T			

SPECIFICATION FOR DRY MAGNETIC PARTICLE EXAMINATION OF WELDS

1.0 Scope

1.1 This specification defines the requirements for magnetic particle examination of welded joints in structures fabricated in accordance with the American Welding Society Structural Welding Code, D1.1-79.

1.2 This specification may also be used for other examinations when specified by the Division of Engineering Design. (This specification is technically identical with Process Specification 3.C.2.1(b) with Addendum 1.)

2.0 Description of Method

2.1 Magnetic particle examination is a nondestructive technique for detecting discontinuities on or near the surface of ferromagnetic materials.

2.2 Finely divided magnetic particles are applied to the magnetized surface of a weldment. The particles are attracted to regions of magnetic nonuniformity associated with defects and other discontinuities, thus producing visually apparent indications.

3.0 Surface Preparation

3.1 The surface to be examined shall be clean and dry. It shall be free of oil, sand, loose rust and scale, and weld spatter.

3.2 The surface may be examined in the as-welded condition if the surface irregularities will not mask indications of unacceptable discontinuities. A light grind may be necessary to provide an acceptable surface for examination.

4.0 Magnetization Equipment

Magnetization shall be by contact electrodes or yokes.

4.1 Prods shall be used at a spacing of 6 to 8 inches unless the geometry of the weldment does not permit; in such cases, a minimum prod spacing of 2 inches may be used.

4.1.1 The prods shall have a remote control switch to control the current. The current shall not be turned on until the prods are positioned on the surface and shall be turned off before the prods are removed.

4.1.2 The magnetizing current shall be half wave or direct current in accordance with the following:

Prod Spacing	Amperage Section Thickness Under 3/4"	Amperage Section Thickness 3/4" & Over
2" to 4"	200-300	300-400
Over 4" to less than 6"	300-400	400-600
6" to 8"	400-600	600-800

4.2 Yokes shall have the following minimum lifting power:

4.2.1 AC Yokes--10 pounds at the maximum pole spacing is to be used.

4.2.2 DC or Permanent Magnet Yokes--40 pounds at the maximum pole spacing is to be used.

5.0 Examination Medium

5.1 The examination medium shall be dry powder of high permeability and low retentivity with suitable sizes and shapes to readily produce magnetic particle indications.

5.2 The powder color shall provide adequate contrast with the background of the surface being examined.

6.0 Examination Technique

6.1 Each area shall be examined twice. The first examination shall be with the lines of magnetic flux perpendicular to the direction of expected discontinuities. The lines of flux of the second examination shall be approximately perpendicular to those of the first examination.

6.2 Each examination shall be conducted with sufficient overlap to ensure complete coverage of the area of interest.

6.3 Examination shall be by the continuous method. The magnetizing force shall be applied during the time the powder is applied and removed.

6.4 The powder shall be applied lightly and sparingly. The excess powder shall be removed with a gentle air stream controlled to not disturb lightly held powder patterns.

6.5 Examination of ASTM A 514 and A 517 steels shall be performed not less than 48 hours after completion of welding.

7.0 Evaluation of Indications

7.1 Adequate light shall be provided for easy observation of indications.

7.2 The formation of indications shall be observed carefully while the powder is applied and while the excess is removed.

8.0 Acceptance Criteria

8.1 The following discontinuities are unacceptable for welds evaluated to the requirements of Section 8, Design of New Buildings, and Section 10, Design of New Tubular Structures, of the Structural Welding Code. (Appendix A may be used in lieu of the requirements of 8.1.)

8.1.1 Cracks

8.1.2 Discontinuities exceeding the values of Table 1 and the accompanying notes. The following definitions apply to Table 1:

Aligned Indications - Three or more indications oriented such that the middle indications touch a line drawn through the two indications at either end.

Indication Accumulation (IA) - The sum of the greatest dimensions of all aligned indications.

Weld Size - Leg length of a fillet, the base material thickness for a full penetration buttweld, the bevel depth for a partial penetration weld, or the bevel depth plus the fillet leg length of a fillet reinforced butt or tee weld.

Table 1

Weld size (w)	Maximum indication size allowable	For aligned indications the maximum IA in a length L (1), (2)	
		IA	L
0 to 1/4-inch inclusive	3/32-inch	1/8-inch	3/4-inch
Greater than 1/4-inch to 1/2-inch inclusive	5/32-inch	1/4-inch	1-1/2 inch
Greater than 1/2-inch to 3/4-inch inclusive	5/16-inch	1/2-inch	3 inch
Greater than 3/4-inch to 1-1/8 inch	1/2-inch	3/4-inch	4-1/2 inch
Greater than 1-1/8 inch	3/4-inch	w	6w

Notes:

(1) For welds with a total length (s) less than L the maximum IA shall be s/L x weld size.

(2) An aligned indication 3/32-inch or greater separated by less than three times its greatest dimension from an adjacent indication shall be evaluated as one continuous indication.

8.1.3 Any indication 3/32-inch or greater, closer than three times its greatest dimension from the end of a weld.

8.1.4 Independent of the requirements of sections 8.1.2 and 8.1.3, discontinuities having a greatest dimension of less than 3/32-inch, if the sum of their greatest dimensions exceeds 3/8-inch in any linear inch of weld.

Appendix B provides examples of the above acceptance criteria.

8.2 The following discontinuities are unacceptable for welds required to be evaluated to the requirements of Section 9, Design of New Bridges, of the Structural Welding Code: (Appendix D may be used in lieu of the requirements of section 8.2)

8.2.1 Cracks

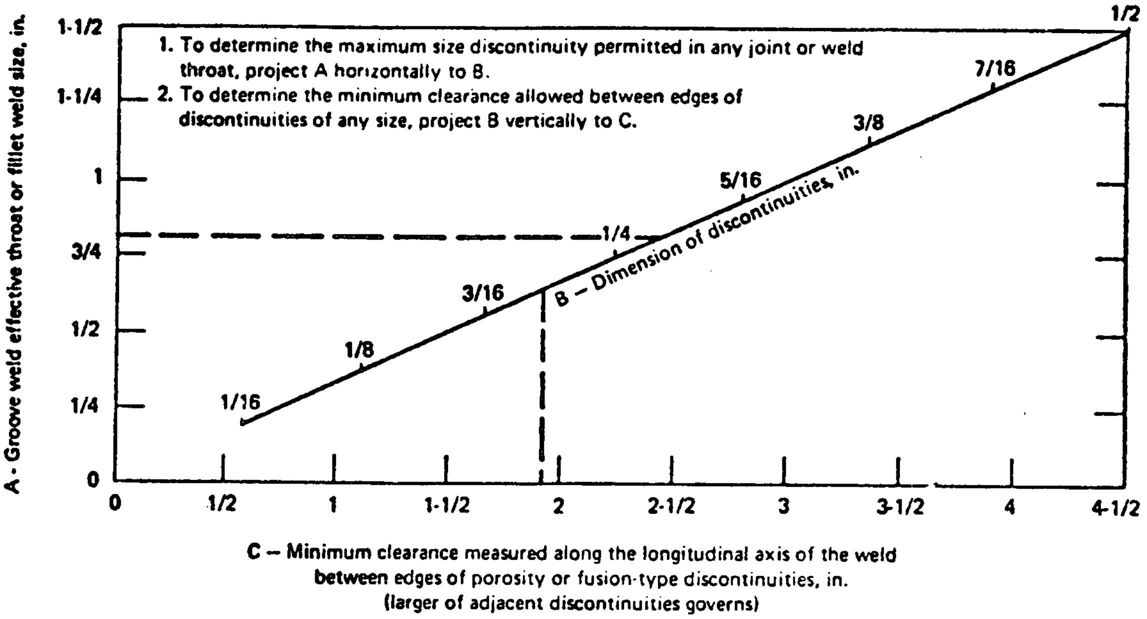
8.2.2 Any porosity or fusion-type discontinuity for which the greatest dimension is 1/16-inch or larger shall not exceed the size, B, indicated in Figure 1 for the effective throat or weld size involved.

8.2.3 The distance from any porosity or fusion-type discontinuity described above to another such discontinuity, to an edge, or to any intersecting weld shall not be less than the minimum clearance allowed, C, indicated by figure 1 for the size of discontinuity under examination.

8.2.4 Independent of the requirements of sections 8.2.2 and 8.2.3, discontinuities having a greatest dimension of less than 1/16-inch shall be unacceptable if the sum of their greatest dimension exceeds 3/8-inch in any linear inch of weld.

Appendix C provides an example of the acceptance criteria of section 8.2.

Note 1: The criteria of section 8.2 of Appendix D meet or exceed the requirements of all examinations performed to the AWS Structural Welding Code and may be used to establish a uniform standard.



Note: Adjacent discontinuities, spaced less than the minimum spacing required by Fig. 1 shall be measured as one length equal to the sum of the total length of the discontinuities plus the length of the space between them and evaluated as a single discontinuity.

FIGURE 1 - WELD QUALITY REQUIREMENTS FOR DISCONTINUITIES OCCURRING IN TENSION WELDS (LIMITATION OF POROSITY AND FUSION-TYPE DISCONTINUITIES)

9.0 Records

A record shall be kept of each examination and shall contain the following information:

Identification of weld and area examined
Disposition of area examined
Type of magnetizing current
Examiner and SNT-TC-1A level
Date of examination

Prepared by 4-15-83

Reviewed by 4-15-83
SNT-TC-1A, Level III

Approved by C E Roberts 4/15/83

APPENDIX A

In lieu of the requirements of section 8.1, the following may be used as the acceptance criteria for welds fabricated to the requirements of Section 8, Design of New Buildings, of the Structural Welding Code:

8.1 The following discontinuities are unacceptable:

8.1.1 Cracks

8.1.2 Individual discontinuities having a greatest dimension of 3/32-inch (2.4 mm) or greater, if:

8.1.2.1 The greatest dimension of a discontinuity is larger than 2/3 of the effective throat, 2/3 the weld size, or 3/4-inch (19.0 nm).

8.1.2.2 The discontinuity is closer than three times its greatest dimension to the end of a groove weld subject to primary tensile stresses.

8.1.2.3 A group of such discontinuities is in line such that:

(a) The sum of the greatest dimensions of all such discontinuities is larger than the effective throat or weld size in any length of six times the effective throat or weld size. When the length of the weld being examined is less than six times the effective throat or weld size, the permissible sum of the greatest dimensions shall be proportionally less than the effective throat or weld size.

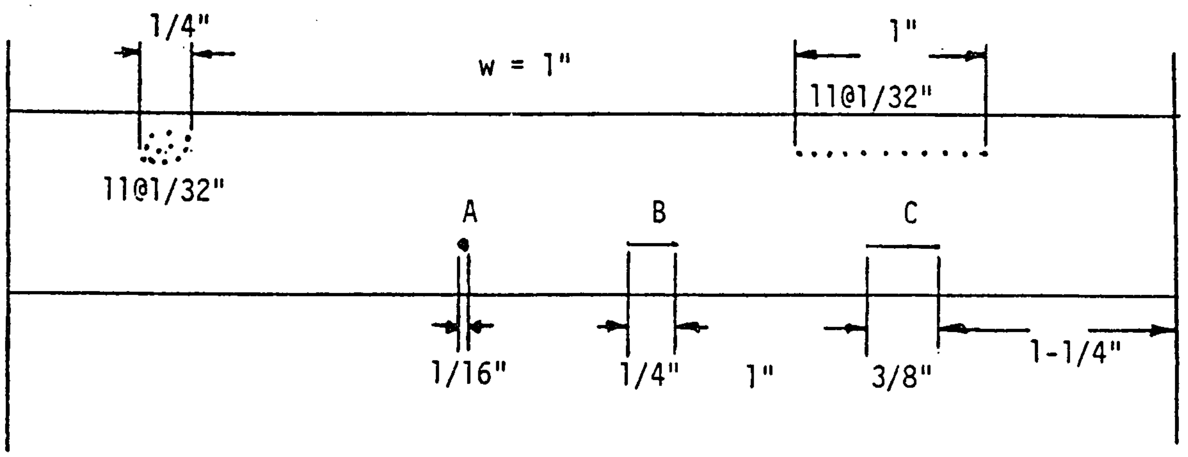
(b) The space between two such discontinuities which are adjacent is less than three times the greatest dimension of the larger of the discontinuities in the pair being considered.

8.1.3 Any indication 3/32-inch or greater, closer than three times its greatest dimension from the end of a weld.

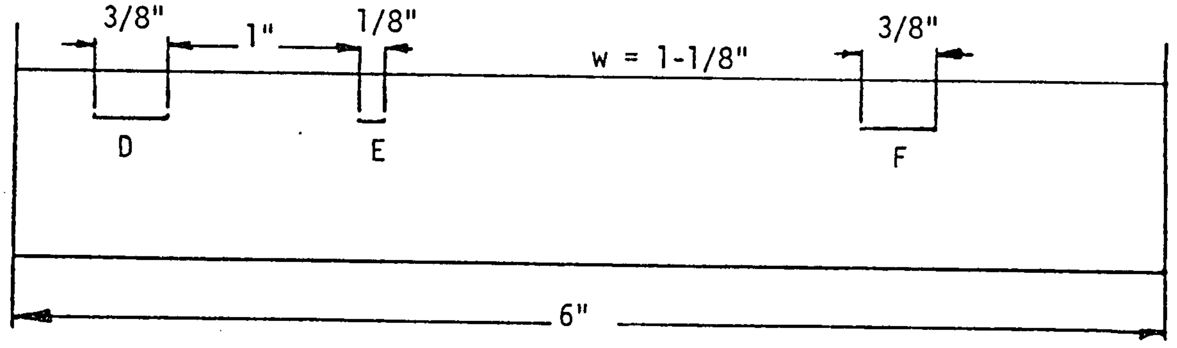
8.1.4 Independent of the requirements of sections 8.1.2 and 8.1.3, discontinuities having a greatest dimension of less than 3/32-inch, if the sum of their greatest dimensions exceeds 3/8-inch in any linear inch of weld.

Appendix B provides examples of the above acceptance criteria.

APPENDIX B

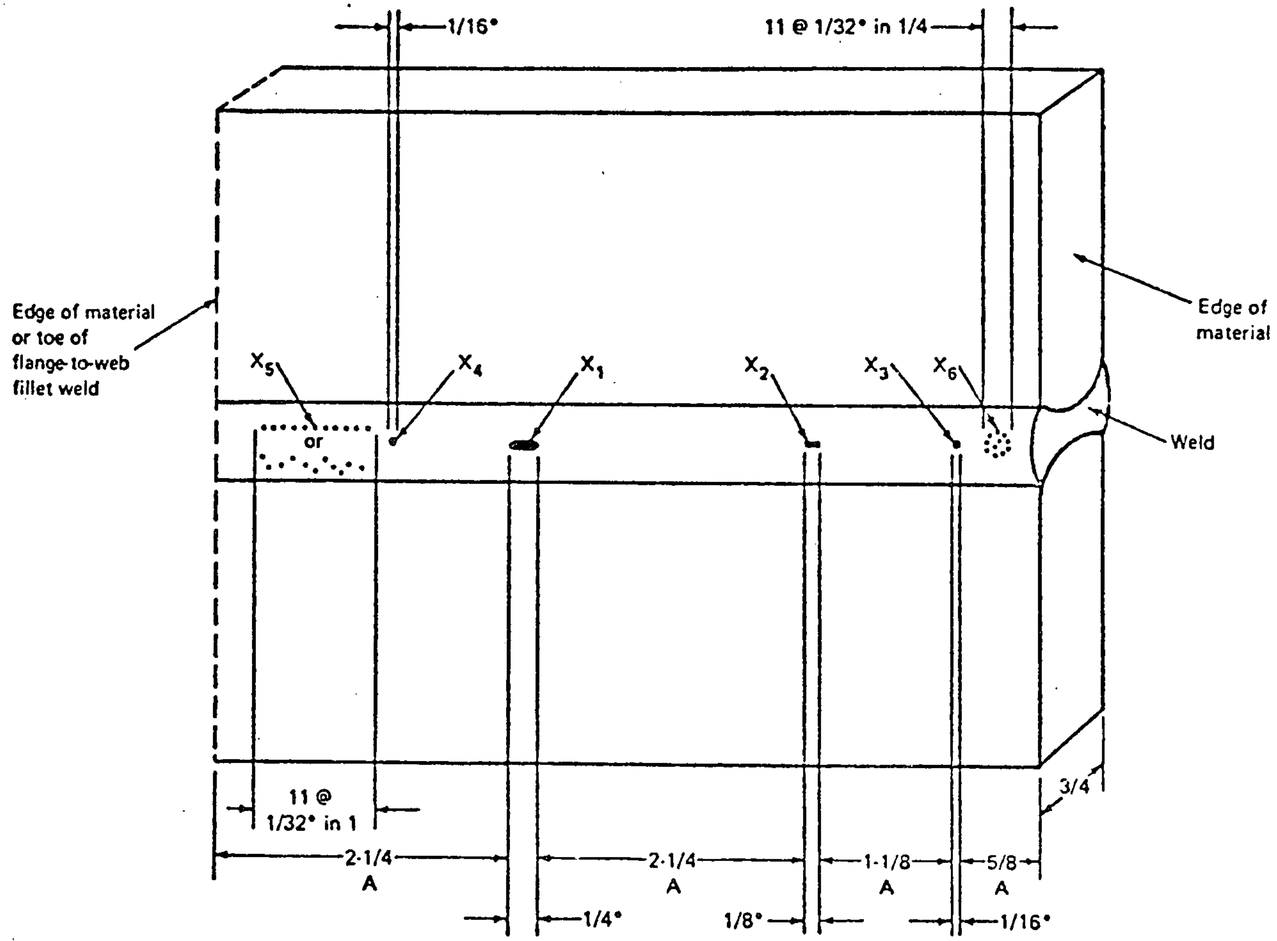


C is not counted in accumulation for 1 inch (See 5.2.4).
A, B, and C are not considered aligned because A, being less than 3/32", is not evaluated as an aligned indication.
C is more than 3 times its greatest dimension from the end of the weld and is acceptable.



D, E, and F are aligned indications and indication accumulation (IA) is acceptable.
D and E are rejectable because they are closer than 3 times the size of D to each other. Removal of either D, E, or F would make this weld acceptable.

APPENDIX C
WELD QUALITY REQUIREMENTS FOR BRIDGES



Notes:

1. A - minimum clearance allowed between edges of porosity of fusion-type discontinuities 1/16-inch or larger. Larger of adjacent discontinuities govern.
2. X_1- largest permissible porosity or fusion-type discontinuity for 3/4-inch joint thickness (see Figure 1).
3. X_2, X_3, X_4- Porosity or fusion-type discontinuity 1/16-inch or larger, but less than maximum permissible for 3/4-inch joint thickness.
4. X^5, X_6- Porosity or fusion-type discontinuity less than 1/16-inch.

Interpretation

1. Porosity or fusion-type discontinuity X_4 is not acceptable because it is within the minimum clearance allowed between edges of such discontinuities (see 8.2.3 and Figure 1).
2. Remainder of weld is acceptable.

*Defect size indicated is assumed to be its greatest dimension.

Process Specification: 3.C.3.1(R1)
Date: 3/7/83
Sheet: 1 of 8

TENNESSEE VALLEY AUTHORITY

RADIOGRAPHIC PROCEDURE NO. C1

1.0 SCOPE

1.1 This procedure defines the requirements for radiographic examination of welded joints in buildings and tubular structures fabricated in accordance with AWS D1.1-77 Structural Welding Code. (This specification is technically identical with Process Specification 3.C.3.1(a) with addenda 1 and 2.)

2.0 PERSONNEL QUALIFICATION AND SAFETY

2.1 Personnel performing nondestructive testing shall be qualified in accordance with the 1975 edition of American Society for Nondestructive Testing Recommended Practice No. SNT-TC-1A. Only individuals qualified for NDT Level I and working under the NDT Level II, or individuals qualified for NDT Level II may perform nondestructive testing.

2.2 X-ray equipment shall be operated and maintained in accordance with the TVA Occupational Health and Safety Manual.

3.0 EQUIPMENT

3.1 X-ray machines or isotope sources (I-192 or Co-60) shall be used to expose radiographic film.

3.2 Film. Radiographs shall be made using film of medium- or low-speed high contrast and low graininess (Type 1 or 2 of ASTM Recommended Practice SE-94).

3.3 Screens. Intensifying screens, except fluorescent type, may be used.

3.4 Filters. Objectionable scattered radiation shall be reduced by suitable filters. As a check on backscattered radiation, a lead symbol "B" of at least 1/16-inch thick and 1/2-inch high shall be attached to the back of the film holder. If the image of the "B" appears on the radiograph, the scattered radiation is objectionable and the radiograph shall be considered unacceptable.

3.5 Film Holders. Film holders or cassettes designed for use with or without intensifying screens should be used.

3.6 Film Location Markers. Two film location markers shall appear as radiographic images on each radiograph. The position of each marker shall be placed on the base metal using either a low stress stencil, vibratory pencil, paint marker, or other approved marking method.

3.7 Film Identification. Weld identification numbers shall appear as radiographic images on each film. This number shall be permanently marked on the material adjacent to the weld (see figure 1).

Any additional information shall be preprinted on the film no less than 3/4-inch from the edge of the weld, or shall be indicated by lead figures on steel.

3.8 Penetrameters. Penetrameters shall conform to details shown in figure 3 except that other penetrameters, such as ASME, may be used provided they have lead identification numbers indicating penetrameter thickness in thousandths of an inch and comply with all other conditions of this paragraph. The thickness of each penetrameter shall be equal to or less than 2 percent of the thickness of the thinner of the parts being joined by the weld under examination, but need not be less than .005 inch. The use of other than AWS penetrameters shall be noted on the radiographic record form.

3.8.1 Two or more penetrameters shall be used for each radiograph on a film 10 inches or more in length. Only one penetrameter need be used for radiographs on films less than 10 inches in length.

3.8.2 Penetrameters shall be placed on the side of the work nearer the radiation source, as shown in figures 1 and 2.

3.9 Shims. When weld reinforcement or backing is not removed, carbon or stainless steel shims shall be placed under the penetrameter so that the total thickness of steel between the penetrameter and the film is at least equal to the average thickness of the weld measured through its reinforcement and backing.

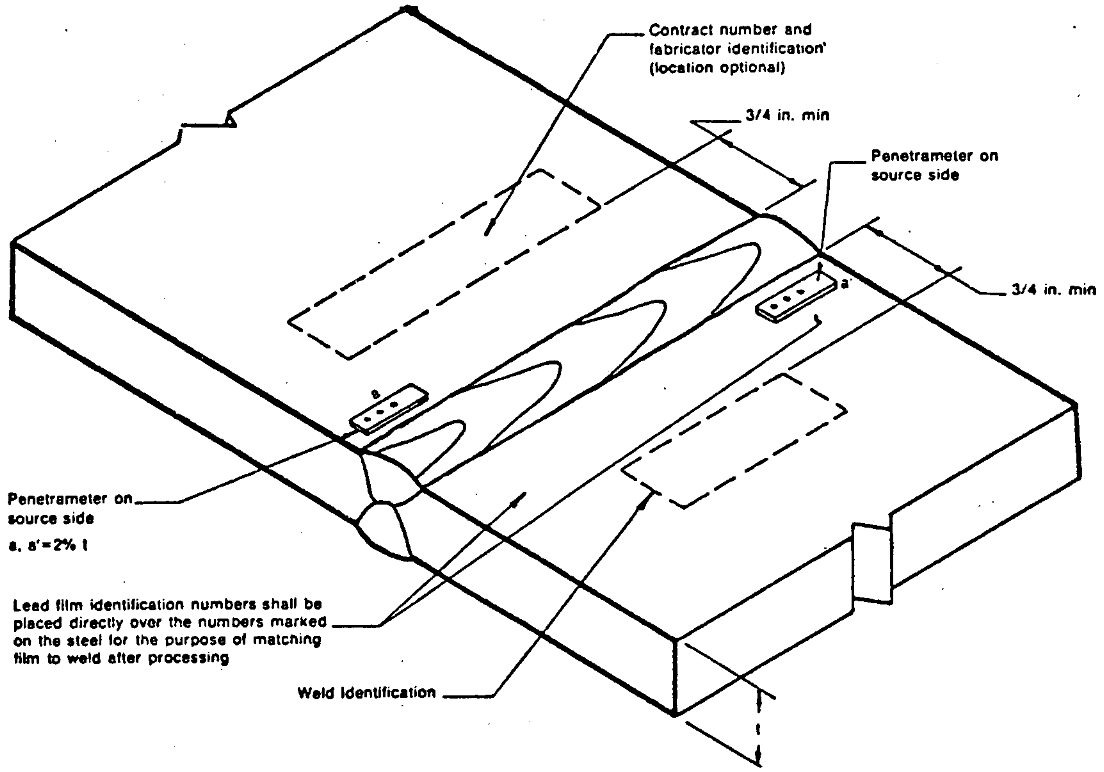


Figure 1 - Radiograph identification and penetrameter location on approximately equal thickness joints.

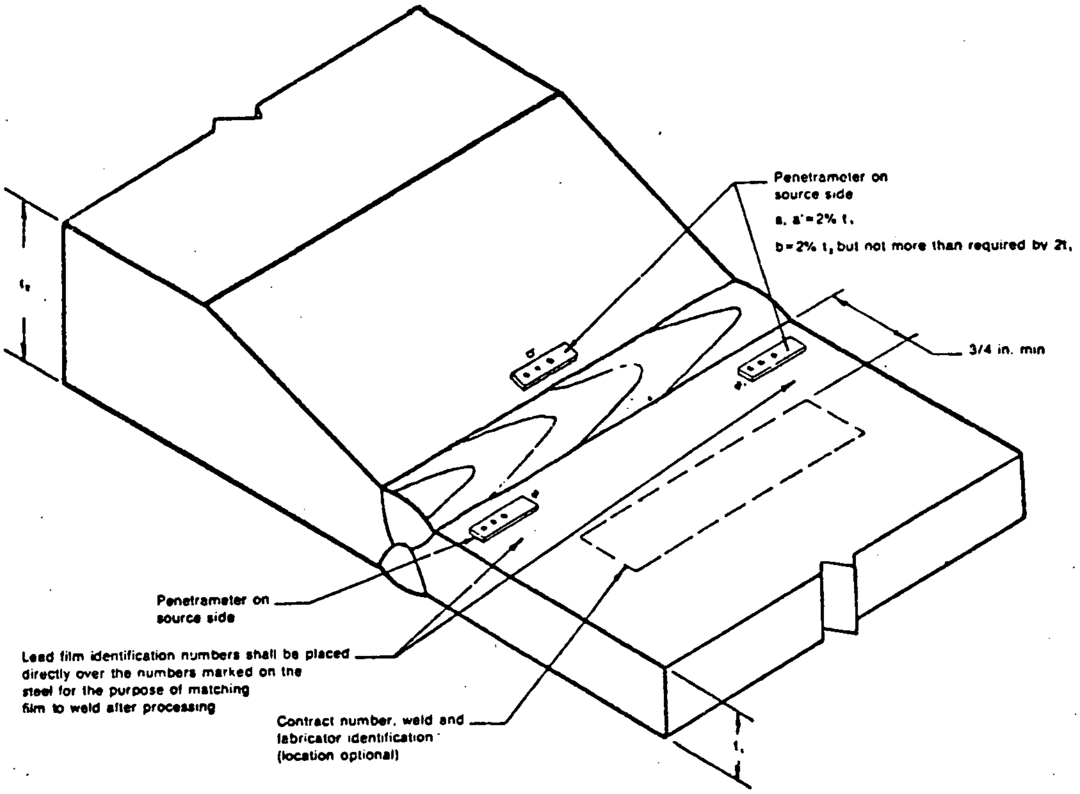


Figure 2 - Radiograph identification and penetrameter location on transition joints.

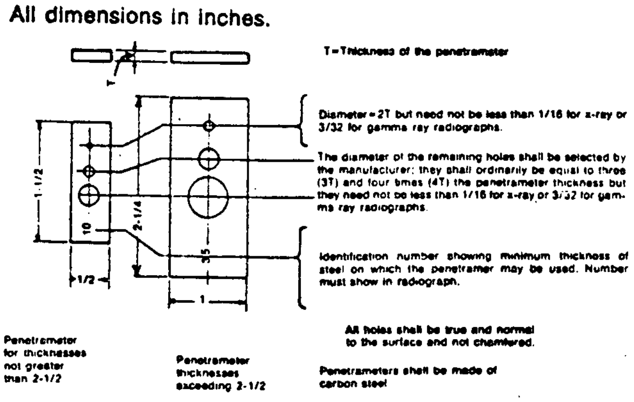


Figure 3 - Details of AWS penetrameters.

4.0 RADIOGRAPHIC PROCEDURE

4.1 Extent of Examination

4.1.1 When complete testing is specified, the entire length of the weld in each designated joint shall be inspected.

4.1.2 When spot testing is specified, the number of spots in each designated category of welded joint to be radiographed in a stated length of weld shall be as indicated in the design specification. Each spot radiograph shall show at least 4 inches of weld length. If a spot radiograph shows discontinuities that require repair as defined in 5.0 two adjacent spots shall be inspected. If discontinuities requiring repair are shown in either of these, the entire length of weld in that welded joint shall be tested radiographically.

4.2 A weld that is to be radiographed need not be ground or otherwise smoothed for purposes of radiographic testing unless its surface irregularities or juncture with the base metal could cause objectionable weld discontinuities to be obscured in the radiograph.

4.3 All radiographs shall determine quantitatively the size of discontinuities having thickness equal to or greater than 2 percent of the thickness of the thinner of the parts joined by the weld under examination.

4.3.1 Radiographs shall be clean, free of film processing defects, and shall have an H&D density of not less than 1.5 nor more than 4.0. Although radiographs (each single film) may have an H&D density of 1.5 minimum to 4.0 maximum, densities within the range of 2.5 to 3.5 are preferred. Radiographs, except as modified by 4.5 shall show:

4.3.1.1 The smallest hole in each penetrameter as specified by Figure 3.

4.3.1.2 The penetrameter identification number.

4.3.1.3 The radiographic identification and location marks indicated in figures 1 and 2 and required by section 3.6.

4.4 Radiographs shall be made with a single source of radiation approximately centered with respect to the length of area being examined. The perpendicular distance from the radiation source to the film shall be no less than seven times the maximum thickness of the weld under examination.

4.5 The film shall not be interpreted where the rays penetrate the weld at an angle greater than 26-1/2 degrees from a line perpendicular to the weld surface. The 26-1/2 degrees equals one-half the source to film distance along the weld from the point on the film directly beneath the source.

4.6 The film, during exposure, shall be close to the surface of the weld opposite the source of radiation as possible.

4.7 When weld transitions in thickness are radiographed, and the ratio of the thicker weld section to the thinner weld section is 3 or greater, radiographs should be exposed to produce a density of 3.0 to 4.0 in the thinner section. When this is done, densities of less than 1.5 will be accepted in the thicker section. Except for this condition, densities outside the maximum and minimum limits specified in section 4.3.1 shall be cause for rejection of the film. Penetrameters on transition joints shall be positioned as shown in figure 3.

5.0 ACCEPTANCE CRITERIA

5.1 Acceptance criteria for ASTM A 514 and A 517 steels shall be based on nondestructive testing performed not less than 48 hours after completion of the welds.

5.2 The following discontinuities are unacceptable for welds required to be evaluated to the requirements of Section 8, Design of New Buildings, and Section 10, Design of New Tubular Structures, of the Structural Welding Code.

5.2.1 Cracks

5.2.2 Discontinuities exceeding the values of Table 1 and the accompanying notes. The following definitions apply to Table 1:

Aligned Indications - Three or more indications oriented such that the middle indications touch a line drawn through the two indications at either end.

Indication Accumulation (IA) - The sum of the greatest dimensions of all aligned indications.

Weld Size - Leg length of a fillet, the base material thickness for a full penetration buttweld, the bevel depth for a partial penetration weld, or the bevel depth plus the fillet leg length of a fillet reinforced butt or tee weld.

Table 1

Weld Size (W)	Maximum Indication Size Allowable	For Aligned Indications the Maximum IA in a Length L (1), (2)	
		IA	L
0 to 1/4-inch inclusive	3/32-inch	1/8-inch	3/4-inch
Greater than 1/4-inch to 1/2-inch inclusive	5/32-inch	1/4-inch	1-1/2 inches
Greater than 1/2-inch to 3/4-inch inclusive	5/16-inch	1/2-inch	3 inches
Greater than 3/4-inch to 1-1/8 inches	1/2-inch	3/4-inch	4-1/2 inches
Greater than 1-1/8 inch	3/4-inch	W	6W

Notes:

(1) For welds with a total length (S) less than L, the maximum IA shall be S/L times weld size.
(2) Analigned indication 3/32-inch or greater separated by less than three times its greatest dimension from an adjacent indication shall be evaluated as one continuous indication.

5.2.3 Any indication 3/32-inch or greater closer than three times its greatest dimension from the end of a weld.

5.2.4 Discontinuities having a greatest dimension of less than 3/32-inch if the sum of their greatest dimension exceeds 3/8-inch in any linear inch of weld.

Note: Appendix B provides examples of the above acceptance criteria.

5.3 The following discontinuities are unacceptable for welds required to be evaluated to the requirements of Section 9, Design of New Bridges, of the Structural Welding Code.

5.3.1 Any porosity or fusion-type discontinuity for which the greatest dimension is 1/16-inch or larger shall not exceed the size B, indicated in figure 4, for the effective throat or weld size involved.

5.3.2 The distance from any porosity or fusion-type discontinuity described above to another such discontinuity, to an edge, or to any intersecting weld shall not be less than the minimum clearance allowed, C, indicated by figure 4, for the size of discontinuity under examination.

5.3.3 Independent of the requirements of paragraphs 5.3.1 and 5.3.2, discontinuities having a greatest dimension of less than 1/16-inch shall be unacceptable if the sum of their greatest dimension exceeds 3/8-inch in any linear inch of weld.

Note: The criteria of 5.3 above meet or exceed the requirements of all examinations performed to the AWS Structural Welding Code and may be used to establish a uniform standard.

(Appendix C illustrates the application of 5.3)

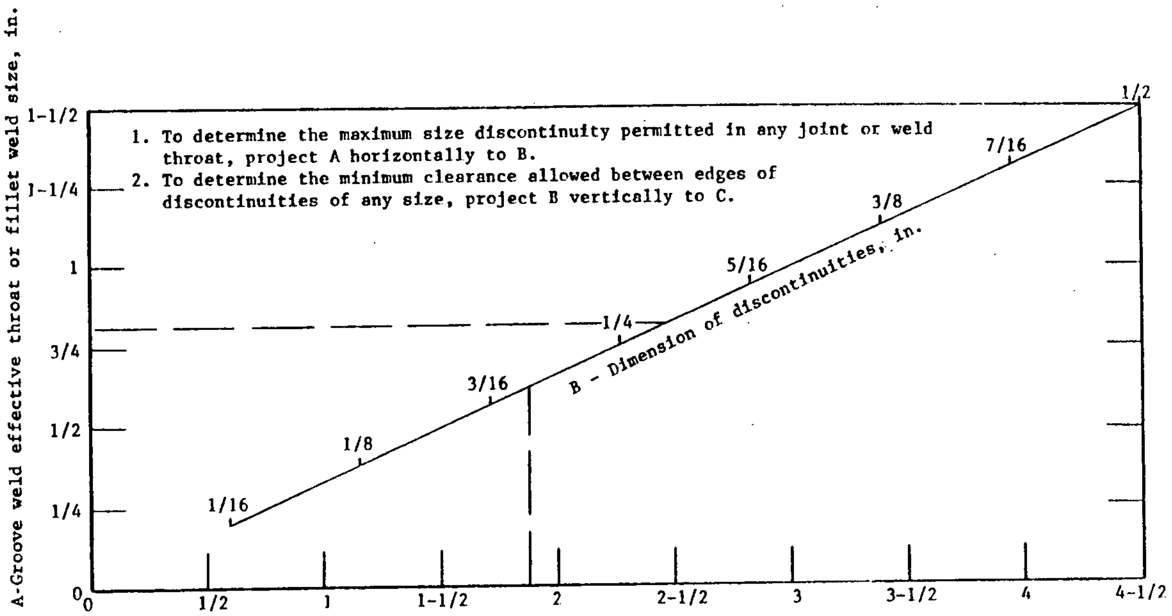
6.0 DOCUMENTATION

6.1 Appendix A shows a typical format for recording the radiographic technique. A copy of the form used shall be placed in the radiographic film envelope.

Prepared by 4-15-83

Reviewed by Robert M Jesse 4-15-83
SNT-TC-1A LEVEL III

Approved by C.E. Roberts 4/15/83



1. To determine the maximum size discontinuity permitted in any joint or weld throat, project A horizontally to B.
2. To determine the minimum clearance allowed between edges of discontinuities of any size, project B vertically to C.

C - Minimum clearance measured along the longitudinal axis of the weld between edges of porosity or fusion type discontinuities, in.
(larger of adjacent discontinuities governs)

Note: Adjacent discontinuities, spaced less than the minimum spacing required by Fig. 4 shall be measured as one length equal to the sum of the total length of the discontinuities plus the length of the space between them and evaluated as a single discontinuity.

FIGURE 4 - WELD QUALITY REQUIREMENTS FOR DISCONTINUITIES OCCURING IN TENSION WELDS (LIMITATION OF POROSITY AND FUSION-TYPE DISCONTINUITIES)

Process Specification: 3.C.3.1 (R1)
Date: 3/7/83
Sheet: 1 of 1

APPENDIX A

REPORT OF RADIOGRAPHIC EXAMINATION OF WELDS

PROJECT: ....

Quality Requirements: Section No. ....

Reported to:

WELD LOCATION AND IDENTIFICATION SKETCH

TECHNIQUE

Source ____________________

Film to source ____________________

Exposure time ____________________

Screens ____________________

Film type ____________________

(Describe Length, Width, and Thickness of All Joints Radiographed)

Date	Weld Identification	Area	Interpretation		Repairs		Remarks
			Accept.	Reject	Accept.	Reject	

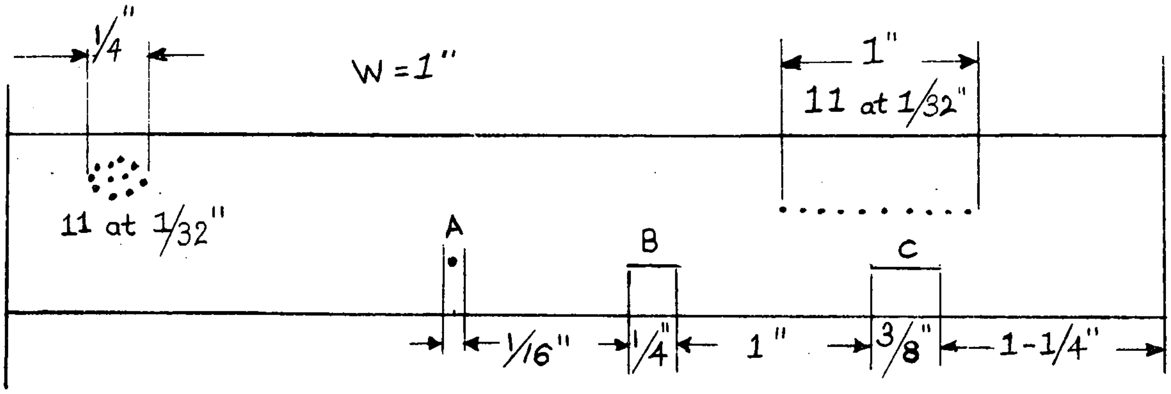
We the undersigned, certify that the statements in this record are correct and that the welds were prepared and tested in accordance with the requirements of the American Welding Society Structural Welding Code, AWS D1.1.

Inspector ____________________

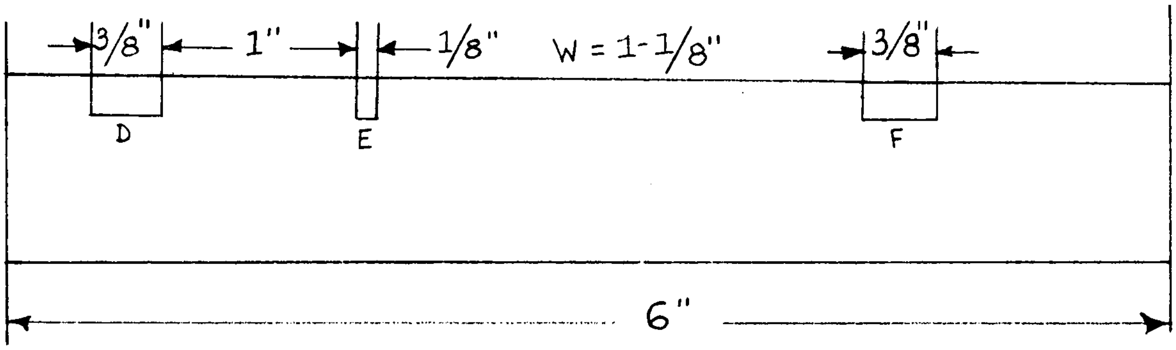
Level ....

Date ....

APPENDIX B



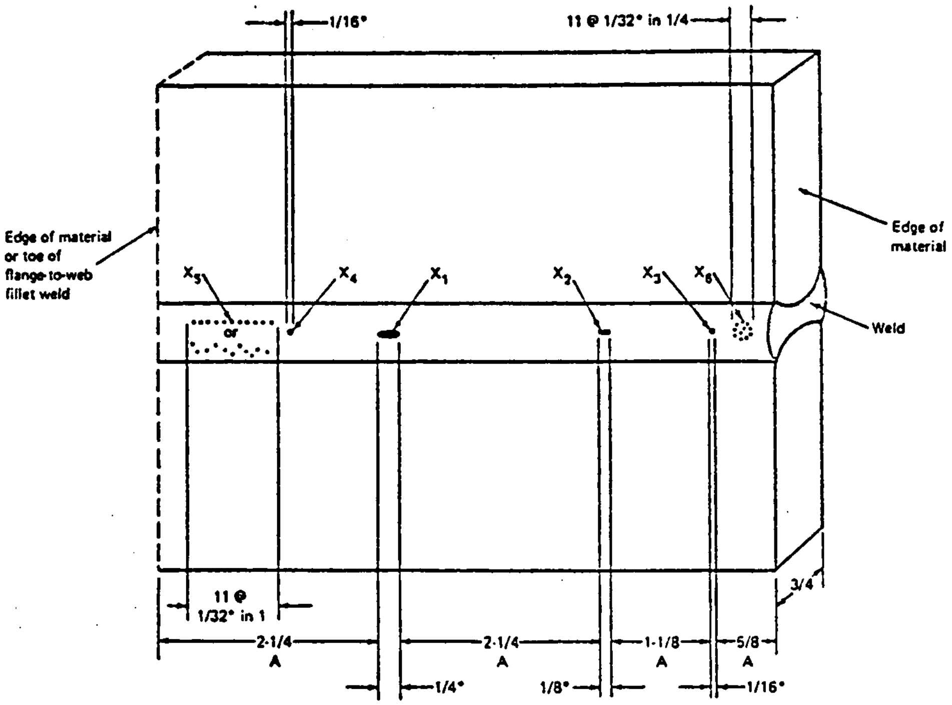
C is not counted in accumulation for 1 inch (see 5.2.4). A, B, and C are not considered aligned because A, being less than 3/32", is not evaluated as an aligned indication. C is more than 3 times is greatest dimension from the end of the weld and is acceptable.



D, E, and F are aligned indications and indication accumulation (IA) is acceptable.

D and E are rejectable because they are closer than 3 times the size of D to each other. Removal of either D, E, or F would make this weld acceptable.

APPENDIX C
WELD QUALITY REQUIREMENTS FOR BRIDGES



Notes:

1. A - minimum clearance allowed between edges of porosity of fusion-type discontinuities 1/16-inch or larger. Larger of adjacent discontinuities govern.
2. X_1- largest permissible porosity or fusion-type discontinuity for 3/4-inch joint thickness (see Figure 1).
3. X_2, X_3, X_4- Porosity or fusion-type discontinuity 1/16-inch or larger, but less than maximum permissible for 3/4-inch joint thickness.
4. X_5, X_6- Porosity or fusion-type discontinuity less than 1/16-inch.

Interpretation

1. Porosity or fusion-type discontinuity X_4 is not acceptable because it is within the minimum clearance allowed between edges of such discontinuities (see 8.2.3 and Figure 1).
2. Remainder of weld is acceptable.

*Defect size indicated is assumed to be its greatest dimension.

Process Specification: 3.C.5.2 (R2)
Date: March 7, 1983
Sheet: 1 of 4

VISUAL EXAMINATION OF WELDS

1.0 SCOPE

1.1 This examination procedure defines the requirements and acceptance standards for visual examination of welded joints in buildings and tubular structures in accordance with AWS D1.1 Structural Welding Code. (This specification is technically identical with Process Specification 3.C.5.2(b) with addenda 1-3.)

2.0 EXAMINATION PRIOR TO WELDING

2.1 Surfaces and edges to be welded shall be free from loose or thick scale, slag, rust, moisture, grease, and other foreign material that would prevent proper welding. Tightly adhering mill scale, rust-inhibitive coatings, or antispatter compounds may remain.

2.2 Examination prior to welding is the responsibility of the welding engineering or weld quality control unit and need not be performed by certified visual examination personnel.

3.0 EXAMINATION REQUIREMENTS AFTER WELDING

3.1 The inspector shall determine that the size, length, and location of all welds conform to the requirements of detail drawings, that no specified welds are omitted, and that no unspecified welds are added.

3.2 Examination of ASTM A 514 and A 517 steels shall be performed not less than 48 hours after completion of welding.

3.3 The weld area shall be free of arc strikes.

3.4 Welds and adjacent surfaces to be painted shall be free of weld spatter. Weld spatter, if not excessive, may remain on plain carbon steel surfaces not requiring paint, providing the spatter does not interfere with other examinations or with the function of the structure.

3.5 The inspector shall determine that the contour and reinforcement of welds meet the specified requirements.

3.6 The inspector shall determine that the following types of defects are within specified requirements:

3.6.1 Weld craters.

3.6.2 Undercut.

3.6.3 Overlap.

3.6.4 Cracks.

3.6.5 Porosity.

3.6.6 Lack of fusion.

3.7 The inspector shall identify with a distinguishing mark all parts or joints which he has inspected and accepted.

4.0 ACCEPTANCE STANDARDS

4.1 Weld Craters

4.1.1 All craters shall be filled to the full cross-section of welds.

4.2 Undercut

4.2.1 Undercut shall be not more than 0.01 inch deep when its direction is transverse to the primary tensile stress in the part that is undercut, nor more than 1/32-inch for all other situations (see note 1.)

Note 1: If the direction of primary stress is not apparent, the more conservative values shall be used.

4.3 Overlap

4.3.1 Welds shall be free from overlap.

4.4 Cracks

4.4.1 Welds shall contain no cracks.

4.5 Porosity and Fusion Type Defects

4.5.1 Complete joint penetration groove welds in butt joints transverse to the direction of computed tensile stress shall have no piping porosity. For all other welds subject only to visual inspection, the sum of diameters of piping porosity shall not exceed 3/8-inch in any one linear inch of weld and shall not exceed 3/4-inch in any 12-inch length of weld. (Piping porosity is defined as pinholes that are oriented in a general direction normal to the weld face and extend to the weld surface.)

4.6 Lack of Fusion

4.6.1 Thorough fusion shall exist between weld metal and base metal.

4.7 Contour of Fillet Welds

4.7.1 The face of fillet welds may be slightly convex, flat, or slightly concave. Except at outside corners, the convexity shall not exceed the value $(0.1_S + .06)$ inch where S is the actual leg size of the fillet welds in inches. They shall be free of defects as shown for fillet welds in Figure 1.

4.8 Groove Weld Reinforcement

4.8.1 Groove welds shall preferably be made with slight or minimum reinforcement. Butt and corner joints shall have reinforcement not to exceed 1/8-inch in height and shall have a gradual transition to the adjacent base metal surface. The 1/8-inch maximum reinforcement does not apply to "T" joints. The contour or "T" joints, where reinforcing fillets are not required, shall have a gradual transition into both members. Fillet weld criteria of paragraph 4.7 shall apply to reinforcing fillets required on "T" joints. These welds shall be free of defects as shown in Figure 1.

4.9 Fillet Weld Size

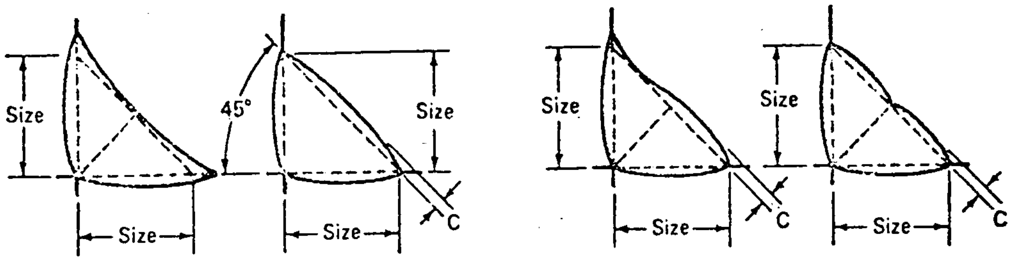
4.9.1 Fillet welds should be limited to 1/8-inch larger than the leg size specified. Maximum fillet weld size shall be 3/16-inch larger than specified. Larger welds will be considered on a case-by-case basis by EN DES.

4.9.2 Fillet welds in any single continuous weld shall be permitted to underrun the nominal fillet size required by 1/16-inch without correction, provided that the undersize weld does not exceed 10 percent of the length of weld. On web-to-flange welds on girders, no underrun is permitted at the end for a length equal to twice the width of the flange.

Prepared by: DEtzler 4-15-83

Reviewed by: Robert M Jesse 4-15-83
SNT-TC-1A, Level III

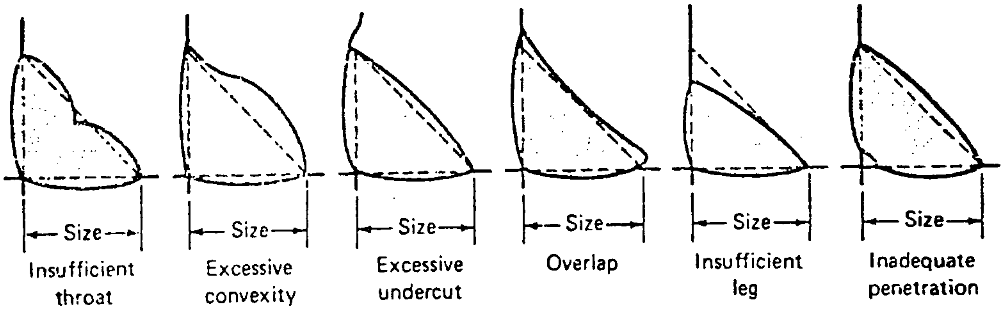
Approved by: C E Roberts 4/15/83



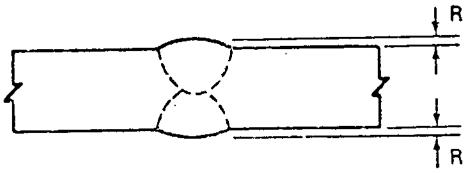
Note: Convexity C shall not exceed 0.1 times actual leg size, or the longer leg in the case of an unequal leg fillet weld, plus 0.06 in. (0.3 mm).

(A) Desirable fillet weld profiles

(B) Acceptable fillet weld profiles

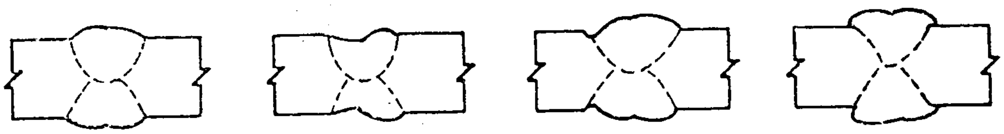


(C) Unacceptable fillet weld profiles



Note: Reinforcement R shall not exceed 1/8 in. (3.2 mm). See 4.8

(D) Acceptable butt weld profile



(E) Unacceptable butt weld profiles

Figure 1 - Acceptable and unacceptable weld profiles

EXAMINATION AND TESTING OF AWS STUD WELDS

1.0 SCOPE

1.1 This examination procedure defines the requirements and acceptance standards for visual examination and testing of studs welded to steel by the automatic timed-arc process in accordance with AWS D1.1. (This specification is technically identical with Process Specification 3.C.5.3(a) with addendum 1.)

2.0 DEFINITIONS

2.1 Shear connectors and nonshear connectors cannot be identified to the extent that differentiation can be made at the construction level.

2.2 If not specifically identified on design drawings or specifications, welded studs shall be considered unidentified and examined to the criteria of 6.0. All studs, if desired, may be examined to 6.0 in order to establish a uniform criteria.

3.0 EXAMINATION AT BEGINNING OF WELDING

3.1 Shear Connectors

3.1.1 The first two stud shear connectors welded on each member, after being allowed to cool, shall be bent to an angle of 30° from their original axes by striking the studs with a hammer. If failure occurs in the weld zone of either stud, the procedure shall be corrected and two more studs shall be welded to the member and tested. If either of the second two studs fail, additional welding shall be continued on separate plates until two consecutive studs shall then be welded to the member, tested, and found to be satisfactory before any more production studs are welded to the member.

3.1.2 The bent stud shear connectors and concrete anchors that show no sign of failure shall be acceptable for use and left in the bent position if no portion of the stud is less than 1 inch from a proposed concrete surface. All required bending and straightening shall be done, without heating, before completion of the stud welding operation on the job.

3.1.3 For members having less than 20 stud shear connectors, the stud welding procedure may be tested at the start of each day's production welding period (a new production period begins with the welding of a given size and type stud with a given welding procedure or with the beginning of each day's production) in lieu of testing in accordance with 3.1.1. Before use in production, each welding unit shall be used to weld two stud shear connectors to separate test material in the same general position (flat, vertical, overhead, sloping) and of similar thickness. After being allowed to cool, they shall be bent as described in 3.1.1. If failure occurs, the procedure shall be corrected and two consecutive studs shall be welded to the test material, tested, and found to be satsifactory before any production studs are welded to the member.

3.1.4 The foregoing testing shall be performed after any change in the welding procedure.

3.1.5 If failure occurs in the stud shank, an investigation shall be made to ascertain and correct the cause before more studs are welded.

3.2 Other Than Shear Connectors

3.2.1 Before starting the welding operations, two stud connectors shall be welded to separate material in the same general position (flat, vertical, overhead, sloping) and of thickness and material similar to the member. After being allowed to cool, each stud shall be bent to an angle of 30° from its original axis by striking the stud with a hammer. If failure occurs in the weld zone of either stud, the procedure shall be corrected and two successive studs successfully welded and tested before any studs are welded to the member. The foregoing testing shall be performed at the start of each day or after any change in the welding procedure. If failure occurs in the stud shank, an investigation shall be made to ascertain and correct the cause before more studs are welded.

4.0 REPAIRING STUD WELDS

4.1 Studs on which a full 360° flash is not obtained may be repaired in accordance with process specification 1.C.1.2. The repair shall be a 5/16-inch minimum fillet weld which extends 3/8-inch beyond each end of the discontinuity.

4.2 If an unacceptable stud has been removed from a component subjected to tensile stresses, then the area from which the stud was removed shall be made smooth and flush. Wherein such areas base metal has been pulled out in the course of stud removal, the pocket shall be welded and ground flush.

4.3 In compression areas of members, if stud failures are confined to shanks or fusion zones of studs, a new stud may be welded adjacent to each unacceptable area in lieu of repair and replacement on the existing weld area (see 1.C.1.2 for placement). If metal is torn from the base metal of such areas, the repair provisions shall be the same as for tension areas except that when the depth of discontinuity is less than 1/8-inch and 7 percent of the base metal thickness the discontinuity may be faired by grinding in lieu of filling the unacceptable area with weld metal. Where a replacement stud is to be placed in the unacceptable area, the just-mentioned repair shall be made prior to welding the replacement stud.

4.4 Replacement shear connector studs shall be tested by bending to an angle of 15° from their original axis.

4.5 The areas of components exposed to view in completed structures shall be made smooth and flush where a stud has been removed.

5.0 INSPECTION OF COMPLETED STUDS

5.1 Shear Connectors

5.1.1 If a visual inspection reveals any stud shear connector that does not show a full 360° flash, any stud that has been repaired by welding, or any stud in which the reduction in length due to welding is less than normal shall be struck with a hammer and bent to an angle of 15° from its original axis. For studs showing less than a 360° weld fillet, the direction of bending shall be opposite to the missing weld fillet. Studs that crack in the weld, the base metal, or the shank under inspection or subsequent straightening shall be replaced (see Process Specification 1.C.1.2).

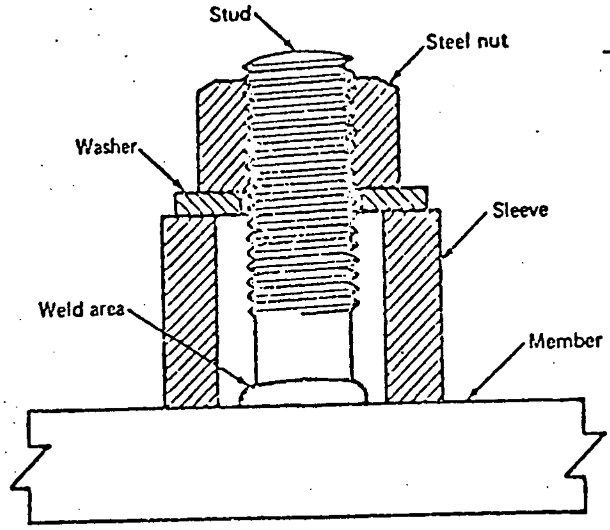
5.1.2 Nonfusion on the vertical leg of the flash, overlap on the horizontal leg, and small-shrink fissures are acceptable.

5.1.3 The bent stud shear connectors and concrete anchors that show no sign of failure shall be acceptable for use and left in the bent position if no portion of the stud is less than 1 inch from a proposed concrete surface. All required bending and straightening shall be done, without heating, before completion of the stud welding operation on the job, except as otherwise provided in the contract.

5.2 Other Than Shear Connectors

5.2.1 For studs other than shear connectors, at least one stud in every 100 shall be bent to an angle of 15° from its original axis by striking with a hammer. If threaded, the stud shall be torque-tested with a calibrated torque wrench to the value given in figure 1 for the diameter and thread of the stud, in a device similar to that shown in figure 1. If the stud fails, the procedures shall be checked in accordance with section 3.2 and two more of the existing studs shall be bent or torque-tested. If either of these two studs fails, all of the studs represented by the tests shall be torque-tested, bend-tested, or rejected.

5.2.2 Nonfusion on the vertical leg of the flash, overlap on the horizontal leg, and small-shrink fissures are acceptable.



Note: The dimensions are appropriate to the size of the stud. The threads of the stud shall be clean and free of lubricant other than the residue of cutting oil.

Required torque for testing threaded studs

Nominal diameter of studs		Threads per inch & series designated	Testing torque	
in.	mm		ft·lb	J
1/4	6.4	28 UNF	5.0	6.8
1/4		20 UNC	4.2	5.7
5/16	7.9	24 UNF	9.5	12.9
5/16		18 UNC	8.6	11.7
3/8	9.5	24 UNF	17.0	23.0
3/8		16 UNC	15.0	20.3
7/16	11.1	20 UNF	27.0	36.6
7/16		14 UNC	24.0	32.5
1/2	12.7	20 UNF	42.0	57.0
1/2		13 UNC	37.0	50.2
9/16	14.3	18 UNF	60.0	81.4
9/16		12 UNC	54.0	73.2
5/8	15.9	18 UNF	84.0	114.0
5/8		11 UNC	74.0	100.0
3/4	19.0	16 UNF	147.0	200.0
3/4		10 UNC	132.0	180.0
7/8	22.2	14 UNF	234.0	320.0
7/8		9 UNC	212.0	285.0
1.0	25.4	12 UNF	348.0	470.0
1.0		8 UNC	318.0	430.0

Figure 1. Torque Testing Arrangement and Table of Testing Torques

6.0 UNIDENTIFIED STUDS

6.1 Studs which are not identified as to type shall be examined as follows:

6.1.1 Prior to production welding the two stud connectors shall be welded to separate material and tested in accordance with section 3.2.

6.1.2 At least one stud in every 100 shall be bent to an angle of 15° from its original axis by striking with a hammer. If threaded, the stud shall be torque-tested with a calibrated torque wrench to the value given in figure 1 for the diameter and thread of the stud, in a device similar to that shown in figure 1. If the stud fails, the procedures shall be checked in accordance with 3.2, and two more of the existing studs shall be bent or torque tested. If either of these two studs fails, all of the studs represented by the tests shall be torque tested, bend tested, or rejected.

6.1.3 If a visual inspection reveals any stud that does not show a full 360° flash, any stud that has been repaired by welding, or any stud in which the reduction in length due to welding is less than normal (1/16-inch) shall be struck with a hammer and bent to an angle of 15° from its original axis. For studs showing less than a 360° weld fillet, the direction of bending shall be opposite to the missing weld fillet. Studs that crack in the weld, the base metal, or the shank under inspection or subsequent straightening shall be replaced (see Process Specification 1.C.1.2).

6.1.4 Nonfusion on the vertical leg of the flash, overlap on the horizontal leg, and small-shrink fissures are acceptable.

Prepared by: 4/14/83
Reviewed by: 4/14/83
ASNT TC-1A LEVEL III
Approved by: C E Roberts 4/14/83

TENNESSEE VALLEY AUTHORITY

WATTS BAR NUCLEAR PLANT
FINAL VISUAL WELD EXAMINATION

1.0 PURPOSE

To describe the requirements for final visual weld examination of structural welds.

2.0 SCOPE

This procedure is applicable to structural welds in category I structures, including pipe hangers, cable tray supports, and duct supports. It may be used for other work when specified by EN DES.

3.0 DEFINITIONS

3.1 Weld Area

The weld and one-half inch either side of weld.

3.2 Fillet Weld Size

The length of the shortest leg in the largest inscribed triangle. Measurement of the leg shall be as described in Attachment C.

3.3 Final Visual Weld Examination

The examination for weld defects, weld contour, size, weld cleanliness, arc stikes, weld spatter, welder's identification, and drawing requirements.

4.0 RESPONSIBILITIES

The responsible Engineering Unit Inspection personnel shall perform all inspections and documentation as required by this procedure.

5.0 PROCEDURE

The inspectors shall check the following items.

5.1 Welder's identification is on the weld.

5.2 The weld area to be inspected is cleaned of all slag, scale, grease, paint, primer, or other material detrimental to visual examination.

5.2.1 Welds made prior to November 2, 1981, which are coated with carbozinc primer may be visually examined in accordance with this process specification without removing the primer provided:

(a) The carbozinc was sprayed in accordance with the applicable coating application specification.

(b) The carbozinc thickness is not greater than 5 mils as documented in coating inspection records and/or log books or as measured adjacent to the weld. Coating thickness measurement techniques shall be in accordance with the specification for coating application.

5.2.2 Welds inspected for weld quality (defects other than size and location) as part of an EN DES-directed sampling program shall be inspected without primer coating unless exempted by EN DES.

5.3 Determine that the size, length, and location of all welds conform to the requirements of detail drawings, that no specified welds are omitted, and that no unspecified welds are added.

5.4 Determine that the contour and reinforcement of welds meet the specified requirements.

5.5 The weld area shall be free of arc strikes.

5.6 The weld area shall be free of weld spatter. Weld spatter, if not excessive, may remain on plain carbon steel surfaces not requiring paint, providing the spatter does not interfere with other examinations or with the function of the structure.

5.7 Identify with a distinguishing mark all parts or joints which he/she has inspected and accepted.

6.0 ACCEPTANCE CRITERIA

6.1 Welding Completed After February 13, 1981

A weld shall be acceptable by visual inspection if the inspection shows that:

6.1.1 Welders identification is next to the weld.

6.1.2 The weld has no cracks.

6.1.3 Thorough fusion exists between adjacent layers of weld metal and base metal.

6.1.4 Craters are filled to the full cross-section of the weld.

6.1.5 Undercut shall not exceed 1/32-inch.

6.1.6 The sum of diameters of piping porosity in fillet welds does not exceed 3/8-inch in any linear inch of weld and does not exceed 3/4-inch in any one-foot length of weld.

6.1.7 The face of fillet welds may be slightly convex, flat, or slightly concave with none of the unacceptable profiles shown in Attachment A, Figure 1. The convexity shall not exceed the value (0.1S + 0.06 inch) where S is the actual leg size of the fillet welds in inches. These requirements do not apply to outside or boxed corners.

6.1.8 A fillet weld in any single continuous weld shall be permitted to underrun the nominal fillet size required by 1/16-inch without correction provided that the undersize portion of the weld does not exceed 10 percent of the length of the weld. On web-to-flange welds or girders, no underrun is permitted to the ends for a length equal to twice the width of the flange.

6.1.9 Fillet welds should be limited to 1/8-inch larger than the leg size specified. Maximum fillet weld size shall be 3/16-inch larger than specified.

6.1.10 Groove welds shall be made with slight or minimum reinforcement. Butt and corner joint reinforcement shall not exceed 1/8-inch in height and shall have a gradual transition to the adjacent base metal surface. The 1/8-inch maximum reinforcement does not apply to "T" joints. The contour of "T" joints, where reinforcing fillets are not required shall have a gradual transition into both members. Fillet weld criteria of section 6.1.7 shall apply to reinforcing fillet welds required on "T" joints. These welds shall be free of defects as shown in Attachment A, Figure 1.

6.1.11 Groove welds shall be free from the discontinuities shown for butt joints in Attachment A, Figure 2.

6.1.12 Complete joint penetration groove welds in butt joints shall have no piping porosity.

6.1.13 Examination of ASTM A514 and A517 steels shall be performed not less than 48 hours after completion of welding.

6.1.14 Welds shall be free from overlap.

6.1.15 Undercut on nonstressed members, as shown in Attachment B, Figure 1 shall not be cause for rejection. Nonstressed members shall be specifically identified by EN DES.

6.1.16 Where mechanical means, such as grinding, burring, etc., are used for surface conditioning and/or corrective action to meet workmanship requirements, reduction of base material thickness will be additive to the amount of undercut. The total of the two conditions will be evaluated to the acceptance requirements for undercut.

6.2 Welding Completed Prior to February 13, 1981

The requirements of section 6.1 apply to work completed prior to February 13, 1981, except as follows:

6.2.1 Cable Tray Supports

a. Undercut on stressed members shall not exceed 1/32-inch in depth except that undercut of an additional 1/32-inch (1/16-inch total depth) and 1/4-inch length, not to exceed 10 percent of the run is acceptable. All welds are to be considered in stressed members unless identified otherwise by EN DES.

b. Allowable minimum fillet weld sizes are shown on drawings revised under ECN 2688.

c. Weld sizes specified to be 3/8-inch or less shall not be more than twice the specified size. Weld sizes specified to be greater than 3/8-inch shall not be more than 3/8-inch larger than the specified size.

d. Random weld spatter and arc strikes are acceptable if cleaned by wire brushing.

6.2.2 Pipe Hangers

a. Weld sizes specified to be 3/8-inch or less shall not be more than twice the specified size. Weld sizes specified to be greater than 3/8-inch shall not be more than 3/8-inch larger than the specified size.

b. Random weld spatter and arc strikes are acceptable if cleaned by wire brushing.

6.2.3 Duct Supports

a. Undercut on stressed members shall not exceed 1/32-inch in depth except that undercut of an additional 1/32-inch (1/16-inch total depth) and 1/4-inch length, not to exceed 10 percent of the run is acceptable. All welds are to be considered in stressed members unless identified otherwise by EN DES.

b. A minimum permissible structural fillet weld size is 3/16-inch. Undersize of 1/16-inch is allowed for fillet welds over 3/16-inch in size.

c. Weld size specified to be 3/8-inch or less shall not be more than twice the specified size. Weld sizes specified to be greater than 3/8-inch shall not be more than 3/8-inch larger than the specified size.

d. Random weld spatter and arc strikes are acceptable if cleaned by wire brushing.

6.2.4 Other Installed Work

a. Weld sizes specified to be 3/8-inch or less shall not be more than twice the specified size. Weld sizes specified to be greater than 3/8-inch shall not be more than 3/8-inch larger than the specified size.

b. Undercut on stressed members shall not exceed 1/32-inch in depth except that undercut of an additional 1/32-inch (1/16-inch total depth) and 1/4-inch length, not to exceed 10 percent of the run is acceptable. All welds are to be considered in stress members unless identified otherwise by EN DES.

c. Random weld spatter and arc strikes on stainless steel and carbon steel are acceptable if cleaned by wire brushing. Weld spatter on all other materials shall be evaluated in accordance with G-29C.

7.0 DOCUMENTATION

Inspectors shall verify that requirements are met and provide a record of the inspections. The record may be the inspector's unique identifying mark on the weldment, marked drawings, or individual inspection records. Weld inspection data card or equivalent will be completed by the responsible Engineering Unit Inspector.

8.0 ATTACHMENTS

A - Figure 1 - Unacceptable Fillet Weld Profiles
    Figure 2 - Unacceptable Butt Weld Profiles

B - Figure 1 - Undercut on Nonstressed Members

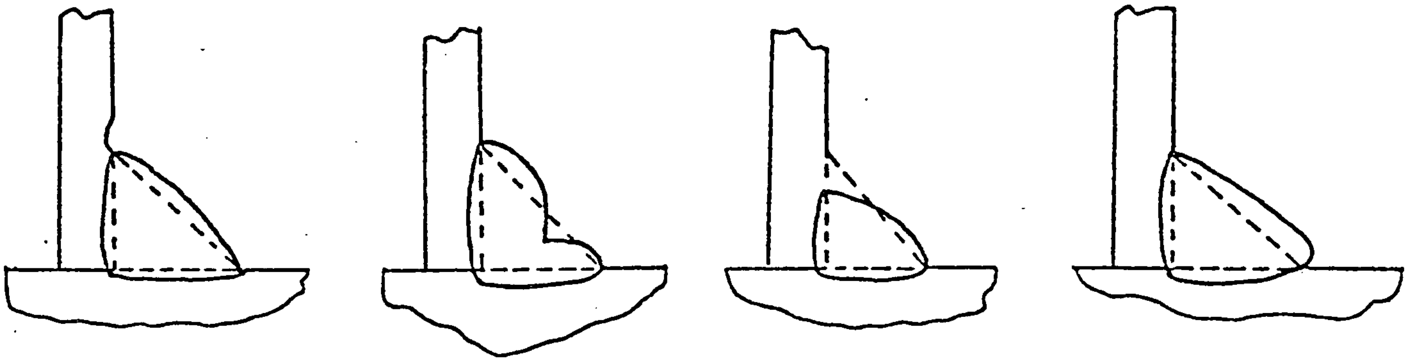
C - Figure 1 - Detail of Fillet Welds

Prepared by: 4-15-83

Reviewed by: Robert M. [illegible] 4-15-83
SNT-TC-1A LEVEL III

Approved by: C E Roberts 4/15/83

Process Specification: 3.C.5.4(R1)
Date: 3/9/83
Sheet: 1 of 1



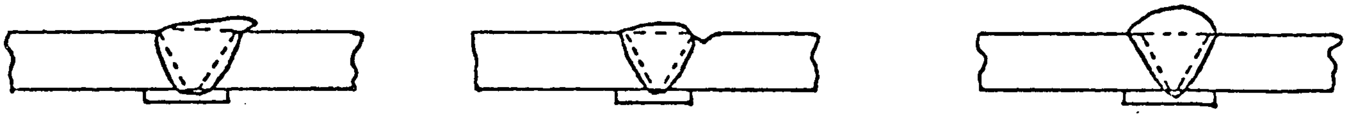
EXCESSIVE UNDERCUT

INSUFFICIENT THROAT

INSUFFICIENT LEG

OVERLAP

Figure 1 Unacceptable Fillet Weld Profiles



OVERLAP

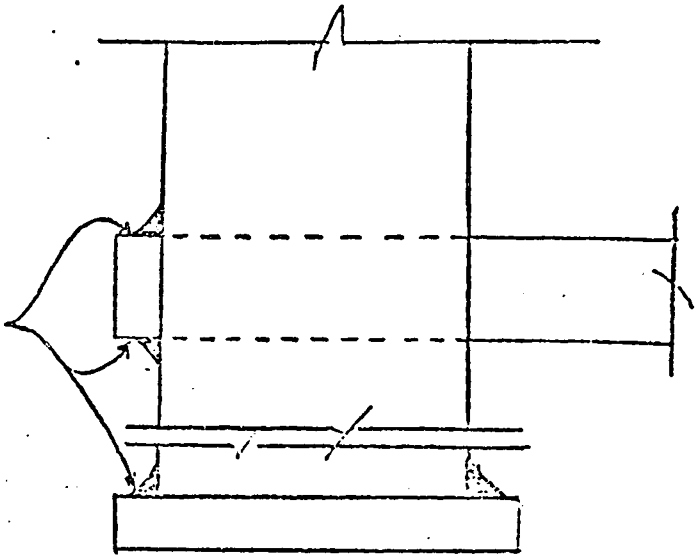
EXCESSIVE UNDERCUT

EXCESSIVE REINFORCEMENT

Figure 2 Unacceptable Butt Weld Profiles

ATTACHMENT A

Process Specification: 3.C.5.4(R1)
Date: 3/9/83
Sheet: 1 of 1



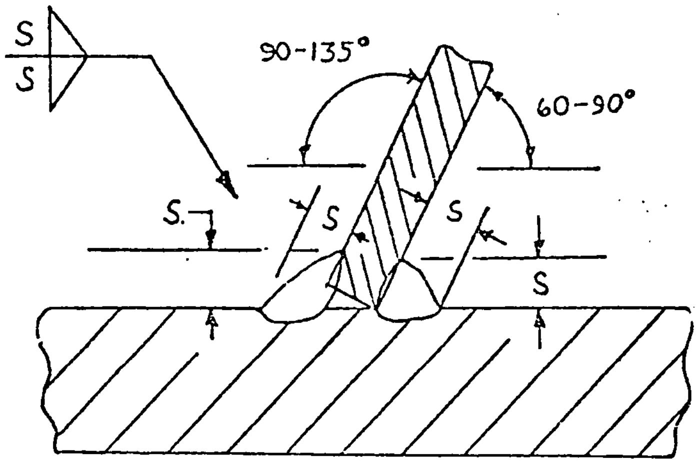
Nonstressed Members

Undercut at locations shown by arrows shall not be cause for rejection.

FIGURE 1

ATTACHMENT B

Process Specification: 3.C.5.4(R1)
Date: 3/9/83
Sheet: 1 of 1



DETAIL OF FILLET WELDS

ATTACHMENT C

TENNESSEE VALLEY AUTHORITY

ULTRASONIC TESTING OF GROOVE WELDS

1.0 SCOPE

1.1 This procedure defined the requirements which govern the ultrasonic testing of groove welds between the thicknesses of 5/16-inch and 8 inches inclusive. This procedure covers groove welds on nontubular structures in accordance with the American Welding Society Structural Welding Code.

1.2 Variations in testing procedure, equipment, and acceptance standards not included in this process specification may be used upon agreement with the Division of Engineering Design, Nuclear Engineering Support Branch; Codes, Standards and Materials Section.

2.0 EXTENT AND METHOD OF EXAMINATION

2.1 When complete testing is specified, the entire length of the weld in each designated joint shall be tested.

2.2 When spot testing is specified, the number of spots in each designated category of weld or the number required to be made in a stated length of weld shall be included in the design drawing. Each spot tested shall cover at least 4 inches of the weld length. When spot testing reveals discontinuities that require repair, two adjacent spots shall be tested. If discontinuities requiring repair are revealed in either of these, the entire length of the weld in that welded joint shall be tested ultrasonically.

3.0 PERSONNEL QUALIFICATIONS

3.1 Personnel performing ultrasonic testing shall be qualified in accordance with the American Society for Nondestructive Testing (ASNT-TC-1A, 1975 edition). Individuals who are Level I qualified may perform the actual inspection under the supervision of a Level II or Level III; however, only Level II personnel may interpret and evaluate test results.

4.0 DEFINITIONS

4.1 DAC (Distance Amplitude Correction) (Swept Gain, Time Corrected Gain, Time Variable Gain, Etc.)--Electronic change of amplification to provide equal amplitude from equal reflectors at different depths.

4.2 Frequency (Inspection)--Effective ultrasonic wave frequency of the system used to inspect the material.

4.3 Pulse Echo Method--An inspection method in which the presence and position of a reflector are indicated by the echo amplitude and time.

4.4 Resolution--The ability of ultrasonic equipment to give simultaneous, separate indications from discontinuities having nearly the same range and lateral position with respect to the beam axis.

4.5 Indication--That which marks or denotes the presence of a reflector.

4.6 Transducer--An electro-acoustical device for converting electrical energy into acoustical energy and vice versa.

4.7 Sensitivity--The ability of an ultrasonic system to detect a very small discontinuity.

5.0 ULTRASONIC EQUIPMENT

5.1 The ultrasonic test instrument shall be of the pulse-echo type. It shall generate, receive, and present on a cathode ray tube (CRT) screen pulses in the frequency range from one to six megahertz (MHz). The presentation on the CRT screen shall be the "video" type, characterized by a clean, crisp trace.

5.2 The horizontal linearity of the test instrument shall be within plus or minus 5 percent over the linear range which includes 90 percent of the sweep length presented on the CRT screen for the longest sound path to be used. The horizontal linearity shall be measured by the techniques prescribed by Section 7.9 of ASTM E317 except that the results may be tabulated rather than graphically presented.

5.3 Test instruments shall include internal stabilization so that after warm up, no variation in response greater than ± 1 dB occurs with supply voltage change of ± 15 percent nominal or, in the case of battery powered instruments, over the battery charge operating life. There shall be an alarm or meter to signal a drop in battery voltage prior to instrument shutoff due to battery exhaustion.

5.4 The test instrument shall have a calibrated gain control (attenuator) adjustable in discrete 1 or 2 dB steps over a range of at least 60 dB. The accuracy of the gain control settings shall be within ± 1 dB.

5.5 The dynamic range of the instrument's CRT display shall be such that a difference of 1 dB of amplitude can be easily detected on the CRT.

5.6 Straight beam search unit transducers shall have an active area of not less than 1/2 in.^{2} nor more than 1 in^2. The transducer shall be round or square. Transducer frequency shall be 2 to 2.5 MHz. Transducers shall be capable of resolving the three reflections as

5.7 Angle beam search units shall consist of a transducer and an angle wedge. The unit may be comprised of the two separate elements or may be an integral unit.

5.7.1 The transducer frequency shall be between 2 and 2.5 MHz, inclusive.

5.7.2 The transducer crystal may vary in size from 1/2 to 1 inch in width and from 1/2 to 13/16-inch in height (see Figure 1).

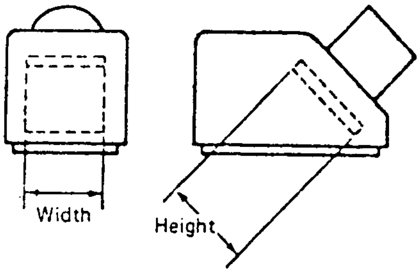
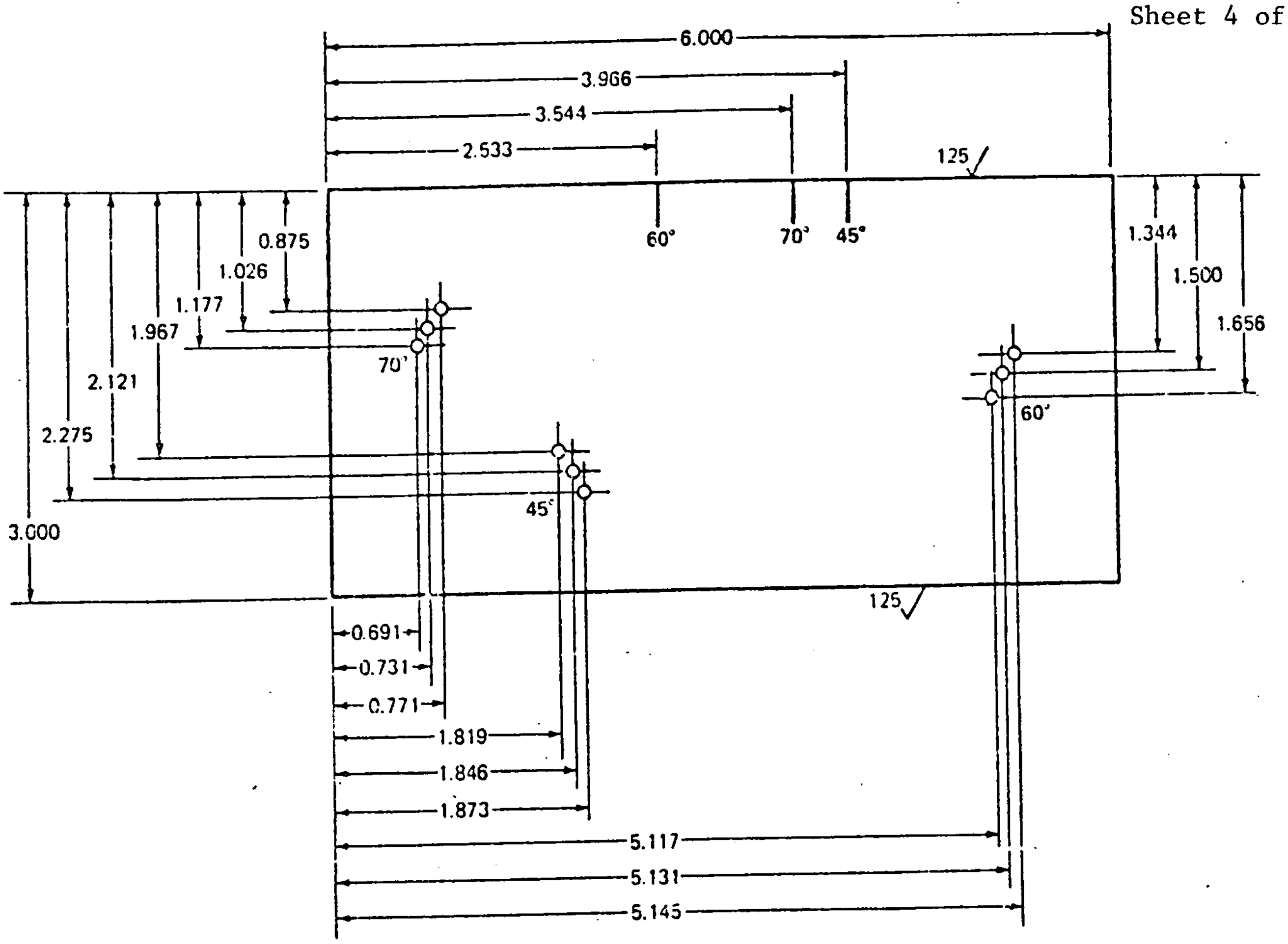


Figure 1 - Transducer Crystal

5.7.3 The search unit shall produce a sound beam in the material being tested within plus or minus 2 degrees of the following proper angles: 70 degrees, 60 degrees, or 45 degrees as described in 11.2.2.

5.7.4 Each search unit shall be marked to clearly indicate the frequency of the transducer, nominal angle of refraction, and index point. The index point location procedure is described in 11.2.1.

5.7.5 Internal reflections from the search unit, with a screen presentation higher than the horizontal reference line, appearing on the screen to the right of the sound entry point shall not occur beyond 1/2-inch equivalent distance in steel when the sensitivity is set as follows: 20 dB more than that required to produce a maximized horizontal reference line height indication from the 0.06-inch diameter hole in the International Institute of Welding (IIW) reference block (see Figure 3).



Notes:

1. The test block is 3 in. x 1 in. x 6 in. Finish all over to a maximum of 125 µin. rms.
2. Material - ASTM A36 or equivalent.
3. 1/16 in. diameter holes are to be drilled at 90 degrees to the surface.
4. Degree lines are to be scribed on the surface as shown.
5. Degree numbers are to be stenciled on the surface as shown.

Figure 2 - Resolution Test Block

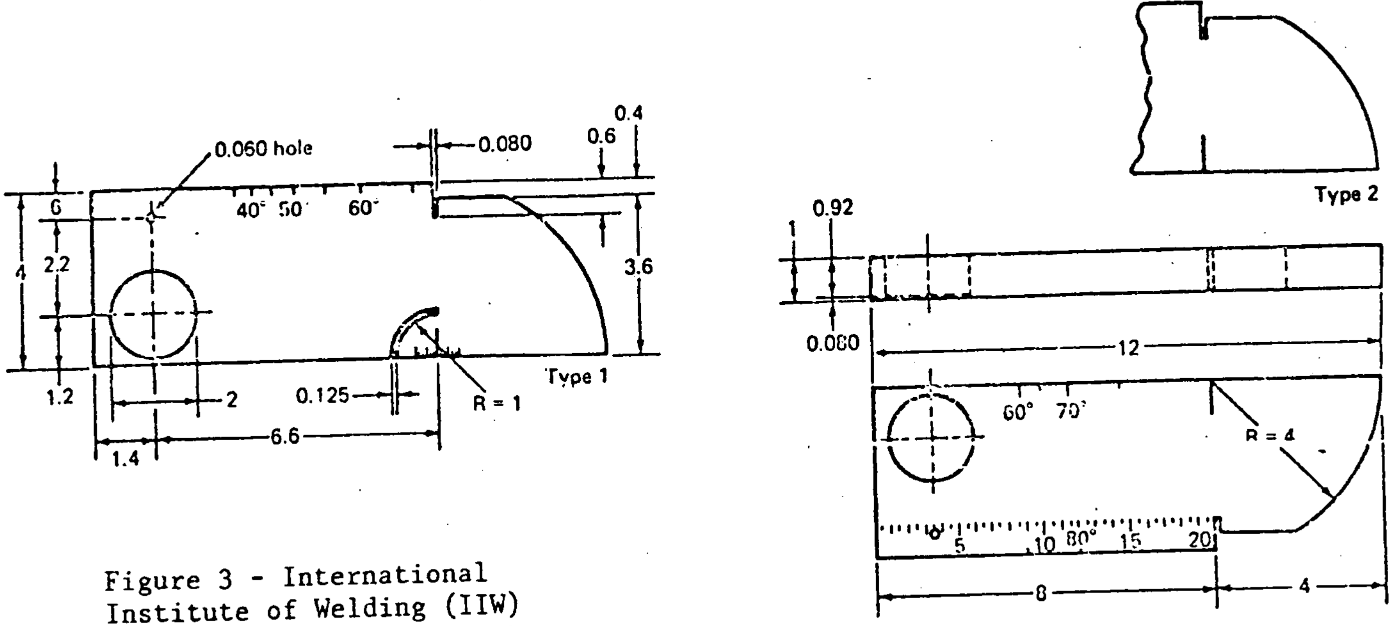


Figure 3 - International Institute of Welding (IIW) Ultrasonic Reference Blocks

Notes:

1. Other IIW-approved reference blocks with slightly different dimensions or distance calibration slot features are permissible.
2. Material: ASTM A36 steel or equivalent.

5.7.6 The dimensions of the search unit shall be such that the closeness of approach to the weld reinforcement shall not exceed the requirements of 11.2.6. The search unit shall be positioned for maximum indication from the 0.06 inch diameter hole in the IIW calibration block.

5.7.7 The combination of search unit and instrument shall resolve three holes in the resolution test block shown in Figure 2. The search unit position is described in 11.2.5. The resolution shall be evluated with the instrument controls set at normal test settings and with indications from the holes brought to mid-screen height. Resolution shall be sufficient to distinguish at least the peaks of indications from the three holes.

6.0 CALIBRATION STANDARDS

6.1 The International Institute of Welding (IIW) ultrasonic reference block shown in Figure 3 shall be the standard used for both distance and sensitivity calibration. More portable reference blocks of other design may be used provided they meet the requirements of this specification and are referenced back to the IIW block. Approved designs are shown in Figure 4. See Figure 5 for applications.

6.2 The use of a "corner" reflector for calibration purposes is prohibited.

7.0 EQUIPMENT CALIBRATION

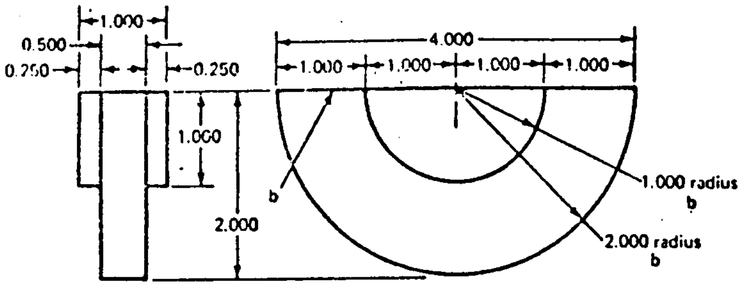
7.1 The instrument's gain control (attentuator) shall meet the requirements of 5.5 and shall be checked for correct calibration at two-month intervals.

7.2 Horizontal linearity shall be checked by the techniques prescribed in 5.2 after each 40 hours of instrument use.

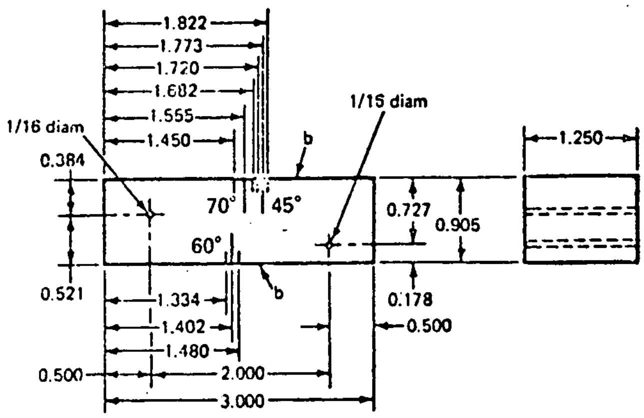
7.3 With the use of an approved calibration block, each angle beam search unit shall be checked after each eight hours of use to determine that the contact face is flat, that the sound entry point is correct, and that the beam angle is within the permitted ± 2 degree tolerance. Search units which do not meet these requirements shall be corrected or replaced.

8.0 CALIBRATION FOR TESTING

8.1 Calibration for sensitivity and horizontal sweep (distance) shall be made by the ultrasonic operator just prior to and at the location of testing of each weld and at intervals of 30 minutes as testing proceeds. Recalibration shall be made each time there is a change of operators, when transducers are changed, when new batteries are installed, or when equipment operating from a 110-volt source is connected to a different power outlet.

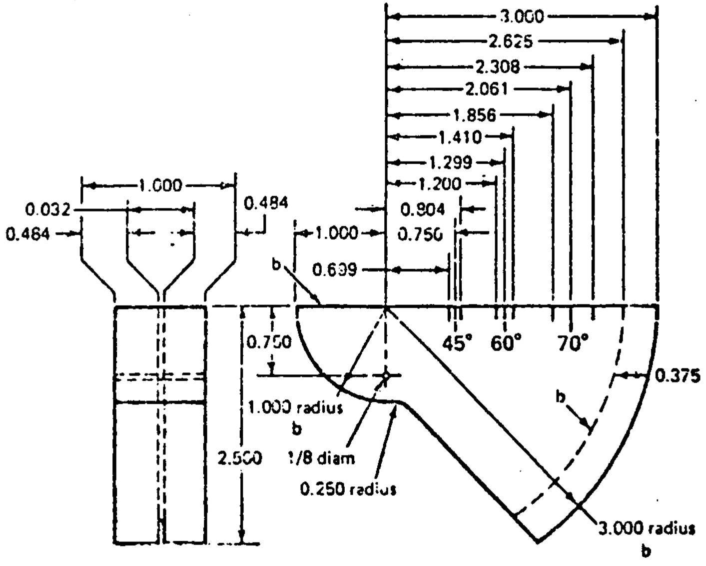


Type DC – Distance calibration block



Note: Sound entry point lines and degree of angle indications to be indented into surfaces where indicated.

Type SC – Sensitivity calibration block

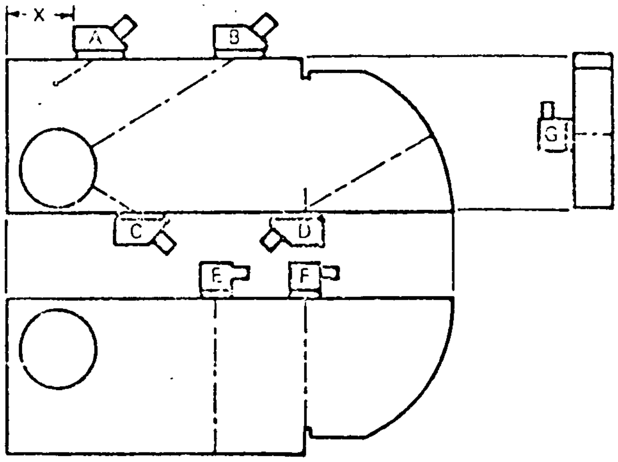


Type DSC – Distance and sensitivity calibration block

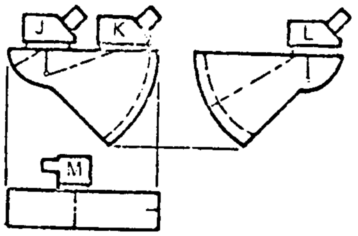
Notes:

1. Material: ASTM A36 or equivalent.
2. Dimension tolerance – ± 0.005.
3. Minimum surface finish – b – 64 to 125 μin. rms.
   others – 125 to 250 μin. rms.

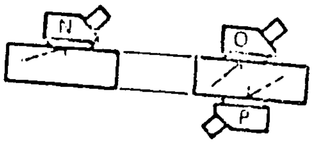
Figure 4 - Other Calibration Blocks



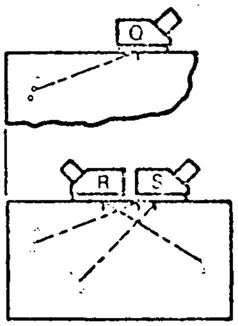
IIW block



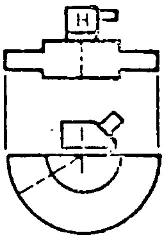
DSC block



SC block



Resolution block



DC block

Figure 5 - Transducer Positions (Typical)

8.2 Calibration for straight beam testing shall be performed as follows:

8.2.1 The horizontal sweep shall be adjusted for distance calibration to present the equivalent of at least two plate thicknesses on the CRT screen.

8.2.2 The sensitivity shall be adjusted at a location free of indications so that the first back reflection from the far side of the plate will be 50 to 75 percent of full screen height (11.1.2). For this purpose, the reject (clipping) control shall be turned off.

8.3 Calibration for angle beam testing shall be performed as follows:

8.3.1 The horizontal sweep shall be adjusted to represent the actual sound path distance by using acceptable distance calibration blocks shown in Figures 3 and 4. This distance calibration shall be made using either the 5-inch scale or 10-inch scale on the CRT screen, whichever is appropriate, unless joint configuration or thickness prevents full examination of the weld at either of these settings. The search unit position is described in 11.2.3.

8.3.2 With the unit adjusted to conform to the requirements of 4.0, the sensitivity shall be adjusted by the use of the gain control (attenuator) so that a horizontal reference level trace deflection results on the CRT screen with the maximum indication from the 0.06-inch diameter hole in the IIW block or from the equivalent reference reflector in other acceptable calibration blocks. The search unit position is described in 11.2.4. This basic sensitivity then becomes the zero reference level for discontinuity evaluation and shall be recorded on the ultrasonic test reports under reference level. See Appendix A for a sample ultrasonic test report form.

9.0 TESTING PROCEDURE

9.1 A "Y" accompanied with a weld identification number shall be clearly marked on the base metal adjacent to the weld at the left end of each weld that is ultrasonically tested. This identification number serves as an orientation direction for weld discontinuity location and as the report number on the report form. (See Appendix A for suggested report form.)

9.2 All surfaces to which a search unit is applied shall be free of weld spatter, dirt, grease, oil (other than that used as a couplant), and loose scale and shall have a contour permitting intimate coupling. Tight layers of paint need not be removed unless the thickness exceeds 10 mils.

9.3 A couplant shall be used between the search unit and the metal. The couplant shall be either glycerin with a wetting agent added, if needed, or a celulose gum and water mixture of a suitable consistency. Light machine oil or equivalent may be used for couplant on calibration blocks.

9.4 The entire base metal through which ultrasound must travel to test the weld shall be tested for laminar reflectors using a straight beam search unit conforming to the requirements of 5.6 and calibrated in accordance with 8.2. If any area of base metal exhibits total loss of back reflection and is located in a position that would interfere with the normal weld scanning procedure, the following alternative weld scanning procedure shall be used.

9.4.1 The area of the laminar reflector and its depth from the surface shall be determined and reported on the ultrasonic test report.

9.4.2 If part of a weld is inaccessible to testing in accordance with the requirements of Table 1, due to laminar content recorded in accordance with 9.4.1 the testing shall be conducted (1) using an alternative scanning pattern shown in Figure 6, or (2) by first grinding the weld surfaces flush to make total weld areas accessible to ultrasonic testing, or both.

9.5 Welds shall be tested using an angle beam search unit conforming to the requirements of 5.7 with the instrument calibrated in accordance with 8.3 using the angle as shown in Table 1. Following calibration and during testing, the only instrument adjustment permitted is in the sensitivity level adjustment with the calibrated gain control or attenuator. Sensitivity shall be increased from the reference level for weld scanning in accordance with Table 2 as applicable.

9.5.1 If mechanically possible, all welds shall be scanned from both sides on the same face for longitudinal and transverse discontinuities. The applicable scanning pattern or patterns shown in Figure 6 shall be used.

9.5.2 The testing angle shall be as shown in Table 1 and the transducer size must conform to 5.7.2.

9.5.3 When a discontinuity indication appears on the screen, the maximum attainable indication from the discontinuity shall be adjusted to produce a horizontal reference level trace deflection on the CRT screen. This adjustment shall be made with the calibrated gain control or attenuator, and the instrument reading, in decibels, shall be recorded on the ultrasonic test report under the heading "Indication Level."

9.5.4 The "Attenuation Factor, " "c," on the test report is attained by subtracting one inch from the sound path distance and multiplying the remainder by two.

9.5.5 The "Indication Rating," "d," on the test report is the difference between the "Reference Level" and the "Indication Level" after the "Indication Level" has been corrected by the "Attenuation Factor."

Instruments with gain in dB: a-b-c=d
Instruments with attenuation in dB: b-a-c=d

9.5.6 The length of a discontinuity as entered under "Indication Length" on the test report shall be determined by locating points at each end at which the indication amplitude drops 6 dB and measuring between the points from the center of the transducer at one end to the center of the transducer at the other end.

9.5.7 Each weld discontinuity shall be accepted or rejected on the basis of its indication rating and its length, in accordance with Table 2 for buildings and Table 3 for bridges. Only those discontinuities which are rejectable need be recorded on the test report.

9.6 Each rejectable discontinuity shall be indicated on the weld by a mark directly over the discontinuity for its entire length. The depth from the surface and type of discontinuity shall be noted on nearby base metal.

9.7 Welds found unacceptable by ultrasonic testing shall be repaired in accordance with Process Specification 1.C.1.2. Repaired welds shall be retested ultrasonically and an additional report form completed.

10.0 PREPARATION AND DISPOSITION OF REPORTS

10.1 A report form which clearly identifies the work and the area of inspection shall be completed by the ultrasonic inspector at the time of inspection. The report form for welds which are acceptable need only contain sufficient information to identify the weld, the inspector (signature), and the acceptability of the weld. An example of such a form is shown in appendix A.

10.2 Before a weld subject to ultrasonic testing by the contractor for the owner is accepted, all report forms pertaining to the weld, including any that show unacceptable quality prior to repair, shall be submitted to the inspector.

10.3 A full set of completed report forms of welds subject to ultrasonic testing by the contractor for the owner, including any that show unacceptable quality prior to repair, shall be delivered to the owner upon completion of the work. The contractor's obligation to retain ultrasonic reports shall cease (1) upon delivery of this full set to the owner; (2) at the end of one full year after completion of the contractor's work, in the event that delivery is not required.

11.0 CALIBRATION OF THE ULTRASONIC UNIT WITH THE IIW OR OTHER APPROVED CALIBRATION BLOCKS

See figures 3, 4, and 5

11.1 Longitudinal Mode

11.1.1 Distance Calibration

(1) Set the transducer in position G on the IIW block, position H on the DC block, or position M on the DSC block.

(2) Adjust instrument to produce indications at 1 inch, 2 inches, 3 inches, 4 inches, etc., on the CRT.

11.1.2 Amplitude

(1) Set the transducer in position G on the IIW block, position H on the DC block, or position M on the DSC block.

(2) Adjust the gain until maximized indication from first back relection attains 50 to 75 percent screen height.

11.1.3 Resolution

(1) Set the transducer in position F on the IIW block.

(2) Transducer and instrument should resolve all three distances.

11.2 Shear Wave Mode (Transverse)

11.2.1 Locate or check the transducer sound entry point (index point) by the following procedure:

(1) Set the transducer in position D on the IIW block, position J or on the DSC block, or I on the DC block.

(2) Move the transducer until the signal from the radius is maximized.

The point on the transducer which is in line with the line on the calibration block is indicative of the point of sound entry.

11.2.2 Check or determine the transducer sound path angle by the following procedure:

(1) Set the transducer in position B on IIW block for angles 40 degrees through 60 degrees.

(2) Set the transducer in position C on IIW block for angles 60 degrees through 70 degrees

(3) Set the transducer in position K on DSC block for angles 45 degrees through 70 degrees

(4) Set the transducer in position N on SC block for 70 degree angle.

(5) Set the transducer in position O on SC block for 45 degree angle.

(6) Set the transducer in position P on SC block for 60 degree angle.

(7) Move the transducer back and forth over the line indicative of the transducer angle until the signal from the radius is maximized. Compare the sound entry point on the transducer with the angle mark on the calibration block (Tolerance: ± 2 degree).

11.2.3 Distance Calibration Procedure

(1) Set the transducer in position D on the IIW block (any angle).

(2) Adjust the instrument to attain indications at 4 inches and 8 inches or 9 inches on the cathode ray tube (CRT), 9 inches on Type 1 block, or 8 inches on Type 2 block.

(3) Set the transducer in position J or L on the DSC block (any angle).

(4) Adjust the instrument to attain indications at 1 inch, 5 inches, and 9 inches on the CRT in the J position.

(5) Adjust the instrument to attain indications at 3 inches and 7 inches on the CRT in the L position.

(6) Set the transducer in position I on the DC block (any angle).

(7) Adjust the instrument to attain indication at 1 inch, 2 inches, 3 inches, 4 inches, etc., on the CRT.

11.2.4 Amplitude or Sensitivity Calibration Procedure

(1) Set the transducer in position A on the IIW block (any angle).

(2) Adjust the maximized signal from the 0.06-inch hole to attain a horizontal reference line height indication.

(3) Set the transducer in position L on the DSC block (any angle).

(4) Adjust the maximized signal from the 1/32-inch slot to attain a horizontal reference line height indication.

(5) Set the transducer on the SC block, position N for 70 degree angle, position O for 45 degree angle, or position P for 60 degree angle.

(6) Adjust the maximized signal from the 1/16-inch hole to attain a horizontal reference line height indication.

(7) The decibel reading obtained in (6) shall be used as the "Reference Level" "b" reading on the Test Report sheet (Appendix A).

11.2.5 Resolution

(1) Set the transducer on resolution block, position Q for 70 degree angle, position R for 60 degree angle, or position S for 45 degree angle.

(2) Transducer and instrument shall resolve the three test holes, at least to the extent of distinguishing the peaks of the indications from the three holes.

11.2.6 Approach Distance of Search Unit

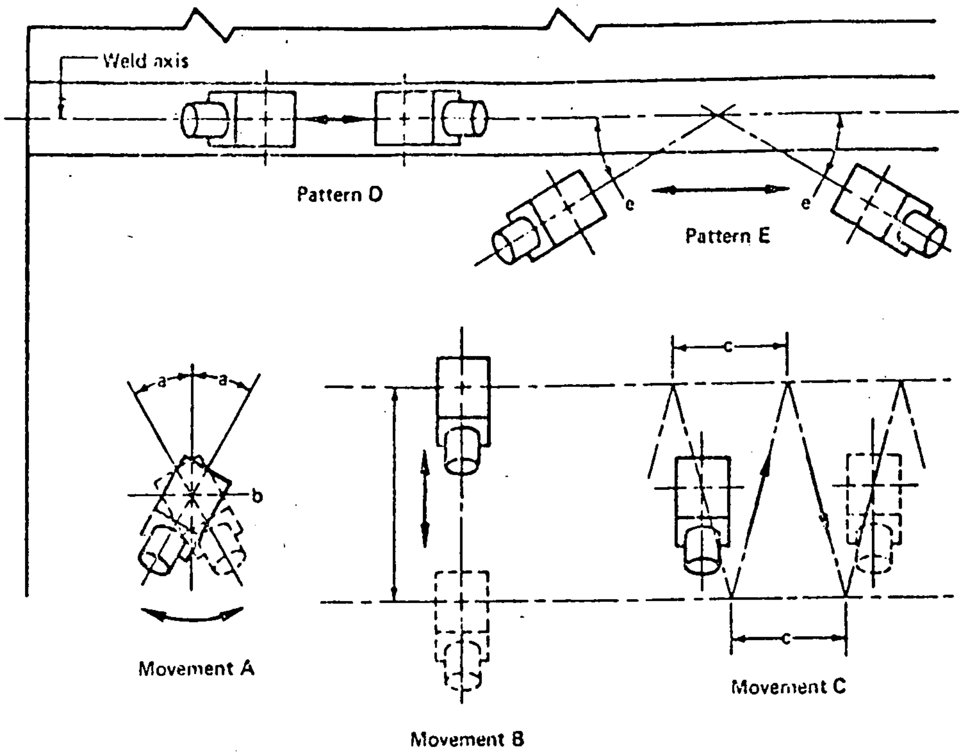
The minimum allowable distance, X, between the toe and the search unit and the edge of the IIW block shall be as follows:

for 70 degree transducer, X = 2 inches
for 60 degree transducer, X = 1-5/8 inches
for 45 degree transducer, X = 1 inch

Prepared by: 4-15-83

Reviewed by: Robert M. [illegible] 4/15/83
SNT-TC-1A, Level III

Approved by: C E Roberts 4/15/83



Notes:

1. Testing patterns are all symmetrical around the weld axis with the exception of pattern D which is conducted directly over the weld axis.
2. Testing from both sides of the weld axis is to be made wherever mechanically possible.

Figure 6 - Plan View of Welded Plate

12.0 SCANNING PATTERNS (See figure 6)

12.1 Longitudinal Discontinuities

12.1.1 Scanning Movement A. Rotation angle a = 10 degrees

12.1.2 Scanning Movement B. Scanning distance b shall be such that the section of weld being tested is covered.

12.1.3 Scanning Movement C. Progression distance c shall be approximately one-half the transducer width.

NOTE: Movements A, B, and C are combined into one scanning pattern.

12.2 Transverse Discontinuities

12.2.1 Scanning Pattern D. (when welds are ground flush).

12.2.2 Scanning Pattern E. (when weld reinforcement is not ground flush).

12.2.3 Scanning angle e = 15 degrees maximum

NOTE: The scanning pattern is to be such that the full weld section is covered.

Table 1 - Testing Angle

Weld type	Material thickness, in.																	
	5/16 to 1-1/2		>1-1/2 to 1-3/4		>1-3/4 to 2-1/2		>2-1/2 to 3-1/2		>3-1/2 to 4-1/2		>4-1/2 to 5		>5 to 6-1/2		>6-1/2 to 7		>7 to 8	
		•		•		•		•		•		•		•		•		•
Butt	1	0	1	F	1G or 4	F	1G or 5	F	6 or 7	F	8 or 10	F	9 or 11	F	12 or 13	F	12	F
T	1	0	1	F or XF	4	F or XF	5	F or XF	7	F or XF	10	F or XF	11	F or XF	12 or 13	F or XF	—	—
Corner	1	0	1	F or XF	1G or 4	F or XF	1G or 5	F or XF	6 or 7	F or XF	8 or 10	F or XF	9 or 11	F or XF	F or 14	F or XF	—	—
Electrogas & electroslag	1	0	1	0	1G or 4	1**	1G or 5	P1 or P3	6 or 7	P3	11 or 15	P3	11 or 15	P3	11 or 15	P3	11 or 15**	P3

Note: All examinations are to be made from Face "A" unless noted and scanned from both sides of weld (on Face "A") where mechanically possible. All examinations are to be made in Leg I where possible or Leg II only when necessary to test weld areas made inaccessible by unground weld surface contour. A maximum of Leg III is to be used only where extra weld bead width prevents scanning of certain weld areas in Leg I or Leg II. (See Glossary of Terms, Appendix I.)

Legend:

X—Check from Face "C."

G—Grind weld face flush.

O—Not required.

A Face—the face of the material from which the initial scanning is done (on T- and corner joints, follow above sketches).

B Face—opposite the "A" face (same plate).

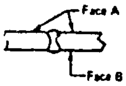
C Face—the face opposite the weld on the connecting member of a T- or corner joint.

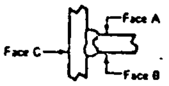
*Required only where reference level indication of discontinuity is noted in fusion zone while searching at scanning level with primary procedure selected from first column.

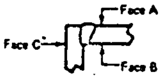
**Use 15 or 20 in. screen distance calibration.

P—Pitch and catch shall be conducted for further discontinuity evaluation in only the middle half of the material thickness with only 45 deg or 70 deg transducers of equal specification, both facing the weld. (Transducers preferably held in a fixture to control positioning—see sketch.) Amplitude calibration for pitch and catch is normally made by calibrating a single search unit. When switching to dual search units for pitch and catch inspection, there should be assurance that this calibration does not change as a result of instrument variables.

F—Further evaluate fusion zone indications with either 70 deg, 60 deg, or 45 deg transducer—whichever sound path is nearest to being perpendicular to the suspected fusion surface.



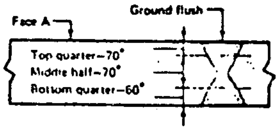




Pitch and catch

Note: Procedure G, 6, 8, 9, 12, 14, or 15 must be followed when testing welds which have been ground flush. The need for grinding may either be to satisfy contract requirements or at the option of the contractor to provide a more favorable working condition. Face "A" on both connecting members must lie in a single plane.

Example: Butt weld in 4 in. base metal
No. 6 procedure



Procedure legend

No.	Area of weld thickness		
	Top quarter	Middle half	Bottom quarter
1	70°	70°	70°
2	60°	60°	60°
3	45°	45°	45°
4	60°	70°	70°
5	45°	70°	70°
6	70°G A	70°	60°
7	60° B	70°	60°
8	70°G A	60°	60°

Procedure legend

No.	Area of weld thickness		
	Top quarter	Middle half	Bottom quarter
9	70°G A	60°	45°
10	60° B	60°	60°
11	45° B	70°***	45°
12	70°G A	45°	70°G B
13	45° B	45°	45°
14	70°G A	45°	45°
15	70°G A	70°A B	70°G B

Table 2

DESIGN OF NEW BUILDING STEEL STRUCTURE UT ACCEPTANCE CRITERIA

Ultrasonic acceptance criteria

Minimum acceptance levels (decibels)

Reflector severity	Weld thickness (in.) and transducer angle													
	5/16 to 3/4	>3/4 to 1-1/2	>1-1/2 to 2-1/2			>2-1/2 to 4			>4 to 6			>6 to 8		
	70°	70°	70°	60°	45°	70°	60°	45°	70°	60°	45°	70°	60°	45°
Large reflectors	+ 8	+ 3	− 1	+ 2	+ 4	− 4	− 1	+ 1	− 7	− 4	− 2	− 9	− 6	− 4
Small reflectors	+ 9	+ 4	+ 1	+ 4	+ 6	− 2	+ 1	+ 3	− 5	− 2	0	− 7	− 4	− 2
Minor reflectors	+10	+ 5	+ 3	+ 6	+ 8	0	+ 3	+ 5	− 3	0	+ 2	− 5	− 2	0

Notes:

1. Discontinuities which have a more serious rating than those of minor reflectors shall be separated by at least 2L, L being the length of the larger discontinuity. Discontinuities not separated by at least 2L are considered to be one discontinuity whose length is determined by the combined length of the discontinuities plus their separation distance.
2. Discontinuities which have a more serious rating than those of minor reflectors shall not begin at a distance smaller than 2L from weld ends carrying primary tensile stress, L being the discontinuity length.
3. Discontinuities detected at 'scanning levels' in the root-face areas of complete joint penetration double-V-groove welds, double-J-groove welds, double-U-groove welds, and double-bevel-groove welds shall be evaluated at an acceptance level 4 db* more sensitive than prescribed in this table when such welds are designated on design drawings as 'tension welds.'
4. Electroslag and electrogas welds—discontinuities which exceed 2 in. (51 mm) in length and occur in the middle half of such welds are to be evaluated at an acceptance level 6 db more sensitive than the above levels.

*i.e., add +4 dB to the number in the table.

Large reflectors

Any discontinuity, REGARDLESS OF LENGTH, having a more serious rating (smaller number) than this level shall be rejected.

Small reflectors

Any discontinuity longer than 3/4 in. (19.0 mm) having a more serious rating (smaller number) than this level shall be rejected.

Minor reflectors

Only those discontinuities exceeding 2 in. (51 mm) in length and having a more serious rating (smaller number) than this level shall be rejected.

Scanning levels

Sound path distance		Above zero reference, dB
in.	mm	
To 2-1/2	63.5	+14
>2-1/2 to 5	63.5 - 127	+19
>5 to 10	127 - 254	+29
>10 to 15	254 - 381	+39

Table 3

DESIGN OF NEW BRIDGES

Ultrasonic acceptance criteria

Minimum acceptance levels (decibels)

Weld thickness (in.) and transducer angle

Reflector severity	5/16 to 3/4	>3/4 to 1-1/2	>1-1/2 to 2-1/2			>2-1/2 to 4			>4 to 6			>6 to 8		
	70°	70°	70°	60°	45°	70°	60°	45°	70°	60°	45°	70°	60°	45°
Large reflectors	+14	+ 9	+ 5	+ 8	+10	+ 2	+ 5	+ 7	− 1	+ 2	+ 4	− 3	0	+ 2
Small reflectors	+15	+10	+ 7	+10	+12	+ 4	+ 7	+ 9	+ 1	+ 4	+ 6	− 1	+ 2	+ 4
Minor reflectors	+16	+11	+ 9	+12	+14	+ 6	+ 9	+11	+ 3	+ 6	+ 8	+ 1	+ 4	+ 6

Scanning levels

Sound path distance		
in.	mm	Above zero reference, dB
To 2-1/2	63.5	+20
>2-1/2 to 5	63.5 - 127	+25
>5 to 10	127 - 254	+35
>10 to 15	254 - 381	+45

Large reflectors

Any discontinuity, REGARDLESS OF LENGTH, having a more serious rating (smaller number) than this level shall be rejected.

Small reflectors

Any discontinuity longer than 3/4 in. (19 mm) having a more serious rating (smaller number) than this level shall be rejected.

Minor reflectors

Any discontinuity longer than 2 in. (51 mm) having a more serious rating (smaller number) than this level shall be rejected.

Notes:

1. Discontinuities which have a more serious rating than those of 'minor reflectors' shall be separated by at least 2L, L being the length of the larger discontinuity. Discontinuities not separated by at least 2L are considered to be one continuous discontinuity whose length is determined by the combined length of the discontinuities plus their separation distance.
2. Discontinuities which have a more serious rating than those of 'minor reflectors' shall not begin at a distance smaller than 2L from the end of the weld, L being the discontinuity length.
3. Discontinuities detected at 'scanning levels' in the root-face areas of complete joint penetration double-V-groove welds, double-J-groove welds, double-U-groove welds, and double-bevel-groove welds shall be evaluated at an acceptance level of 4 dB* more sensitive than prescribed in this table when such welds are designated on design drawings as 'tension welds.'
4. Discontinuities which have a more serious rating than those of 'minor reflectors' and which have a length greater than 3/4 in. (19 mm) and less than 2 in. (51 mm) are permitted in the middle half of the weld thickness.

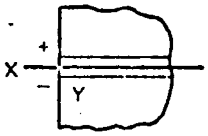
*i.e., add +4 dB to the number in the table.

APPENDIX A

Suggested Form

REPORT OF ULTRASONIC EXAMINATION OF WELDS

Project ______________________________ Report no. ______________



Weld identification ______________________________
Material thickness ______________________________
Weld joint AWS ______________________________
Welding process ______________________________
Quality requirements – section no. ______________________________
Remarks ______________________________

Line number	Indication number	Transducer angle	Leg*	Decibels				Defect					Discontinuity evaluation	Remarks
				Indication level	Reference level	Attenuation factor	Indication rating	Length	Angular distance (sound path)	Depth from "A" surface	Distance			
				a	b	c	d				From X	From Y		
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														

Notes:

1. In order to attain "Rating D"
   (A) With instruments with gain control, use the formula
   $$a - b - c = d$$
   (B) With instruments with attenuation control, use the formula
   $$b - a - c = d$$
   (C) "A + OR" sign must accompany the "D" figure unless "D" is equal to zero.
2. Distance from X is used in describing the location of a weld discontinuity in a direction perpendicular to the weld reference line. Unless this figure is zero, "A + OR" sign must accompany it.
3. Distance from Y is used in describing the location of a weld discontinuity in a direction parallel to the weld reference line. This figure is attained by measuring the distance from the "Y" end of the weld to the beginning of said discontinuity.
4. Make a separate report following repairs. (Suffix report no. with R1, R2, etc.)

*Use Leg I or II – see glossary of terms (Appendix I).

We, the undersigned, certify that the statements in this record are correct and that the welds were prepared and tested in accordance with the requirements of 6C of AWS D1.1, Structural Welding Code.

Inspected by ______________________ Manufacturer or contractor ______________________

Authorized by ______________________

Date ______________________

Process Specification: 3.C.10.1(R1)
Date: 3/7/83
Sheet: 1 of 4

TENNESSEE VALLEY AUTHORITY

ULTRASONIC EXAMINATION PROCEDURE OF BASE MATERIAL FOR LAMELLAR TEARS AND LAMINATIONS

1.0 PURPOSE

1.1 This procedure establishes the personnel qualifications, equipment testing techniques, and acceptance standards for ultrasonic inspection for lamellar tears and plate laminations in structural steel fabrications. (This specification is technically identical with Process Specification 3.C.10.1(a) with addendum 1.)

2.0 SCOPE

2.1 This procedure applies to fabrications when specified elsewhere in G-29C or on design drawings or other work authorization documents.

3.0 PERSONNEL QUALIFICATIONS

3.1 TVA personnel performing ultrasonic inspections to the requirements of this procedure shall be certified at a Level II or III in accordance with ASNT-TC-1A.

4.0 EQUIPMENT

4.1 The ultrasonic test instrument shall be of the pulse-echo type. It shall generate, receive, and present on a cathode ray tube (CRT) screen pulses in the frequency range from one to six megahertz (MHz). The presentation on the CRT screen shall be the "video" type, characterized by a clean, crisp trace.

4.2 Straight Beam search unit transducers shall have an active area of not less than 1/2-inch nor more than 1 inch. The transducer shall be round or square. Transducer frequency shall be 2 to 2.5 MHz.

5.0 CALIBRATION

5.1 Calibration for sensitivity and horizontal sweep (distance) shall be made by the ultrasonic operator just prior to and at the location of testing of each weld and at intervals of 30 minutes as testing proceeds. Recalibration shall be made each time there is a change of operators, when transducers are changed, when new batteries are installed, or when equipment operating from a 110-volt source is connected to a different power outlet.

5.2 The horizontal sweep shall be adjusted for distance calibration to present the equivalent of at leasat two plate thicknesses on the CRT screen.

5.3 The sensitivity shall be adjusted at a location free of indications so that the first back reflection from the far side of the plate will be 50 to 75 percent of full screen height. For this purpose, the reject (clipping) control shall be turned off.

5.4 Scanning

5.4.1 The volume of the plate identified in section 7.0 shall be examined for laminations and lamellar tears.

5.4.2 The search unit shall be moved in parallel paths indexing each adjacent path by at least 10 percent.

5.4.3 The scanning speed shall not exceed 6 inches per second.

6.0 SURFACE PREPARATION

6.1 All surfaces to which a search unit is applied shall be free of weld spatter, dirt, grease, oil (other than that used as a couplant), and loose scale, and shall have a contour permitting intimate coupling. Tight layers of paint need not be removed unless the thickness exceeds 10 mils.

6.2 A couplant shall be used between the search unit and the metal. The couplant shall be either glycerin with a wetting agent added, if needed, or a cellulose gum and water mixture of a suitable consistency. Light machine oil or equivalent may be used for couplant on calibration blocks.

7.0 INSPECTION METHODS AND ACCEPTANCE CRITERIA

7.1 Straight Beam Inspection for Lamellar Tears and Laminar Reflectors Prior to Welding the Connection

7.1.1 Where UT of buttering is performed, the area (see Figure 1) to be tested shall be scanned using a straight beam search unit calibrated in accordance with section 5.3. The area may be scanned prior to buttering, but final examination shall be performed after buttering.

7.1.2 Any area of base metal which exhibits an indication greater than 50 percent of full back reflection, has any dimension greater than 1 inch in any direction, and is located in the base material under the buttering to 1/2-inch below the base material buttering interface is rejectable. Indications shall be dimensioned per section 7.1.3.

7.1.3 Move the transducer away from the center of the discontinuity until the height of the discontinuity indication is 25 percent of full scale. Mark the plate at a point equivalent to the center of the transducer. Repeat the operation four times to establish the indication boundaries.

7.1.4 Rejectable defects shall be repaired in accordance with Process Specification 1.C.1.2, Appendix A.

7.2 Straight Beam Inspection for Lamellar Tears After Welding the Connection

7.2.1 Calibrate the equipment on a section of the material to be tested as in section 5.3

7.2.2 Scan the test area (see Figure 2) from the back side of the welded connection. Any reflections which produce a signal greater than 50 percent of the full back reflection, exceed 1 inch in any dimension, and are in the area between the plate surface and 1/2-inch below the plate surface are rejectable. The maximum dimensions shall be established per section 7.1.3.

7.2.3 Loss of back reflection during scanning does not constitute cause for rejection because the initial signal may be lost due to part geometry.

7.2.4 Rejectable defects shall be repaired in accordance with Process Specification 1.C.1.2, Appendix A.

7.3 Straight Beam Inspection for Lamellar Tears and Laminar Reflectors When Specified on Design Drawings.

7.3.1 When UT examination of an area is specified on design drawings, the applicable method specified in section 7.1 or 7.2 shall be applied; however, the entire area (see Figure 3) between the front and back plate surfaces shall be evaluated.

8.0 REPORT FORM

8.1 Appendix A shows a typical format for recording the results of ultrasonic examination for lamellar tearing. Only rejectable indications need be reported.

Prepared by: 4-15-83

Reviewed by: 4-15-83
ASNT-TC-1A LEVEL III

Approved by: 4/18/83

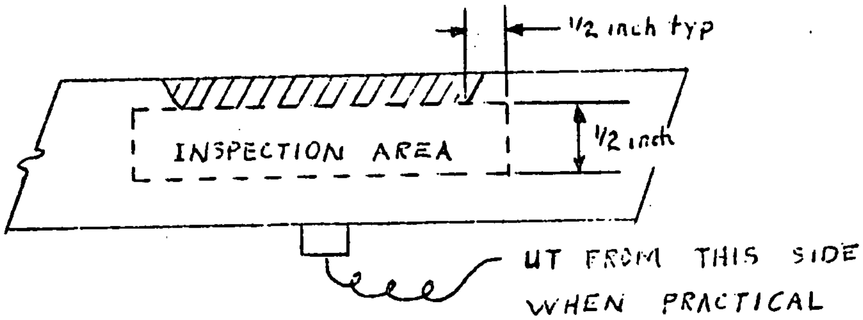


Figure 1. UT inspection area of members prior to making the connection.

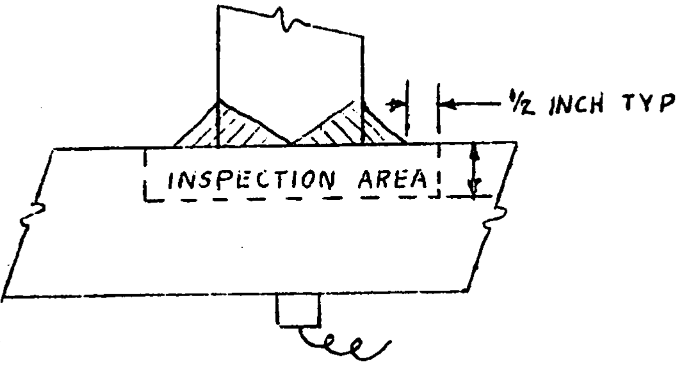


Figure 2. UT inspection of members after making the connection.

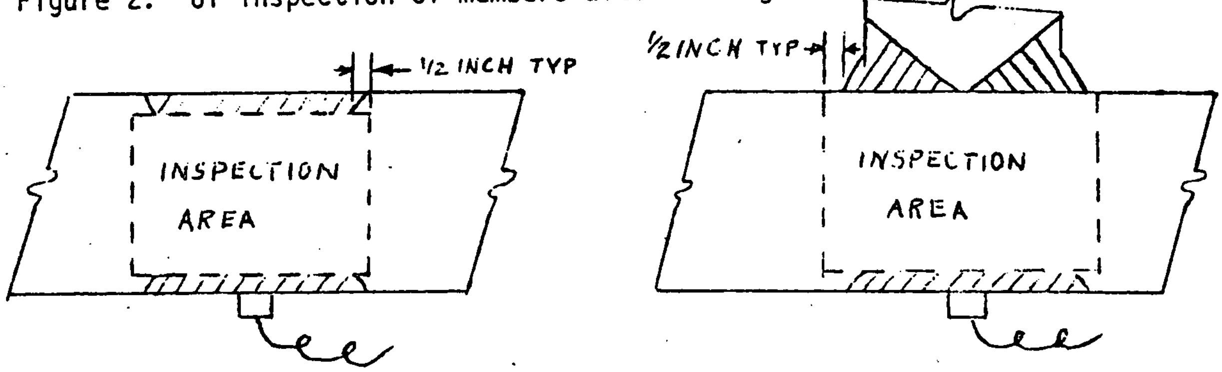


Figure 3. UT inspection of members when required by design drawings.

APPENDIX. A

REPORT NO.

TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION
ULTRASONIC EXAMINATION DOCUMENTATION REPORT

PROCEDURE NO. TECHNIQUE NO. LOCATION

ASME CLASS TVA CLASS MATERIAL

THICKNESS	SURFACE CONDITION	COVERAGE

WELD PROCESS	WELDER I. D.	WELD TYPE	WELD STATUS

PARAMETERS

COUPLANT:

TEST INSTRUMENT: MANUFACTURER MODEL TVA NO.

SEARCH UNIT (S):	SERIAL NO.	SIZE (IN.)	TYPE	FREQ. (MHz)	ANGLE (°)
STRAIGHT BEAM:					
ANGLE BEAM:					

CALIBRATION BLOCK(S):	SERIAL NO.	TYPE	THICKNESS (IN.)	CONTOUR
STRAIGHT BEAM:				
ANGLE BEAM:				

CALIBRATION DATA:	REFERENCE LEVEL (DB)	SENSITIVITY LEVEL (DB)	SCANNING LEVEL (DB)	DISTANCE AMPLITUDE CORRECTION
STRAIGHT BEAM:				
ANGLE BEAM:				

TRANSFER METHOD: ☐ V-NOTCHES ☐ CORNERS ☐ HOLES ☐ SEARCH UNIT ☐ OTHER

ULTRASONIC TECHNICIAN LEVEL DATE

INDICATION NUMBER	DISTANCE FROM ZERO	DISTANCE FROM C/L	LENGTH	DEPTH	MAXIMUM AMPLITUDE	STRAIGHT	ANGLE	ACCEPT	REJECT	INDICATE DEFECT TYPE	REMARKS

INTERPRETER: LEVEL DATE

☐ ACCEPTABLE ☐ UNACCEPTABLE

UNIT SYSTEM WELD I.D. DWG. NO. U.N.I.D.

REPORT NO.

Authorized Code Inspector: (If Applicable) Date: Reject Cleared By:

TVA 10299

ESB '83 0826 202

TENNESSEE VALLEY AUTHORITY

DIVISION OF ENGINEERING DESIGN

ALL PROJECTS

GENERAL CONSTRUCTION SPECIFICATION

NO. G-29E

FOR PROCESS SPECIFICATIONS FOR WELDING, HEAT TREATMENT, NONDESTRUCTIVE EXAMINATION, AND ALLIED FIELD FABRICATION OPERATIONS

	REVISION 0 *	R1*	R2*	R3	R4	R5
EFFECTIVE DATE	November 20, 1970	4/19/78	7/27/81	9/1/83		
PREPARED		WPJ	SAC	MAW		
REVIEWED				SAC		
SPONSORED	R. L. Harris	RMJ	CER	CER		
SUBMITTED	J. E. Holladay	GFD	TGC			
RECOMMENDED (SPONSOR BR. CHIEF)	M. N. Sprouse	DRP	JAR/jfc	JARaulston/jfc		
CONCURRED						
APPROVED (MGR. of CONST)						
APPROVED (MGR. of EN DES)		FPL	MNS	MNS		

TVA 10574A (EN DES-1-82)

TVA

Title: PROCESS SPECIFICATION FOR WELDING, HEAT TREATMENT NONDESTRUCTIVE EXAMINATION, AND ALLIED FIELD FABRICATION OPERATIONS

REVISION LOG

G-29E

Revision No.	DESCRIPTION OF REVISION	Date Approved
3	1. Replace Table of Contents with March 11, 1983, issue. 2. Replace Process Specification 1.E.1.1(b) with Process Specification 1.E.1.1(R2). 3. Add or replace the following Detail Weld Procedures: a. Replace SM-Cast Iron, Rev 0, with Rev 1. b. Replace GT23.23-2, Rev 1, with Rev 2. c. Replace TB101.107-1, Rev 0, with Rev 1. d. Add TB102.102-1, Rev 0. e. Add TB103.103-1, Rev 0. 4. In Process Specification 1.E.1.1(R2), add or replace the following Performance Qualification Tests: a. Replace GM-SD-23-L(2), Rev 0, 8/6/80, with Rev 1, 7/6/82. b. Add GT-22-0-1-L, Rev 1, 7/28/82. 5. Add Welding Procedure Qualification Record SM-Cast Iron, 5-28-82. 6. Add Process Specification 1.E.2.1(R0).	9/1/83
	E13083.07	

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Prepared by Stuart A Crawford 4/5/83

Reviewed by Petrich 4/5/83

Approved by C.E. Roberts 4/6/83

TENNESSEE VALLEY AUTHORITY

GENERAL WELDING PROCEDURE SPECIFICATION

(This specification is technically identical to process specification 1.E.1.1(b) with addendum 1.)

1.0 SCOPE

1.1 This welding procedure specification shall be applicable to all welding performed on electrical conductors and connections, and includes welding, brazing, and soldering.

1.2 The procedures contained herein are not required to be in accordance with fabrication codes; however, they are substantially in accordance with ASME Code, Section IX. They may be used for other miscellaneous non-code welding, brazing, or soldering when specified by EN DES.

2.0 WELDING PROCEDURE SYSTEM

2.1 Detail welding procedures shall be coded by letter and number to indicate the welding, brazing, or soldering process, base material(s), and welding procedure number as follows:

2.1.1 Welding Processes:

SM - Manual Shielded Metal Arc
GT - Gas Tungsten Arc
GM - Gas Metal Arc
TB - Torch Brazing
TS - Torch Soldering

2.1.2 Base Materials:

Base materials shall be designated by the P number assigned by ASME Code, Section IX, Tables QW-422, and QB-422.

2.1.3 Weld Procedure Number:

A number shall follow the welding process and base material designations to identify a particular procedure in a series for the same process and base materials.

3.0 WELDING PROCEDURE QUALIFICATION AND/OR TESTING

3.1 All welding, brazing, or soldering procedures shall reference the qualification record when tests have been performed, which may be either a record of successful qualification to ASME Code or a record of tests performed.

4.0 WELDER AND BRAZER PERFORMANCE QUALIFICATION

4.1 All welders shall be qualified for the welding process being used prior to performing work in accordance with this specification. If the selected performance qualification tests included in this specification are not appropriate, welders shall be qualified in accordance with the requirements of G-29M or G-29C. Brazers shall make a workmanship sample for each material combination and joint type prior to performing production joints.

5.0 BASE MATERIAL PREPARATION

5.1 Base materials may be prepared by chipping, grinding, machining, flame cutting, arc-air or plasma cutting, or combinations of these methods.

5.2 All methods of base material preparation shall provide a surface for welding which is clean to the extent that it will not interfere with the welding operation.

5.3 The base material surfaces on aluminum materials and for all brazed joints shall be prepared for joining by removal of surface oxides to clean, sound metal.

6.0 WELD JOINT DESIGN

6.1 Weld joint designs shall be in accordance with an approved TVA standard.

6.2 The weld joint design on the Detail Weld Procedure generally indicates the joint type used for qualification or testing. In cases where the joint design on the Detail Weld Procedure differs from an engineering standard, the engineering standard shall control.

7.0 WELDING CONDITIONS

7.1 All welding conditions including welding current, arc voltage, electrode size and type, preheat, post weld heat treatment, shielding gas type and flow rate, purging gas, filler materials, etc., shall be as specified on the Detail Weld Procedure.

8.0 PREHEAT

8.1 Preheat for welding may be applied by flame, induction, resistance, or any other method which is not detrimental to the materials involved.

8.2 When oxyacetylene flame heating is used for preheating, care shall be exercised to ensure that only a neutral flame is used in order to prevent oxidation or carburization of the surfaces to be welded, unless otherwise indicated on the Detail Weld Procedure.

8.3 Preheat temperatures may be measured by temperature indicating crayons (tempilsticks), contact pyrometers, infrared thermometers, optical pyrometers or thermocouples, but not by low-melting metallic alloys.

9.0 POST WELD HEAT TREATMENT

9.1 Post weld heat treatment, when specified on the Detail Weld Procedure, shall be performed in accordance with the instructions on the weld procedure.

9.2 Welds which have been post weld heat treated and subsequently repaired by welding shall be post weld heat treated again after the repair welding is completed.

10.0 WELDING REQUIREMENTS

10.1 There shall be no welding performed if there is impingement of rain, snow, sleet, or high wind in the weld area.

10.2 All slag, flux, and weld spatter shall be removed from the weld and adjacent weld preparation or base material surfaces, to the extent that it will not be detrimental to the deposition of sound weld metal, prior to the deposition of succeeding weld passes.

10.3 Welding shall not be performed over defective weld metal. All cracks, slag inclusions, undercut in excess of 1/64-inch, and areas of lack of fusion shall be removed prior to deposition of additional weld metal.

10.4 Gas tungsten arc welding shall not be performed without the use of filler metal, unless specifically stated on the Detail Weld Procedure.

10.5 Wire brushes used on aluminum shall be stainless steel, shall not have been used on materials other than aluminum, and shall be kept free of contaminants such as oil, grease, or other foreign matter.

10.6 Welding electrodes and filler metals shall be protected during storage and use to prevent contamination, moisture absorption, or other conditions detrimental to deposition of sound welded joints.

11.0 TORCH BRAZING REQUIREMENTS

11.1 Oxides shall be thoroughly removed from the braze joint area by grinding, wire brushing, emery cloth, or any other suitable method.

11.2 Where brazing flux is employed and added prior to the application of heat, the flux shall be applied as soon as possible after cleaning. The braze area shall be adequately covered with flux to minimize formation of oxides during the brazing operation.

11.3 Torch heating shall be applied to the braze joint by constant movement of the torch over the joint area until the parts reach the brazing temperature. Torch movement shall be performed in a manner that will prevent local overheating, and movement shall be continued while adding filler metal.

11.4 When using copper-zinc alloy filler metal (bronze), the filler rod shall be heated for a distance of approximately one inch from the tip and dipped in the borax-boric acid flux prior to application to the joint.

11.5 Care shall be exercised so that excessive filler metal is not added to brazed joints. (Brazed joints rely on capillary action for flow and distribution of filler metal and cannot be properly built up in the same manner as welded joints.)

11.6 After completion of the brazed joint, heat shall be retracted slowly while maintaining torch movement in a manner that will provide uniform slow cooling of the parts joined.

11.7 Brazing flux shall be removed from brazed joints after completion of the brazing operation. Hot water and wire brushing may be used as an aid in flux removal.

11.8 Brazed joints and adjacent cable in grounding connections which are to be embedded or buried shall be coated with an approved coating to minimize galvanic corrosion.

11.9 Where detail brazing procedures specify the use of type RB-CuZn-A (naval brass) rod, type RB-CuZn-C (low fuming bronze) rod may be substituted unless design drawings specifically require use of the former.

12.0 TORCH SOLDERING

12.1 Oxides shall be thoroughly removed from the solder joint area by means of abrasive cloth or paper.

12.2 Where soldering flux paste, corrosive or noncorrosive (rosin), is employed, it shall be added as soon as possible after mechanical oxide removal. The solder area shall be adequately covered with flux to minimize formation of oxides during the soldering operation.

12.3 Heat shall be applied to the solder joint with a propane or oxygen fuel torch. Heating shall be applied to the solder joint by constant movement of the torch over the joint area until the parts reach the soldering temperature. Torch flames should not impinge directly on the fluxed jont surfaces. Torch movement shall be such that local overheating will be prevented and movements shall be continued while solder is being added and flowed into the joint.

12.4 Soldering flux paste residue shall be removed from soldered joints after completion of the soldering operation. Flux residue should be removed with an organic solvent.

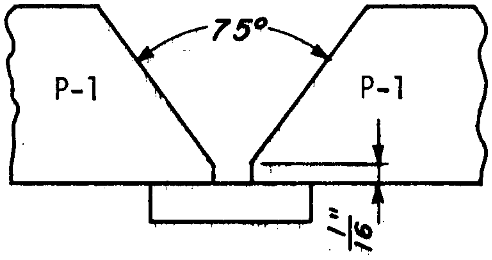
Prepared by J DeWitt 4/15/83

Reviewed by W.P. Jest 4/15/83

Approved by C.E. Roberts 4/15/83

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM 1.1-1 **Rev.:** 1 **Date:** 12/13/77



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-		
Current	80-115 amps	105-145 amps	130-190 amps
Polarity	DCRP	DCRP	DCRP
Arc Voltage	23 volts	24 volts	24 volts
Travel Speed	-	-	-
Electrode Type	E7018	E7018	E7018
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-	-	-
Filler Metal Size	-	-	-
Flux Type	-	-	-
Flux Particle Size	-	-	-
Shielding Gas	-	-	-
Shielding Gas Flow Rate	-	-	-
Purging Gas	-	-	-
Purging Gas Flow Rate	-	-	-
Gas Cup Size	-	-	-
Gas Cup To Work Distance	-	-	-
Preheat	None*		
Interpass Temp.	500° F max		
Post Weld Heat Treatment	None		
Welding Position	F,H,V,OH		
Other			

*When base metal temperature is below 32° F, preheat to 70° F, and maintain during welding.

Reference documents: P.S. 1.E.1.1(a), WS 1111R-4

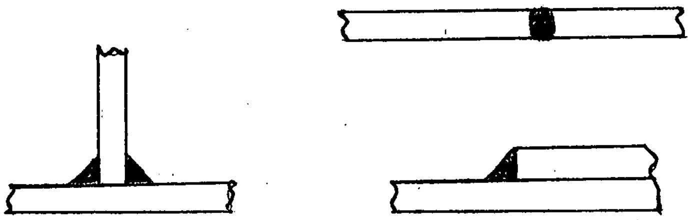
Prepared by: ____________

Approved by Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM1.1-2 **Rev.:** 1 **Date:** November 30, 1979

ONE OR BOTH MEMBERS GALVANIZED (A36 OR SHEET METAL)



TYPICAL
WELD JOINT DESIGN

Welding Conditions:

Layer No.	-	-
Current	50-80	80-120
Polarity	DCRP	DCRP
Arc Voltage	23-27	23-27
Travel Speed	2 min	3 min
Electrode Type	E7010-A1	E7010-A1
Electrode Size	3/32"	1/8"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	-	-
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup To Work Distance	-	-
Preheat	60° F min	
Interpass Temp.	500° F max	
Post Weld Heat Treatment	None	
Welding Position	F, H, V, OH	
Other		

Welders to be qualified in accordance with G29-M or G29-C for F-3 electrodes.

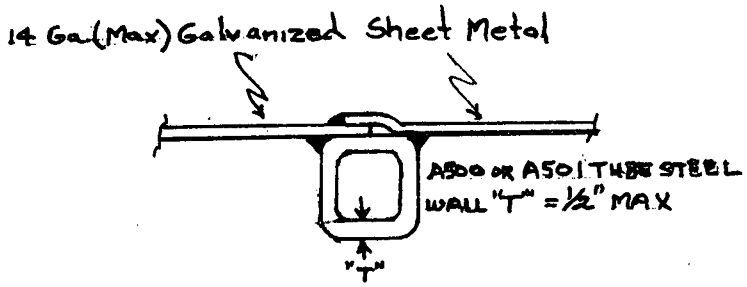
Reference documents: P.S. 1.E.1.1(a)

Prepared by:

Approved by W. P. Jost

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM1.1-3 Rev.: 0 Date: 1/31/80



TYPICAL
WELD JOINT DESIGN

Welding Conditions:

Layer No.	-	-
Current	50-80	80-120
Polarity	DCRP	DCRP
Arc Voltage	23-27	23-27
Travel Speed	2 min	3 min
Electrode Type	E7018	E7018
Electrode Size	3/32"	1/8"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	-	-
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup To Work Distance	-	-
Preheat	60° F min	
Interpass Temp.	500° F max	
Post Weld Heat Treatment	None	
Welding Position	F, H. V, OH	
Other		

Welders to be qualified in accordance with G29-M or G29-C for F-4 electrodes.

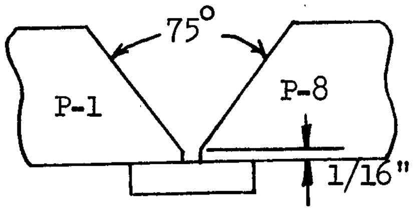
Reference documents: P.S. 1.E.1.1(a)

Prepared by J D White

Approved by Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM18-1 **Rev.:** 0 **Date:** 8-28-75



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-	-	-
Current	50-80 amp	70-115 amp	100-145 amp
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Travel Speed	2 IPM Min.	3 IPM Min.	4 IPM Min.
Electrode Type	E309-15	E309-15	E309-15
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-	-	-
Filler Metal Size	-	-	-
Flux Type	-	-	-
Flux Particle Size	-	-	-
Shielding Gas	-	-	-
Shielding Gas Flow Rate	-	-	-
Purging Gas	-	-	-
Purging Gas Flow Rate	-	-	-
Gas Cup Size	-	-	-
Gas Cup To Work Distance	-	-	-
Preheat	60° F Min.		
Interpass Temp.	350° F Max.		
Post Weld Heat Treatment	None		
Welding Position	F, H, V, OH		
Other			

Reference documents: P.S. 1.E.1.1(a), PQR SM18-B-1

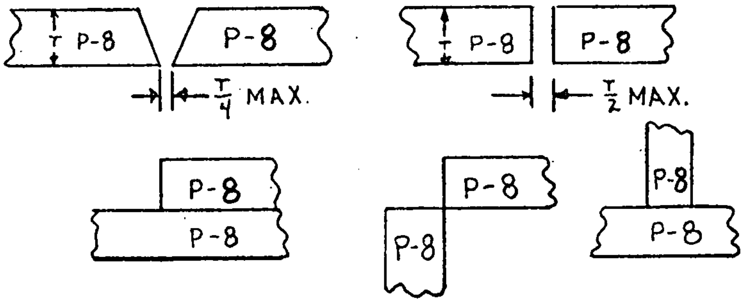
Prepared by Roger Cantrell

Approved by Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM88-1 Rev.: 0 Date: 10/2/80

1. Butt welds may only be considered full penetration when backing strip is used, joint is double welded, or joint is visually examined on back side.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-	-
Current	50-80 amperes	70-115 amperes
Polarity	DCRP	DCRP
Arc Voltage	22-26 volts	23-27 volts
Travel Speed	-	-
Electrode Type	E308-15, 16	E308-15, 16
Electrode Size	3/32"	1/8"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	-	-
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup To Work Distance	-	-
Preheat	60° F min.	
Interpass Temp.	350° F max.	
Post Weld Heat Treatment	-	
Welding Position	All	
Other	-	

Reference documents: P.S.1.E.1.1

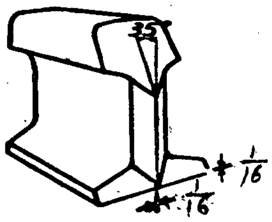
Prepared by

Approved by W. P. Joest

SM88.1

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-Crane Rail **Rev.:** 1 **Date:** 3/18/77



TYPICAL RAIL END PREPARATION

ASTM A-1
Crane Rail

Welding Conditions:

Increment	-	-	-
Current	75-115	100-145	130-205
Pulse Rate	-	-	-
Polarity	DCRP	DCRP	DCRP
Arc Voltage	22-26	23-27	23-27
Transfer Mode	-	-	-
Travel Speed (IPM)	3 min.	4 min.	5 min.
Electrode Type*	-	-	-
Electrode Size	3/32"	1/8"	5/32"
Filler Metal Type	-	-	-
Filler Metal Size	-	-	-
Flux Type	-	-	-
Flux Particle Size	-	-	-
Shielding Gas	-	-	-
Shielding Gas Flow Rate	-	-	-
Purging Gas	-	-	-
Purging Gas Flow Rate	-	-	-
Gas Cup Size	-	-	-
Gas Cup to Work Distance	-	-	-
Contact Tube to Work Dist.	-	-	-
Preheat	500 F min. (6" min, each side of joint)		
Interpass Temperature	800 F max.		
Post Weld Heat Treatment	700-800 F and slow cool by covering with insulating blanket		
Welding Position	F,H,V,OH		
Other			

*E12018 or E11018 for nonheat treated rail only
E14018 HT for any rail
Electrodes shall be used within 1/2 hour after removal from drying ovens or sealed containers.

Welders shall be qualified in accordance with G-29M or G-29C to weld with F-4 electrodes in the applicable positions.

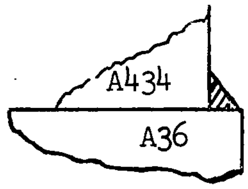
Reference documents: P.S. 1.E.1.1(a)

Prepared by: W. P. Frost

Approved by: Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM-Special-1 **Rev.:** 0 **Date:** 2/10/78



TYPICAL WELD JOINT DESIGN

Welding Conditions:

Increment	-
Current	60-110
Pulse Rate	-
Polarity	DCRP
Arc Voltage	23-27
Transfer Mode	-
Travel Speed (IPM)	3 min
Electrode Type	E7018
Electrode Size	3/32"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup to Work Distance	-
Contact Tube to Work Dist.	-
Preheat	60° F min
Interpass Temperature	500° F max
Post Weld Heat Treatment	-
Welding Position	F, H, V, OH
Other	-

Reference documents: ~~P.S. 1~~.E.1.1(a)

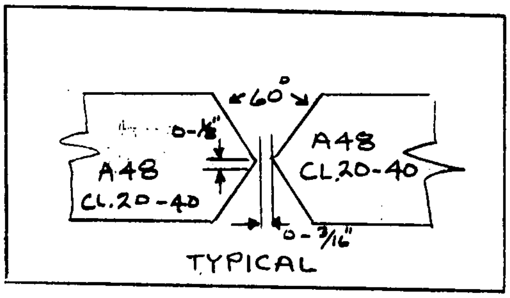
Prepared by: ____________

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: SM -Cast Iron Rev.: 1 Date: 5/28/82

Joint Design: (TYP)



Welding Conditions:

Increment	-	-
Current (Amps)	40-80	80-120
Pulse Rate	-	-
Polarity	DCRP	DCRP
Arc Voltage	22-25	22-25
Transfer Mode	-	-
Travel Speed (IPM)	-	-
Electrode Type	ENi-CI*	ENi-CI*
Electrode Size	3/32"	1/8"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	-	-
Flux Particle Size	-	-
Shielding Gas	-	-
Shielding Gas Flow Rate	-	-
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	-	-
Gas Cup to Work Distance	-	-
Contact Tube to Work Dist.	-	-
Preheat	See Below	
Interpass Temperature	See Below	
Post Weld Heat Treatment	None	
Welding Position	F, V, H, OH	

Other -- Preheat of 400°F - 600° F with 800°F maximum interpass recommended when entire casting can be uniformly preheated. Otherwise welding may be performed with with 60°F preheat and 300°F maximum interpass. With either technique, slow cooling after completion of welding is recommended.

*Certanium 889 is an acceptable alternate.

Reference documents: P.S.1.E.1.1(a), PQR SM - Cast Iron

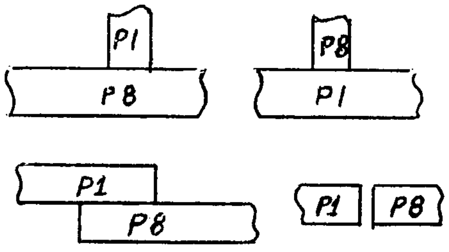
Prepared by: Reviewed by:

Approved by: C.E. Roberts DE06:SMCI.R1

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM 1.8-0-1 **Rev.:** 1 **Date:** February 8, 1978

For welding of type 304 stainless steel of 3/16 in. maximum thickness to P1 materials of 3/16 in. maximum thickness, or of 304 stainless steel sheet metal of 1/8 in. maximum thickness to P1 material of unlimited thickness, or P1 sheet metal of 1/8 in. maximum thickness to 304 material of unlimited thickness.



WELD JOINT DESIGN

Welding Conditions:

Increment	-
Current	60-160
Pulse Rate	-
Polarity	DCRP
Arc Voltage	14-22
Transfer Mode	Short circuiting
Travel Speed (IPM)	4 min.
Electrode Type	ER309
Electrode Size	.035"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	90 Ar, 7.5 He, 2.5 CO_2
Shielding Gas Flow Rate	10-25 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	5/8" max.
Gas Cup to Work Distance	5/8" max.
Contact Tube to Work Dist.	3/4" max.
Preheat	50 F min.
Interpass Temperature	350 F max.
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

Reference documents: P. S. 1.E.1.1

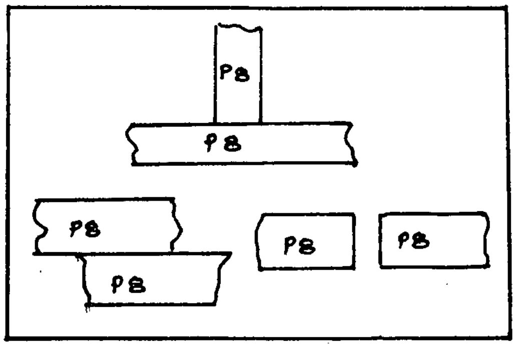
Prepared by:

Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM88-0-1 Rev.: 1 Date: 11/25/80

For weld of type
304 stainless steel
to 3/16" maximum
thickness.



Welding Conditions:

Increment	-
Current	60-160
Pulse Rate	-
Polarity	DCRP
Arc Voltage	14-22
Transfer Mode	Short circuiting
Travel Speed (IPM)	4 min.
Electrode Type	ER308*
Electrode Size	0.035"
Filler Metal Type	-
Filler Metal Size	-
Flux Type	-
Flux Particle Size	-
Shielding Gas	90 Ar, 7.5 He, 2.5 CO_2
Shielding Gas Flow Rate	10-25 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	5/8" max
Gas Cup to Work Distance	5/8" max
Contact Tube to Work Dist.	3/4" max.
Preheat	50° F min
Interpass Temperature	350° F max
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

*ER308L or ER308LSi may also be used with this procedure.

Reference documents: P.S. 1.E.1.1

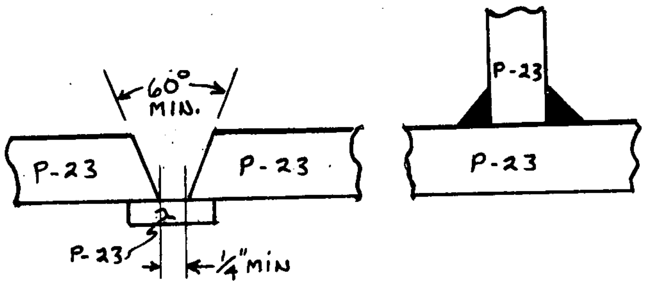
Prepared by:

Approved by: W. P. Jost

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GM23.23-1 Rev.: 3 Date: 1/8/80

Notes:
1. Clean weld area with Acetone or other suitable solvent prior to welding. Maintain cleanliness during welding by wire-brushing.



TYPICAL
WELD JOINT DESIGN

Welding Conditions:

Layer No.	-	-
Current	160-225 amps	180-300 amps
Polarity	DCRP	DCRP
Arc Voltage	23-29 volts	23-29 volts
Travel Speed	-	-
Electrode Type	ER4043 or ER5356	Er4043 or ER5356
Electrode Size	3/64"	1/16"
Filler Metal Type	-	-
Filler Metal Size	-	-
Flux Type	-	-
Flux Particle Size	-	-
Shielding Gas	Argon	Argon
Shielding Gas Flow Rate	30-50 cfh	30-50 cfh
Purging Gas	-	-
Purging Gas Flow Rate	-	-
Gas Cup Size	5/8"	5/8"
Gas Cup To Work Distance	5/8" max	5/8" max
Preheat	60 F min.	
Interpass Temp.	500 F max.	
Post Weld Heat Treatment	None	
Welding Position	F, H, V, OH	
Other		

Reference documents: P.S. 1.E.1.1

Prepared by: L D White

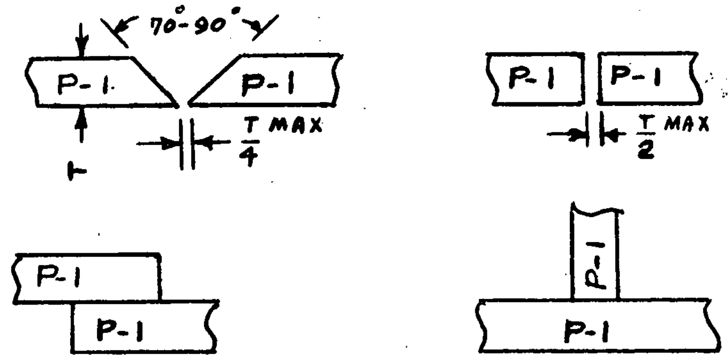
Approved by Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT 1.1-1 Rev.: 0 Date: 4-9-76

NOTES:

1. This procedure may be used for welding over galvenized surfaces.
2. This procedure is for braze welding, in which the amount of base metal melted is minimized by pushing filler rod into the joint or laying the filler flat in the joint and maintaining the arc between the tungsten electrode and filler rod.



WELD JOINT DESIGN

Welding Conditions:

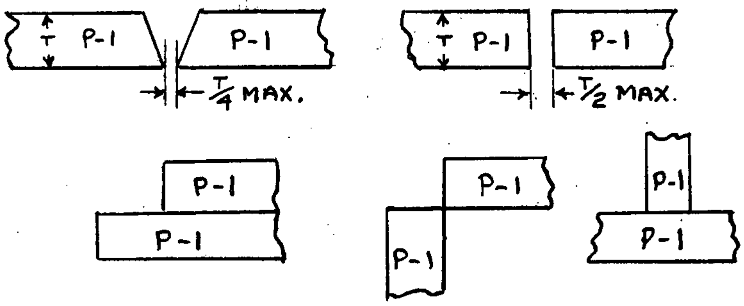
Layer No.	All
Current	35-75 Amperes
Polarity	SP
Arc Voltage	10-14
Travel Speed	-
Electrode Type	EWTH-2
Electrode Size	1/16"-3/32"
Filler Metal Type	R Cu Si-A (silicon bronze)
Filler Metal Size	1/16, 3/32
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	10-20 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/8" min
Gas Cup To Work Distance	1/2" max
Preheat	60 F min
Interpass Temp.	500 F max
Post Weld Heat Treatment	-
Welding Position	All
Other	

Reference documents: P.S.1.E.1.1

Approved by Robert M Isaacs

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT1.1-2 **Rev.:** 0 **Date:** 12/12/79



TYPICAL
WELD JOINT DESIGN

Notes:

1. This procecure may be used for welding over galvanized surfaces.
2. To assist in flushing zinc vapor from the arc area on galvanized surfaces, torch-to-work angle should be approximately 70° and shield gas flow rate set toward high side of specified range.

Welding Conditions:

Layer No.	All
Current	35-75 Amperes
Polarity	SP
Arc Voltage	10-14
Travel Speed	-
Electrode Type	EWTH-2
Electrode Size	1/16" - 3/32"
Filler Metal Type	E70S-3*
Filler Metal Size	1/16, 3/32
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	10-30 CFH
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/8" min
Gas Cup To Work Distance	1/2" max
Preheat	60° F min
Interpass Temp.	500° F max
Post Weld Heat Treatment	-
Welding Position	All
Other	

*E70S-2 may be substituted.

Reference documents: P.S.1.E.1.1

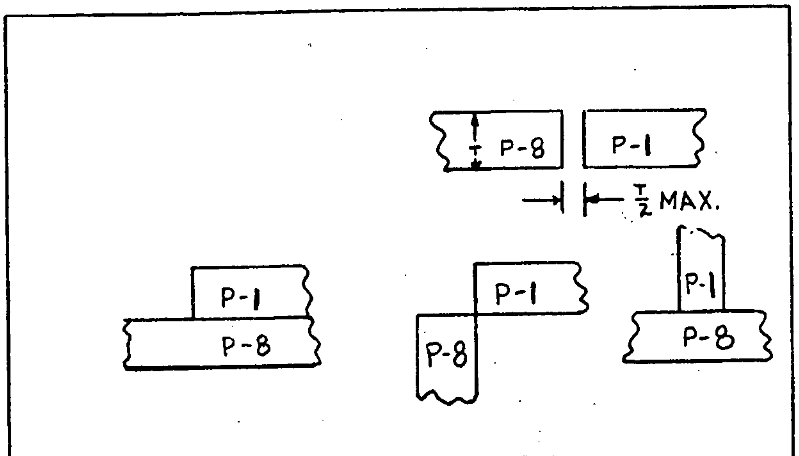
Prepared by: J. White

Approved by Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT18-1 **Rev.:** 0 **Date:** 10/2/80

1. This procedure is not valid for butt welds when full penetration is required.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	All
Current	35-75 amperes
Polarity	DCSP
Arc Voltage	10-14
Travel Speed	-
Electrode Type	EWTH-2
Electrode Size	1/16" - 3/32"
Filler Metal Type	ER-309
Filler Metal Size	1/16" - 3/32"
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	10-30 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/8" min.
Gas Cup To Work Distance	1/2" max.
Preheat	60° F min.
Interpass Temp.	350° F max.
Post Weld Heat Treatment	-
Welding Position	All
Other	

Reference documents: P.S.1.E.1.1

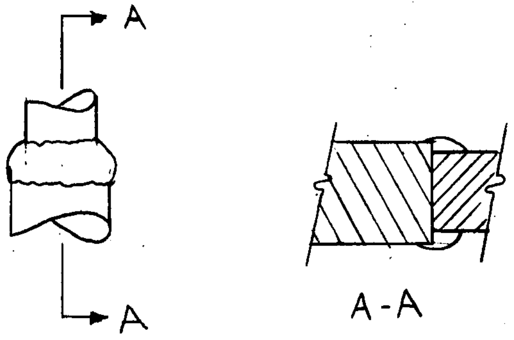
Prepared by __________

Approved by W. P. Joest

GT18.1

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT 1.35-1 **Rev.:** 0 **Date:** 6/7/77



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	140-170
Polarity	ACHF[1]
Arc Voltage	-
Travel Speed	-
Electrode Type	EWP[2]
Electrode Size	1/8"
Filler Metal Type	R Cu Al-A2 or E Cu Al-A2
Filler Metal Size	1/8"-3/32"
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	18-22 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	1/2"
Gas Cup To Work Distance	5/8" max
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	F,H,V,OH
Other	-

[1] Alternating current with superimposed high frequency.

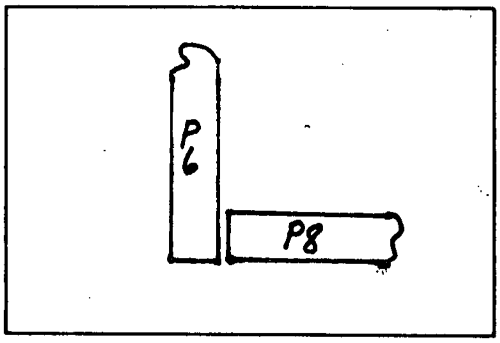
[2] Pure tungsten

Reference documents: P.S. 1.E.1.1(a)

Approved by Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT68-B-1 **Rev.:** 0 **Date:** 8/8/77



For tack welding P6 to P8 material.

The weld and adjacent base metal shall be liquid penetrant examined.

Welding Conditions:

Increment	Root & Rem
Current	60-130 amp
Pulse Rate	-
Polarity	DCSP
Arc Voltage	10-14 V
Transfer Mode	-
Travel Speed (IPM)	3/4" min*
Electrode Type	EWTH-2
Electrode Size	3/32" dia
Filler Metal Type	ENiCr-3
Filler Metal Size	1/16", 3/32", 1/8"
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	15-25 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	1/2" max
Gas Cup to Work Distance	1/2" max
Contact Tube to Work Dist.	-
Preheat	60 F min
Interpass Temperature	350 F max
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

*3/4 for root; 1-3/4 for remainder

Reference documents: P.S. 1.E.1.1

Prepared by: W. P. Joest

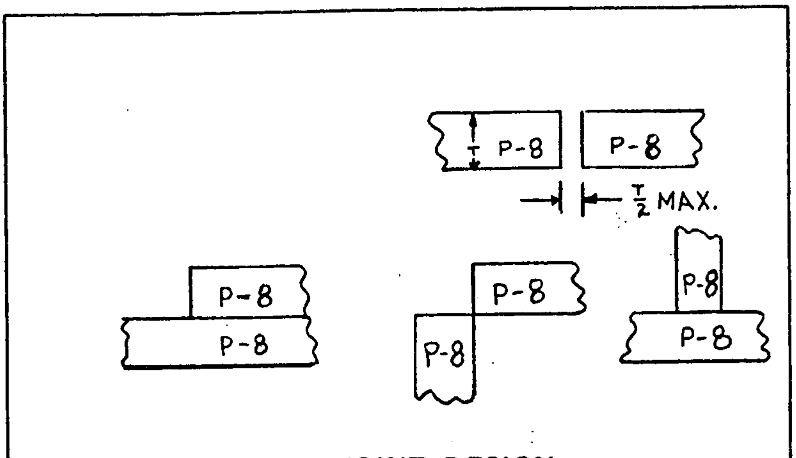
Approved by: Robert M [illegible]

3651 - 8/8/77

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT88-1 Rev.: 0 Date: 10/2/80

1. This procedure is not valid for butt welds when full penetration is required.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	All
Current	35-75 amperes
Polarity	DCSP
Arc Voltage	10-14
Travel Speed	-
Electrode Type	EWTH-2
Electrode Size	1/16" - 3/32"
Filler Metal Type	ER-308
Filler Metal Size	1/16" - 3/32"
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	10-30 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	3/8" min.
Gas Cup To Work Distance	1/2" max.
Preheat	60° F min.
Interpass Temp.	350° F max.
Post Weld Heat Treatment	-
Welding Position	All
Other	

Reference documents: P.S. 1.E.1.1

Prepared by: ______________________

Approved by W.P. Joest

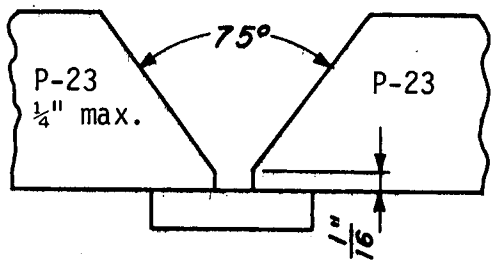
GT88.1

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT 23.23-1 **Rev.:** 1 **Date:** May 21, 1979

Notes:

1. Clean weld area with Acetone or other suitable solvent prior to welding.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	All
Current	90-250 amps
Polarity	ACHF[1]
Arc Voltage	-
Travel Speed	-
Electrode Type	EWP[2]
Electrode Size	1/8" or 3/16"
Filler Metal Type	ER5356
Filler Metal Size	3/32" - 3/16"
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	35-80 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	1/2"
Gas Cup To Work Distance	5/8" max.
Preheat	60° F min.
Interpass Temp.	500° F max.
Post Weld Heat Treatment	None
Welding Position	F,H,V,OH
Other	

[1] Alternating current with superimposed high frequency
[2] Pure tungsten

Reference documents: P.S. 1.E.1.1(a), WS 232322

Prepared by

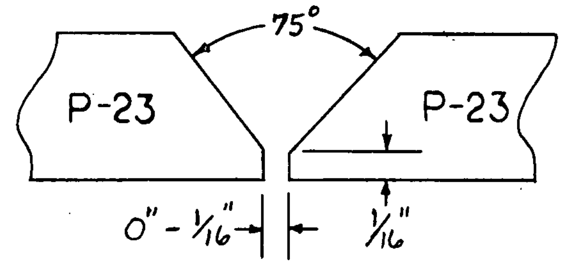
Approved by Robert M Jessen

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT23.23-2 Rev.: 2 Date: July 6, 1982

Notes:

1. Clean weld area with Acetone or other suitable solvent prior to welding.



TYPICAL WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	90-170 amps
Polarity	ACHF[1]
Arc Voltage	-
Travel Speed (IPM)	-
Electrode Type	EWP[2]
Electrode Size	1/8"
Filler Metal Type	ER5356
Filler Metal Size	3/64", 1/16", 3/32", 1/8"
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	35-60 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	1/2"
Gas Cup to Work Distance	5/8" max.
Preheat	60°F min.
Interpass Temperature	500°F max.
Post Weld Heat Treatment	None
Other	F,H,V,OH

[1] Alternating current with superimposed high frequency

[2] Pure tungsten

Reference documents: P.S.1.E.1.1, WS 232322

Prepared by: J P Haueter Reviewed by:

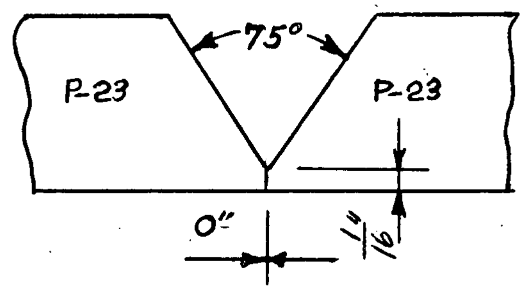
Approved by: C E Roberts

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: GT 23.23-3 **Rev.:** 1 **Date:** 4-21-76

Notes:

1. Clean weld area with Acetone or other suitable solvent prior to welding.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	90-170 amps
Polarity	ACHF[1]
Arc Voltage	-
Travel Speed	-
Electrode Type	EWP[2]
Electrode Size	1/8"
Filler Metal Type	ER4043
Filler Metal Size	3/64", .035"[3]
Flux Type	-
Flux Particle Size	-
Shielding Gas	Argon
Shielding Gas Flow Rate	35-60 cfh
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	1/2"
Gas Cup To Work Distance	5/8" Max.
Preheat	60 F Min.
Interpass Temp.	500 F Max.
Post Weld Heat Treatment	None
Welding Position	F, H, V, OH
Other	

[1] Alternating current with superimposed high frequency.

[2] Pure tungsten.

[3] Use automatic feeder, feed rate 25-35 IPM.

Reference documents: P.S. 1.E.1.1(a), WS 232322

Prepared by W. P. Joest

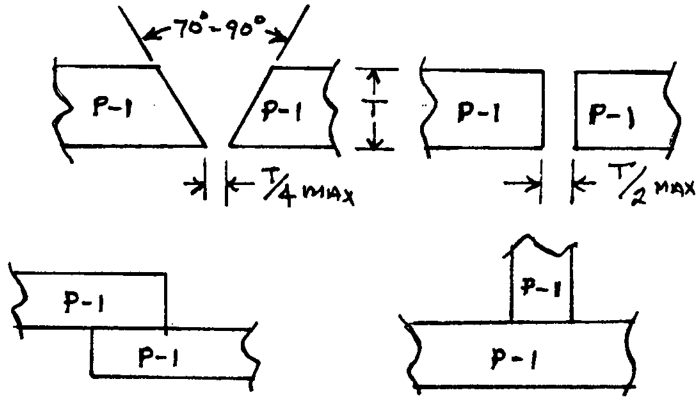
Approved by Robert M. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: CA 1.1-1 **Rev.:** 1 **Date:** March 29, 1979

Notes:

1. This procedure may be used for welding over galvanized surfaces.
2. This procedure is for braze welding, in which the amount of base metal melted is minimized by pushing filler rod into the joint or laying the filler flat in the joint and maintaining the arc between the carbon electrode and filler rod.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	All
Current	20-110 Amperes
Polarity	SP
Arc Voltage	18-24
Travel Speed	-
Electrode Type	Carbon
Electrode Size	3/16"
Filler Metal Type	R Cu Si-A (silicon bronze)
Filler Metal Size	1/16, 3/32
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	60 F min
Interpass Temp.	500 F max
Post Weld Heat Treatment	-
Welding Position	All
Other	

Reference documents: P.S.1.E.1.1

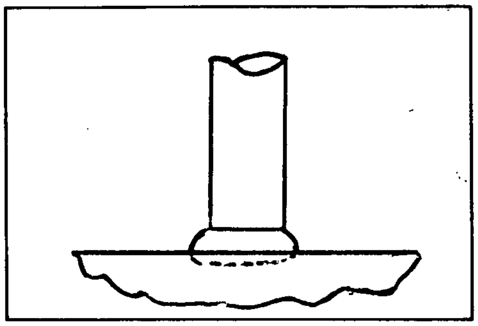
Prepared by JDWhite

Approved by Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: AW-SW-P-1 **Rev.:** 0 **Date:** 11/2/76

Note 1. Remove arc shield after weld is completed.



WELD JOINT DESIGN

Materials

Base	Stud
A 36	A 108 Gr
A 53 Gr B	1010
A 242	1015
A 106 Gr B	1017
A 441	1020
A 500	Semi or
A 501	Fully
A 514	Killed
A 529	
A 570, Gr D,E	
A 588	
A 516	

Welding Conditions:

Stud Dia.	Current* (Amps)	Time* (Cycles)	Lift (Arc Length)	Plunge (Burn-Off)	Total Travel
**#6-#10 Screw	45-70	15-20	1/32-1/16"	1/8"	1/8"-3/16"
3/16"	300	7	1/16"	1/8"	3/16"
1/4"	400	10	1/16"	1/8"	3/16"
5/16"	500	15	1/16"	1/8"	3/16"
3/8"	600	15	1/16"	1/8"	3/16"
7/16"	700	25	1/16"	1/8"	3/16"
1/2"	900	30	3/32"	5/32"	1/4"
5/8"	1200	40	3/32"	5/32"	1/4"
3/4"	1600	50	1/8"	3/16"	5/16"
7/8"	1800	60	1/8"	3/16"	5/16"
1"	2000	70	1/8"	3/16"	5/16"

The first two studs welded at the beginning of each shift and at least one stud per 100 thereafter shall be tested by bending to an angle of 30°. If failure occurs in the weld zone of either stud, the procedure shall be corrected and two additional studs welded and tested.

*±10%

**Full fillet not required if bend tests indicate satisfactory weld.

Reference documents: P.S.I. E.1.1(a)

Prepared by: JDW For W.P. Joost

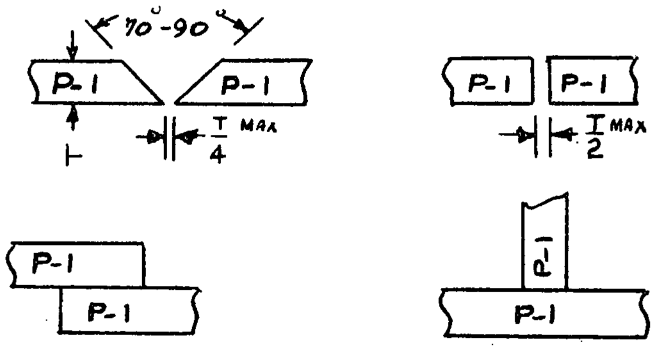
Approved by: Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 1.1-1 Rev.: 0 Date: 4-9-76

NOTES:

1. Use slightly oxidizing flame, oxygen-acetylene fuel, tip size to suit application.
2. Use jigs or clamps to hold work and prevent distortion. Parts shown by experience not to suffer from distortion may be tack-welded or unrestrained.



WELD JOINT DESIGN

3. When joint area reaches a dull red, deposit filler metal; direct flame more out the rod than the workpiece.
4. Use leftwards forehand technique, avoid lateral weaving of torch to avoid heat buildup.
5. This procedure may by used for brazing zinc-coated surfaces.

Welding Conditions:

Layer No. -
Current -
Polarity -
Arc Voltage -
Travel Speed -
Electrode Type -
Electrode Size -
Filler Metal Type R B Cu Zn - A
Filler Metal Size *
Flux Type AWS Type 5 (optional)
Flux Particle Size -
Shielding Gas -
Shielding Gas Flow Rate -
Purging Gas -
Purging Gas Flow Rate -
Gas Cup Size -
Gas Cup To Work Distance -
Preheat -
Interpass Temp. -
Post Weld Heat Treatment -
Welding Position -
Other -

*Dia 1-1/2 Base metal thickness 1/4" max

Reference documents: P.S. 1.E.1.1

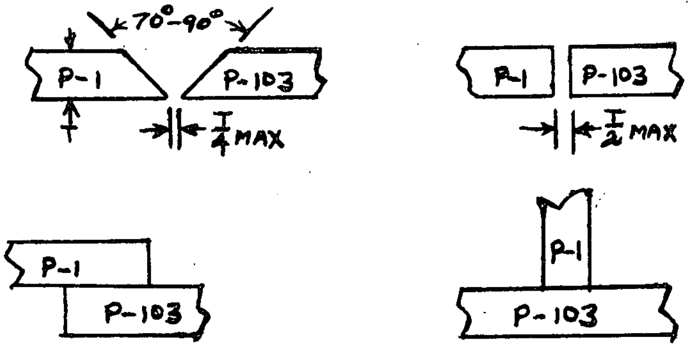
Approved by Robert M

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 1.103-1 **Rev.:** 0 **Date:** 8-27-76

NOTES:

1. Use slightly oxidizing flame, oxygen-acetylene fuel, tip size to suit application.
2. Use jigs or clamps to hold work and prevent distortion. Parts shown by experience not to suffer from distortion may be tack-welded or unrestrained.



WELD JOINT DESIGN

3. When joint area reaches a dull red, deposit filler metal; direct flame more on the rod than the workpiece.
4. Use leftwards forehand technique, avoid lateral weaving of torch to avoid heat buildup.
5. This procedure may be used for brazing zinc-coated surfaces
6. After completion of brazing, assembly should be cooled slowly as possible to ambient temperature by wrapping with insulating material, etc.

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	R B Cu Zn - A
Filler Metal Size	*
Flux Type	AWS Type 5 (optional)
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

*Dia. 1-1/2 Base metal thickness 1/4" max.

Reference documents: P.S. 1.E.1.1

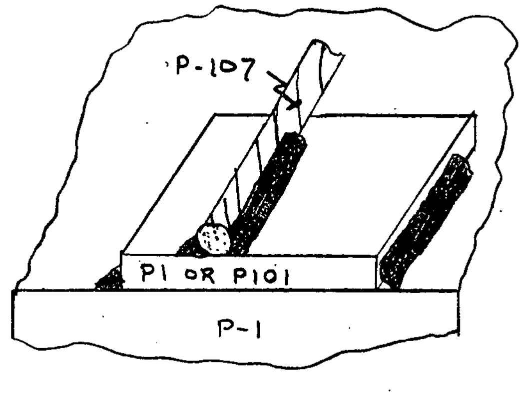
Approved by Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 101.107-1 Rev.: 1 Date: January 25, 1983

Notes:

1. Cables may be brazed directly to members when the thickness of the member at the point of attachment does not exceed 1/4", otherwise braze cable to 2" x 2" x 1/4" (approx.) steel plate and weld plate to member.



TYPICAL JOINT DESIGN

2. Length of braze shall be 3 cable diameters minimum.
3. Cable strands may be brazed together prior to attachment to members or steel plate.
4. Use slightly oxidizing flame, oxygen-acetylene fuel, tip size to suit application.

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed (IPM)	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	RBCuZn-A
Filler Metal Size	1/8"
Flux Type	Selox 2 or equivalent
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup to Work Distance	-
Preheat	-
Interpass Temperature	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

This procedure may also be used for other joint configurations between carbon steel and copper materials.

Reference documents: P.S.1.E.1.1(a)

Prepared by: Reviewed by: W. P. Joest

Approved by: C.E. Roberts

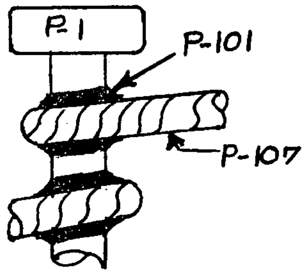
E43025.06

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 101.107-2 **Rev.:** 0 **Date:** 4-12-76

Notes:

1. Stud size shall be a minimum 1/4" diameter. Bare copper ground cable shall be No. 2 AWG maximum. Length of braze shall be 3 cable diameters minimum. The ground cable shall be wrapped a minimum of one complete loop around the stud.



WELD JOINT DESIGN

2. Length of braze shall be 3 cable diameters minimum.

3. Cable strands may be brazed together prior to attachment to members or steel plate.

4. Use slightly oxidizing flame, oxygen-acetylene fuel, tip size to suit application.

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	RBCuZn-A
Filler Metal Size	1/8"
Flux Type	Selox #2 or equivalent
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

Reference documents: P.S. 1.E.1.1(a)

Prepared by W. P. Joest

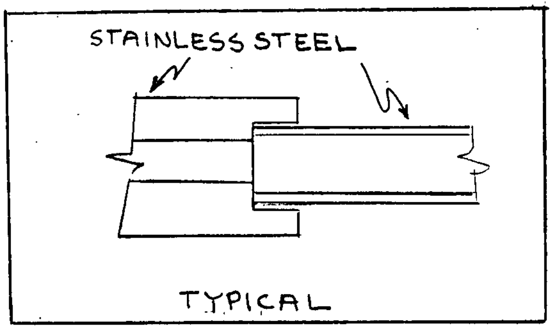
Approved by Robert M Jesse

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB102.102-1 **Rev.:** 0 **Date:** 6/18/82

Notes:

1. Remove oxide from tube and fitting surfaces to be brazed using abrasive cloth or paper. Final clean with organic solvent
2. Joint should be fluxed within one hour of cleaning.
3. Use neutral flame, oxy-acetylene fuel; tip size to suit application



Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BAg-1, BAg-2, or BAg-3
Filler Metal Size	1/16" - 1/8"
Flux Type	AWS Type 3A
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

Reference documents: P.S. 1.E.1.1

Prepared by W. P. Joest

Reviewed by

Approved by Robert M Jessee

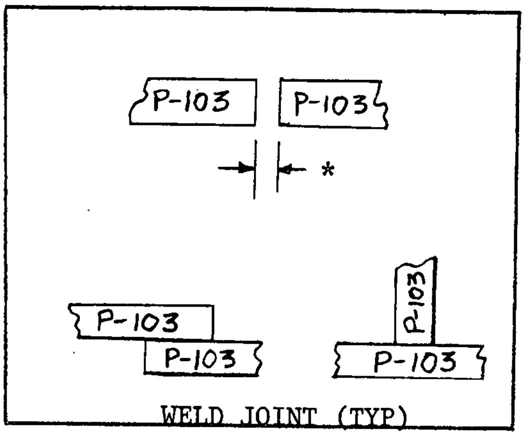
TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 103.103-1 Rev.: 0 Date: 11/23/81

NOTES

1. Use slightly oxidizing flame, oxygen-acetylene fuel, tip size to suit the application.

2. Use jigs or clamps to hold work and prevent distortion. Parts shown by experience not to suffer from distortion may be tacked or unrestrained.



WELD JOINT (TYP)

3. When joint area reaches a dull red, deposit filler metal; direct flame more on the rod than the workpiece.

4. Use leftwards-forhand technique, avoid lateral weaving of torch to avoid heat buildup.

*5. Recommended maximum gap between faying surfaces is 0.01 inch; for larger sections, keep the gap as small as possible.

6. After completion of brazing assembly should be cooled slowly as possible to ambient temperature by wrapping with insulating material, etc.

Welding Conditions:

Increment	-
Current	-
Pulse Rate	-
Polarity	-
Arc Voltage	-
Transfer Mode	-
Travel Speed (IPM)	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BAg-3 or BAg-4
Filler Metal Size	1/16" or as obtainable
Flux Type	AWS Type 3A or 3B
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup to Work Distance	-
Contact Tube to Work Dist.	-
Preheat	-
Interpass Temperature	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

Reference documents: P.S. 1.E.1.1

Prepared by: J. K. Haneter

Approved by: E.E. Roberts

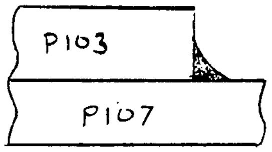
TB103.1

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB103.107-1 Rev.: 0 Date: 4/9/80

Notes:

1. Use slightly oxidizing flame, oxygen-acetylene fuel, tip size to suit application.
2. Use jigs or clamps to hold work and prevent distortion. Parts shown by experience not to suffer from distortion may be tack-welded or unrestrained.



TYPICAL
WELD JOINT DESIGN

3. When joint area reaches a dull red, deposit filler metal; direct flame more on the rod than the workpiece.
4. Use leftwards forehand technique, avoid lateral weaving of torch to avoid heat buildup.
5. After completion of brazing, assembly should be cooled slowly as possible to ambient temperature by wrapping with insulating material, etc.

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	R B Cu Zn - A
Filler Metal Size	
Flux Type	AWS Type 5 (optional)
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

Reference documents: P.S. 1.E.1.1

Prepared by: ______________________

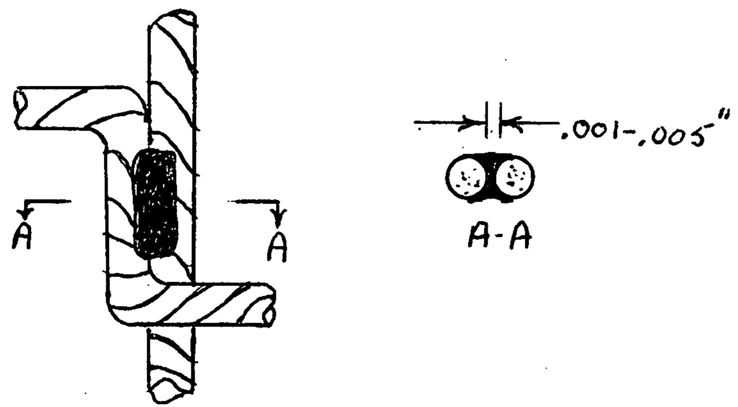
Approved by Robert M Jesse

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 107.107-1 **Rev.:** 2 **Date:** 8/17/79

Notes:

1. Length of braze shall be 3 cable dia. minimum.
2. Use neutral flame, oxygen-acetylene fuel, tip size to suit.
3. AWS flux types 3A, 3B, or 5 may be used.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BCuP-2
Filler Metal Size	1/8" to 1/4"
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	

Reference documents: P.S. 1.E.1.1(a)

Prepared by: W. P. Jest

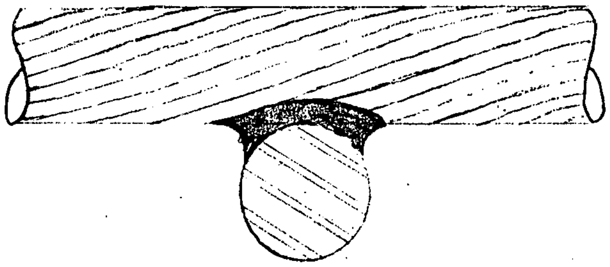
Approved by Robert M Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 107.107-2 **Rev.:** 0 **Date:** 11/17/70

Notes:

1. Fillet size shall be 1/8" min.
2. Use neutral flame, oxygen-acetylene fuel, tip size to suit application.
3. AWS flux types 3A,3B or 5 may be used.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BCuP-2
Filler Metal Size	1/8"
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	

Reference documents: P.S. 1.E.1.1(a)

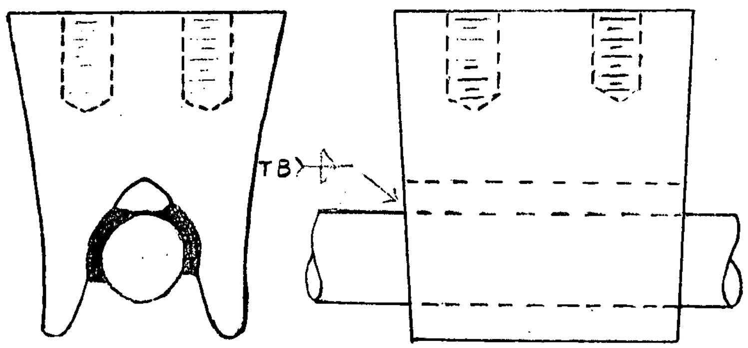
Approved by Robert L Harris

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 107.107-3 Rev.: 0 Date: 11/17/70

Notes:

1. Fillet size shall be 1/8" minimum.
2. Use neutral flame, oxygen-acetylene fuel, tip size to suit.
3. AWS flux types 3A, 3B or 5 may be used.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BCuP-2
Filler Metal Size	1/8"
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	

Reference documents: P.S. 1.E.1.1(a)

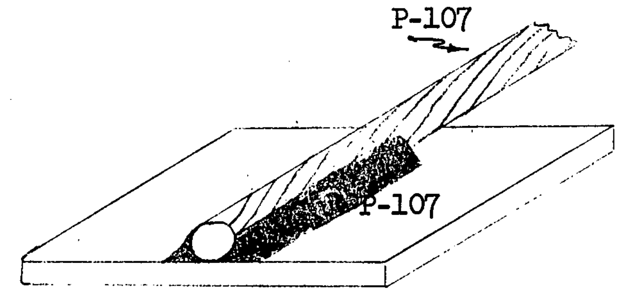
Approved by Robert L Harris

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB107.107-4 Rev.: 0 Date: 11/17/70

Notes:

1. Length of braze shall be 3 cable diameters min.
2. Cable strands may be brazed together prior to attachment to strap.
3. Use neutral flame, oxygen-acetylene fuel, tip size to suit.
4. AWS flux types 3A, 3B or 5 may be used.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BCuP-2
Filler Metal Size	1/8"
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	

Reference documents: P.S. 1.E.1.1(a)

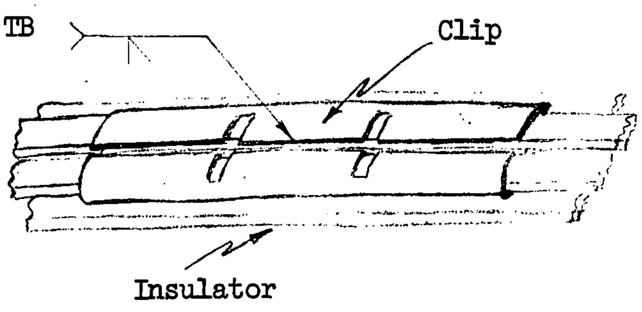
Approved by Robert L Harris

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 107.107-5 **Rev.:** 0 **Date:** 11/17/70

Notes:

1. Use neutral flame, oxygen-acetylene fuel, tip size to suit application



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BCuP-2
Filler Metal Size	1/8" dia.
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	

Reference documents: P.S. 1.E.1.1(a)

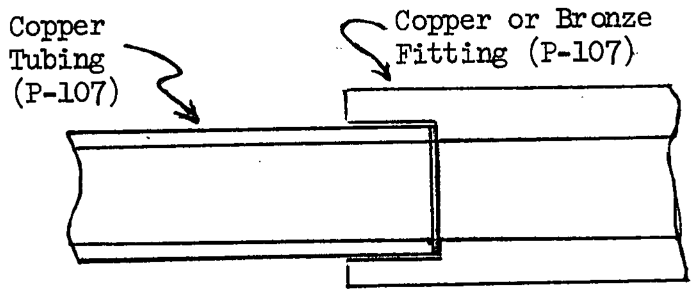
Approved by Robert L Harris

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB107.107-6 **Rev.:** 0 **Date:** July 3, 1978

Notes:

1. Remove oxide from tube and fitting surfaces to be brazed using abrasive cloth or paper. Final clean with organic solvent.
2. Joint should be fluxed within one hour of cleaning.
3. Use neutral flame, oxy-acetylene fuel; tip size to suit application.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BC$_u$P-2
Filler Metal Size	1/16"-1/8"
Flux Type	AWS Type 3A, 3B, or 5
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

Reference documents: P.S.1.E.1.1.(a)

Prepared by

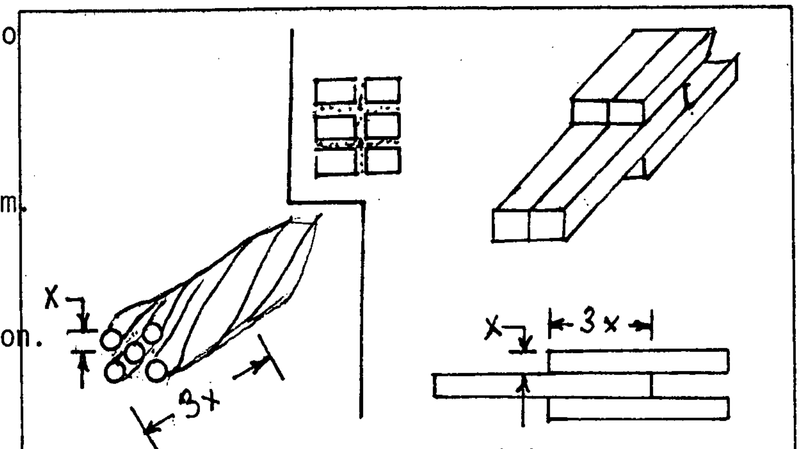
Approved by

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB107.107-7 **Rev.:** 0 **Date:** 4/19/79

NOTE:

1. Length of area to be brazed shall be 3 times the diameter or thickness of the wire as a minimum.
2. Use clamps to hold work and present distortion.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BCuP-5 (15% Ag 80% Cu 5% P)
Filler Metal Size	1/32", 1/16", 3/32", 1/8"
Flux Type	-
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	

Reference documents: P.S. 1.E.1.1(a)

Prepared by W. P. Joest

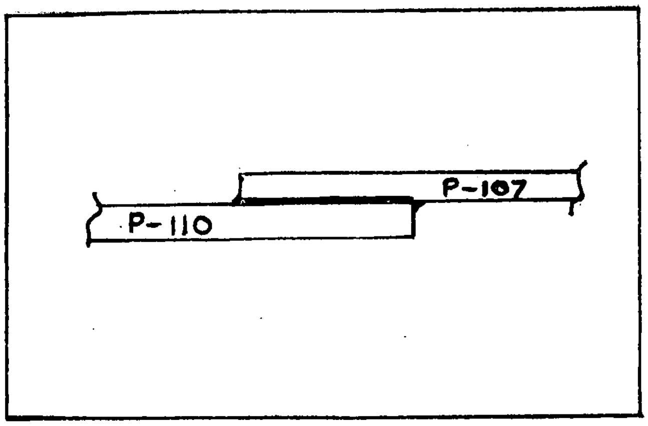
Approved by Robert H. Jessee

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TB 110.107-1 Rev.: 1 Date: 10/21/80

Notes:

1. Prepare surfaces to be brazed with emery cloth followed by acetone cleaning.
2. Apply flux to faying surfaces
3. Heat to brazing temperature (approximately 1150°) with slightly reducing flame and apply brazing alloy.



4. Remove accessible flux residue after cooldown.

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed (IPM)	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	BAg-7
Filler Metal Size	-
Flux Type	3A
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup to Work Distance	-
Contact Tube to Work Dist.	-
Preheat	-
Interpass Temperature	-
Post Weld Heat Treatment	-
Welding Position	-
Other	

Reference documents: P.S. 1.E.1.1

Prepared by: J White

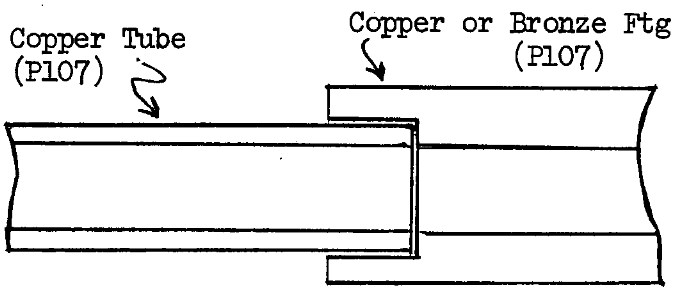
Approved by: D. P. Jost

TB110.1

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TS 107.107-1 **Rev.:** 0 **Date:** July 3, 1978

Notes:
1. Clean surfaces to be soldered to bright metal with abrasive cloth or paper.
2. Apply flux paste heat with propane or oxy-fuel torch and flow solder into joint.
3. Flux paste residue on exterior surfaces of joint should be removed with an organic solvent.



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	50-50 lead-tin solder (solid or acid core)
Filler Metal Size	1/16"-1/8" dia
Flux Type	Paste type-corrosive
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

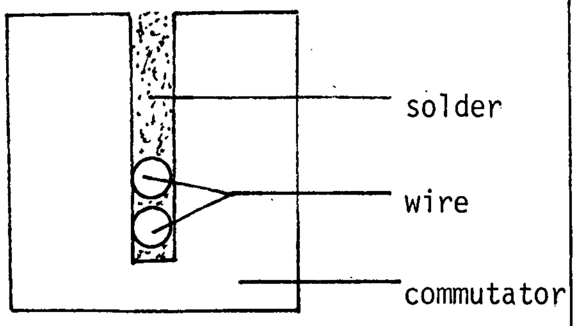
Reference documents: P.S.1.E.1.1.(a)

Prepared by J D White

Approved by Robert M [illegible]

TENNESSEE VALLEY AUTHORITY

Detail Weld Procedure No.: TS107.107-2 **Rev.:** 0 **Date:** 4/19/79



WELD JOINT DESIGN

Welding Conditions:

Layer No.	-
Current	-
Polarity	-
Arc Voltage	-
Travel Speed	-
Electrode Type	-
Electrode Size	-
Filler Metal Type	95-5 tin-antimony solder
Filler Metal Size	1/32", 1/16", 3/32", 1/8"
Flux Type	Rosin
Flux Particle Size	-
Shielding Gas	-
Shielding Gas Flow Rate	-
Purging Gas	-
Purging Gas Flow Rate	-
Gas Cup Size	-
Gas Cup To Work Distance	-
Preheat	-
Interpass Temp.	-
Post Weld Heat Treatment	-
Welding Position	-
Other	-

Reference documents: P.S. 1.E.1.1(a)

Prepared by W. P. Jost

Approved by Robert M Jessee

PERFORMANCE QUALIFICATION TEST

Test No.: GM-SD-23-L(1) Revision 0 Date: 1/8/80

1. Welding Process: Gas Metal Arc - Solid Wire
2. Electrode: ER4043
3. Base Material: 6061 or 5456 Aluminum (2) 3/8" th x 3" w x 6" lg (rolling direction of plate shall be transverse to the direction of welding)
4. Welding Position: Vertical, Overhead, and Horizontal
5. V Weld Progression: Vertical up
6. Weld Joint Design: 45° included angle, 1/4" root opening, backing strip 3/8" x 1" x 6" for mechanical testing, or 3/8" x 3" x 6" for radiographic testing.
7. Welding Procedure: GM23.23-1
8. Mechanical Tests: 1 face bend and 1 root bend or 2 side bends per ASME Section IX, paragraph QW302.1, or radiographic tests per paragraph QW302.2
9. Limits of Qualification:

   9.1 This test shall qualify a welder for welding with electrodes of AWS A5.10 Specification, F21 through F24 Classification, in all positions, on single welded joints with backing and double welded joints, up to and including 3/4-inch thickness, and fillet welds of any thickness.

   9.2 The following welding procedures may be used with this qualification:

   GM23.23-1

Prepared by: J D White

Approved by: Robert M Jesse

General Construction Specification: G-29E
Date: 7/6/82
Sheet: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No. GM-SD-23-L(2)   Revision: 1   Date: 7/6/82

1. Welding Process: Gas Metal Arc
2. Electrode Type: ER5356 or ER4043
3. Base Material: 6061T6, 2" dia. schedule 160 (.343" W.T.)
4. Welding Positions: 2G+5G, or 6G
5. 3G Weld Progression: Vertical up
6. Welding Procedure: GM23.23-1
7. Tests: Face and root bends for each test position per ASME Section IX, paragraph QW-302.1.
8. Limits of Qualification:

8.1 This test shall qualify a welder for welding with F22 electrode classification, in all positions, on single welded joints with a backing strip and on double welded joints, from 1/16" to 0.686" on pipe diameter greater than 1 inch and on fillet welds of any thickness or diameter.

8.2 The following welding procedures may be used with this qualification:

GM23.23-1

Prepared by J. R. Haneter

Reviewed by

Approved by C E Roberts

GCSG29.E1

General Construction Specification: G-29E
Date: 4/24/81
Sheet: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No. GM-SD-23-L(3)   Revision: 0   Date: 4/24/81

1. Welding Process: Gas Metal Arc
2. Electrode Type: ER5356 or ER4043
3. Base Material: 6063 or 6061, 3/8" W.T. x 5" or 6" pipe
4. Welding Positions: 2G+5G, or 6G
5. 3G Weld Progression: Vertical up
6. Joint Design: Single Vee with backing ring
7. Welding Procedure: GM23.23-1
8. Tests: Face and root bends for each test position per ASME Section IX, paragraph QW-302.1.
9. Limits of Qualification:

   9.1 This test shall qualify a welder for welding with F22 electrode classification, in all positions, on single welded joints with a backing strip and on double welded joints, from 1/16" to 3/4" on pipe diameter greater than 2-7/8-inch and on fillet welds of any thickness or diameter.

   9.2 The following welding procedures may be used with this qualification:

   GM23.23-1

Prepared by J D White

Approved by C.E. Roberts

General Construction Specification: G-29E
Date: 7/28/82
Sheet: 1 of 1

PERFORMANCE QUALIFICATION TEST

Test No: GT-22-0-1-L Revision: 1 Date: 7/28/82

1. Welding Process: Gas Tungsten Arc
2. Electrode Type: ER-5356
3. Base Material: 6061T6, 2" dia. schedule 160 (.343" W.T.)
4. Welding Positions: 2G+5G, or 6G
5. 3G Weld Progression: Vertical up
6. Welding Procedure: GT 23.23-2
7. Tests: Face and root bends for each test position per ASME Section IX, paragraph QW-302.1.
8. Limits of Qualification:

   8.1 This test shall qualify a welder for welding with F22 electrode classification, in all positions, on single welded joints, with or without a backing strip and on double welded joints, from 1/16" to 0.686" on pipe diameter greater than 1 inch and on fillet welds of any thickness or diameter.

   8.2 The following welding procedures may be used with this qualification:

   GT-23.23-1 GT-23.23-2 GT-23.23-3

Prepared by: J. R. Haueter

Reviewed by:

Approved by: C. E. Roberts

TENNESSEE VALLEY AUTHORITY

WELDING PROCEDURE QUALIFICATION RECORD

Date: May 28, 1982

WPQR No. SM - Cast Iron

DWP No. SM - Cast Iron

Welding Process: SMAW [✓ Manual] Semiautomatic Automatic

Mtl. Type and Spec. ASTM A48 Cl.40 To Cl.40 S-No. N/A To P-No. N/A

Thickness (and Dia. if Pipe) 1" Plate Thickness Range Qualified Unlimited

WELDING MATERIALS

Filler Metal F-No. A-No.

Electrode F-No. N/A A-No. N/A

Spec. or Analysis:

Proprietary Material

Flux:

Other Additives:

WELDING PROCEDURE

Position Qualified: Flat 1(G)

Qualifying For: All Positions

Single of Multiple Pass: Multiple

Number of Arcs: Single

Preheat Temp. 60°F Min

Interpass Temp. 300°F Max

Post Weld Heat Treatment: Slow cool on completion of welding

FOR INFORMATION ONLY

Trade Name Filler Mtls.

Certanium 889

Type Current: DCRP

Joint Configuration: Double Vee

Bead No.	Electrode or Filler Size	Amperes	Arc Volts	Travel Speed (In/Min)
All	1/8"	85-100	23	

ALL WELD METAL AND/OR TRANSVERSE JOINT REDUCED SECTION TENSILE TESTS

Type Specimen	Area Sq. In.	Ultimate Load Lbs.	Ultimate Stress-Psi	Character and Location of Failure

GUIDED BEND TESTS

Type	Specimen No.	Results

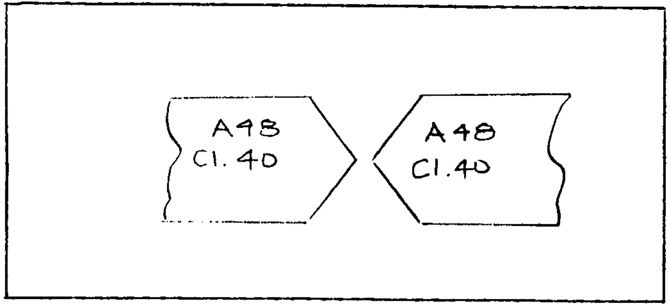
NONDESTRUCTIVE EXAMINATION

Examination Method	Location	Results
Magnetic Particle		
Liquid Penetrant	Weld	Acceptable
Ultrasonic		
Radiographic		
Macro - 4 Loc.	Weld & BM	Acceptable

CHARPY V NOTCH IMPACT TESTS

Location	Temp.	Ft/Lb Value	Avg of 3	Lateral Expansion	% Shear

WELD JOINT DESIGN



Dept. Conducting Test Nuc. Pwr.

Welder W.C. Jones Symbol BBE

Testing No.

Testing Lab. Singleton Matls. Eng. Lab

We certify that the statements in this record are correct, and that the test welds were prepared, welded and tested as described hereon.

BY C E Roberts

Process Specification: 1.E.2.1(R0)
Date: 3/11/83
Sheet: 1 of 2

TENNESSEE VALLEY AUTHORITY

CAPACITOR DISCHARGE STUD WELDING SPECIFICATION

1.0 SCOPE

1.1 This specification shall be applicable to welding by the capacitor discharge method, studs of 1/4-inch and less diameter to safety-related materials, components, and structures other than those under jurisdiction of the ASME Code. It may also be used for such welding in non-safety-related applications.

2.0 OPERATOR QUALIFICATIONS

2.1 The quality control tests required by 6.0 shall also serve to qualify the operator.

3.0 MATERIALS AND EQUIPMENT

3.1 Base materials and studs shall be as specified by applicable drawings and specifications. Stud welding power supply shall be of the capacitor discharge type with compatible gun and appropriate circuitry.

4.0 BASE MATERIAL PREPARATION

4.1 Base material in the area of the weld shall be free of paint, oil, rust or other foreign material. Galvanized or other metallic coating may remain.

5.0 WELDING

5.1 Machine settings shall generally be as recommended by the equipment manufacturer, but optimum settings shall be established for each combination of stud and base material as required in 6.0.

6.0 QUALITY CONTROL

6.1 At the start of each shift and after any change in stud or base material, or in machine control setting hereafter, each operator shall establish or confirm the correct machine setting for the welds to be made by welding three studs on scrap material of the same type and thickness as the production material. These three studs shall (1) show no evidence of burning or melting through the base material and (2) be bent to an angle of 30° from their original axes without failure of the weld.

Prepared by 4/15/83

Reviewed by W.P. Jost 4/15/83

Approved by C.E. Roberts 4/15/83