

Materials & Tests Unit



NCDOT
(Steel Section)

FIELD WELDING PROCEDURES



Sunset Beach, NC



Cleveland, NC



BUILDING NORTH CAROLINA'S FUTURE

Materials & Tests Unit



NCDOT
(Steel Section)

FIELD

WELDING

PROCEDURES

4th Edition-June 2011

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Introduction

The information contained within this book of Approved Welding Procedures is intended to assist the NCDOT Construction Inspector and guide the Welding Contractor with acceptable procedures and practices for the application of weld in a field environment on NCDOT bridge projects. Additional information and procedures have been included to assist Bridge Maintenance Personnel with "Repair of Existing Structures". The information is in no way considered to be complete or all encompassing but instead offers aid to some of the most common applications to field welding that are found on NCDOT bridge construction projects. A Welding Procedure Specification (WPS) may be generated by an authorized person (i. e. CWI) and then submitted to the NCDOT Materials & Tests Unit (Steel Section) at 770A Park Centre Drive in Kernersville, NC 27284 (phone: 336-993-2300) for approval in the event that the contractor does not want to utilize the material provided.

These approved welding procedures may also be found at the following web address:

http://www.ncdot.org/doh/operations/materials/structural/appr_proc.html

This manual may also be found at the following web address:

<http://www.ncdot.org/doh/operations/materials/pdf/fwp.pdf>

Previous editions of this manual include:

1st Edition-October 2008

2nd Edition-April 2009

3rd Edition-May 2010

General Information

Reference Standards

As stated by the NCDOT “Standard Specifications For Roads and Bridges JULY 2006” page 4-55 section 440-7:

“Perform field welding only when called for on the plans and in accordance with 1072-20.”

“Remove paint or galvanizing at the location of field welds by blast cleaning (SSPC SP-6 finish), or hand (SSPC SP-2 finish) or power tool cleaning (SSPC SP-3 finish) just prior to welding. Clean sufficiently to prevent contamination of the weld by the paint.”

note: Refer to Appendix B for SSPC standards.

The NCDOT “Standard Specifications For Roads and Bridges JULY 2006” page 10-141 section 1072-20 makes reference to the ANSI/AWS/AASHTO Bridge Welding Code D-1.5 and states in section 1072-20 (B) **General** “Weld all structural steel in the shop or in the field for bridges, whether permanent or temporary, and perform all other work related to structural welding including, but not limited to, testing and inspection of welds, preparation of material, oxygen cutting, electrodes, shielding, and shear studs, meeting the requirements of the Bridge Welding Code. Weld other steel items in accordance with the requirements of the applicable AWS Welding Code.”

"Weld only where shown on the plans or where called for in the Specifications unless requesting and receiving written approval for additional welding."

Additional governing information pertaining to field welding can be found on contract documents such as NCDOT approved plans and special provisions.

Qualification of Personnel

For the purpose of field welding on NCDOT construction projects, all personnel must be tested and approved by the NCDOT Materials & Tests Unit (Steel Section). Prior to performing any welding activities, the qualified person must present the Welder ID card that was issued by the M & T Unit along with another photo ID, such as a driver’s license, to the NCDOT representative (i. e. Construction Inspector). Currently there are three levels of NCDOT field welder certification.

SIP Welder- This certification qualifies a welder to weld stay in place deck forms to girders.

Bridge Welder- This certification qualifies a welder to weld anything on a project except pipe less than 24 inches in diameter.

Pipe Welder: This certification qualifies a welder to weld anything on a project.

Additional information about welder certification can found at the following web address:
<http://www.ncdot.org/doh/operations/materials/pdf/fwcprocedure.pdf>

Qualification of Welds and Procedures

(7-21-09)
R43

SP10

Page 10-143, Subarticle 1072-20(D) Qualification of Welds and Procedures, replace the third sentence of the first paragraph with the following:

For all prequalified field welds, submit Welding Procedure Specifications (WPS) for each joint configuration for approval at least 30 days prior to performing any welding. In lieu of this, use the WPS provided and pre-approved by the Department. These pre-approved WPSs are available from the Materials and Tests Unit or at:

http://www.ncdot.org/doh/operations/materials/structural/appr_proc.html

Use non-prequalified welds only if approved by the Engineer. Submit WPS for all non-prequalified welds to the Engineer for approval. At no cost to the Department, demonstrate their adequacy in accordance with the requirements of the Bridge Welding Code.

Application

AWS D-1.5 Section 1.1.1 This code covers welding fabrication requirements applicable to welded highway bridges. The code is applicable to both shop and field fabrication of steel bridges and bridge components,

Workmanship

AWS D-1.5 Section 3.1.3 Welding shall not be done when the ambient temperature is lower than 0° F, when surfaces are wet or exposed to rain, snow, or high wind velocities, nor when welders are exposed to inclement conditions.

AWS D-1.5 Section 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 or produce objectionable fumes. Mill scale that can withstand vigorous wire brushing, a thin rust-inhibitive coating, or antispatter compound may remain...

AWS D-1.5 Section 3.2.2 In all thermal cutting, the cutting flame shall be so adjusted and manipulated as to avoid cutting beyond (inside) the prescribed lines. The roughness of thermal cut surfaces shall be no greater than that defined by the American National Standards Institute, ANSI B46.1, Surface Texture. For material up to 100mm [4 in] thick, the maximum surface roughness value shall be 25 μm (1000 μin). Steel and weld metal may be thermally cut, provided a smooth and regular surface free from cracks and notches is secured, and provided that an accurate profile is secured by the use of a mechanical guide. Free-hand thermal cutting shall be done only where approved by the Engineer.

Workmanship (cont.)

AWS D-1.5 Section 3.2.4 Reentrant corners of base-metal cut edges shall be formed to provide a smooth transition with a radius of not less than 25mm [1 in] that meets the adjacent edges without offset or cutting past the point of tangency. The reentrant corners must be formed by thermal cutting, followed by grinding to meet the surface requirements of 3.2.2.

AWS D-1.5 Section 3.3.1 The parts to be joined by fillet welds shall be brought into as close contact as practical. The root opening shall not exceed 3/16" except in cases involving either shapes or plates 3" or greater in thickness if, after straightening and in assembly, the root opening cannot be closed sufficiently to meet this tolerance. ... If the root opening is greater than 1/16", the leg of the fillet weld shall be increased by the amount of the root opening or the Contractor shall demonstrate that the required weld size has been obtained.

AWS D-1.5 Section 3.3.1.2 The use of filler plates shall be prohibited except as specified on the drawings or as specially approved by the Engineer...

AWS D-1.5 Section 3.3.3 Parts to be joined by groove welds shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignment, the offset from theoretical alignment shall not exceed 10% of the thickness of the thinner part joined, but in no case shall be more than 1/8".

AWS D-1.5 Section 3.3.7 Tack welds shall be subject to the same quality requirements as the final welds.

AWS D-1.5 Section 3.3.8 Temporary welds shall be subject to the same WPS requirements as final welds. They shall be removed unless otherwise allowed by the Engineer. When they are removed, the surface shall be made flush with the original surface. There shall be no temporary welds in tension zones...

Weld Profiles

AWS D-1.5 Section 3.6.1.1 (in reference to fillet weld profiles) The convexity of a weld or individual surface bead shall not exceed 0.07 times the actual face width of the weld or individual bead, respectively, plus 1.5mm [0.06 in].

AWS D-1.5 Section 3.6.2 (in reference to groove weld profiles) Groove welds shall preferably be made with slight or minimum face reinforcement except as may be otherwise provided. In the case of butt and corner joints, the face reinforcement shall not exceed 3mm [1/8 in] in height and shall have gradual transition to the plane of the base surface... They shall be free of the discontinuities shown for butt joints...

AWS D-1.5 Section 3.6.5 Welds shall be free from overlap.

Repairing Welds

AWS D-1.5 Section 3.7.2 The Contractor has the option of either repairing an unacceptable weld, or removing and replacing the entire weld... If the Contractor elects to repair the weld, it shall be corrected as follows:

AWS D-1.5 Section 3.7.2.1 **Overlap or Excessive Convexity.** Excess weld metal shall be removed.

AWS D-1.5 Section 3.7.2.2 **Excessive Concavity of Weld or Crater, Undersize Welds, Undercutting.** Surfaces shall be prepared (see 3.11) and additional weld metal deposited.

AWS D-1.5 Section 3.7.2.3 **Excessive Weld Porosity, Excessive Slag Inclusions, Incomplete Fusion.** Unacceptable portions shall be removed and re-welded.

AWS D-1.5 Section 3.7.2.4 **Cracks in Weld or Base Metal.** The extent of the crack shall be ascertained by use of MT, PT, or other equally positive means; the metal shall be removed for the full length of the crack plus 500mm [2 in] beyond each end of the crack, and re-welded.

Weld Cleaning

AWS D-1.5 Section 3.11.1 **In-Process Cleaning.** Before welding over previously deposited metal, all slag shall be removed and the weld and adjacent base metal shall be brushed clean. This requirement shall apply not only to successive layers but also to successive beads and to the crater area when welding is resumed after an interruption...

AWS D-1.5 Section 3.11.2 **Cleaning of Completed Welds.** Slag shall be removed from all completed welds, and the weld and adjacent base metal shall be cleaned by brushing or other suitable means. Tightly adherent spatter remaining after the cleaning operation shall be acceptable unless its removal shall be required for the purpose of NDT or painting. Welded joints shall not be painted until after welding has been completed and the weld has been accepted.

Backing Bar

AWS D-1.5 Section 3.13.5 Steel backing shall be placed and held in intimate contact with the base metal. The maximum gap between steel backing and the base metal at the weld root shall be 2 mm (1/16 in).

Preheat and Interpass Temperature

Unless stated otherwise on the approved welding procedure, all preheat temperatures on NCDOT projects shall be 100° F.

AWS D-1.5 Section 4.2.7 When the base metal is below the temperature listed for the welding process being used and the thickness of material being welded, it shall be preheated (except as otherwise provided) in such a manner that the steel on which weld metal is being deposited is at or above the specified minimum temperature for a distance equal to the thickness of the part being welded, but not less than 75mm [3 in] in all directions from the point of welding.

AWS D-1.5 Section 4.2.8 **Preheat and Interpass Temperature Requirements** When the base metal temperature is below 0° C [32° F], the base metal shall be heated to at least 20° C [70° F], and this minimum temperature shall be maintained during welding.

Electrode Storage

AWS D-1.5 Section 4.5.2 All electrodes having low hydrogen coverings conforming to AWS 5.1/A5.1M shall be purchased in hermetically sealed containers... Immediately after opening the hermetically sealed container or removal of the electrodes from drying ovens, electrodes shall be stored in ovens held at a temperature of at least 120°C [250°F]. After the opening of hermetically sealed containers or removal from drying or storage ovens, electrode exposure to the atmosphere shall not exceed the requirements of 4.5.2.1.

AWS D-1.5 Section 4.5.2.1 Electrodes exposed to the atmosphere upon removal from drying or storage ovens or hermetically sealed containers shall be used within the time limit shown in Table 4.7...

AWS D-1.5 Section 4.5.2.2 Electrodes exposed to the atmosphere for periods less than those allowed by Table 4.7 may be returned to a holding oven maintained at 250° F minimum and after a minimum period of four hours at that temperature may be reissued. The Provisions of 4.5.4 shall apply.

AWS D-1.5 Section 4.5.4 Electrodes that conform to the provisions of 4.5.2 shall be re-dried no more than one time. Electrodes that have been wet shall not be used.

AWS D-1.5 Table 4.7 illustrates the following:

“Allowable Atmospheric Exposure of Low-Hydrogen SMAW Electrodes”

Electrode	Hours
E70XX	4 max.
E80XX	2 max.
E70 or E80XXR or H4R	9 max.

Weld Acceptance Criteria

AWS D-1.5 Section 6.26.1 All welds shall be visually inspected. A weld shall be acceptable by visual inspection if it conforms to the following requirements:

AWS D-1.5 Section 6.26.1.1 The weld shall have no cracks.

AWS D-1.5 Section 6.26.1.2 Thorough fusion shall exist between adjacent layers of weld metal and between weld metal and base metal.

AWS D-1.5 Section 6.26.1.3 All craters are to be filled to the full cross section of the weld...

AWS D-1.5 Section 6.26.1.4 Weld profiles shall be in conformance with 3.6.

AWS D-1.5 Section 6.26.1.5 In primary members, undercut shall be no more than 0.25mm [0.01 in] deep when the weld is transverse to tensile stress under any design loading condition. Undercut shall be no more than 1mm [1/32 in] deep for all other cases.

Porosity limitation guidelines (AWS D-1.5 Section 6.26.1.6) are too complex to be presented in this manual. Contact the M&T Unit (Steel Section) for technical assistance regarding discontinuities of this type.

AWS D-1.5 Section 6.26.1.7 A fillet weld in any single continuous weld may under run the nominal fillet weld size specified by 2mm [1/16 in] without correction, provided that the undersize portion of the weld does not exceed 10% of the length of the weld.

AWS D-1.5 C-6.26.1 Visual Inspection. All welds are required to be visually inspected. Visual inspection is performed before welding, during welding, and after welding, as necessary to ensure that the requirements of the Contract Documents are met and that all welds conform to the visual requirements of this sub-clause. The Inspector is not required to inspect each weld pass, but periodically observe welding with sufficient frequency to verify the skills of the welder, proper joint preparation, WPS variables, and the visual quality of typical root, intermediate, and final weld passes. In addition to inspection before and during welding, the Inspector is expected to visually inspect every completed weld to verify conformance to these requirements. See C6.5.

AWS D-1.5 C-6.5 Each welder, welding operator and tack welder should be a visual inspector of his or her own work. Welding personnel should know when welds display visual discontinuities not acceptable under the Code. Because each weld pass of every weld is to be inspected by the welder, and the inspector monitors welding in progress and makes a detailed inspection of completed welds, major weld defects or gross nonconformance to the Code should be detected.

Stud Welding

Contact the NCDOT M&T Unit (Steel Section) when "automatically timed stud welding equipment" is being used.

AWS D-1.5 Section 7.4.1 At the time of welding, the studs shall be free from rust, rust pits, scale, oil, moisture, and other deleterious matter that would adversely affect the welding operations.

AWS D-1.5 Section 7.4.2 The stud base shall not be painted, galvanized, nor cadmium-plated prior to welding.

AWS D-1.5 Section 7.5.5 At the option of the Contractor, studs may be fillet welded by the SMAW, provided the following requirements are met:

AWS D-1.5 Section 7.5.5.3 The stud base shall be prepared so that the base of the stud fits against the base metal.

AWS D-1.5 Section 7.5.5.4 All rust and mill scale at the location of the stud shall be removed from the base metal by grinding. The end of the stud shall also be clean.

Equipment Requirements

Any qualified person intending to perform welding on an NCDOT project shall arrive at the job site with all of the appropriate equipment which includes but is not limited to a **welding machine** that has an adequate power range to produce the amperage necessary to satisfy the WPS requirements, an **electrode storage oven** to stay within the guidelines of the exposure limits of the welding consumables, a **grinder** that is suitable for preparing the base metal in the area that is to be welded, a **torch** or other preheating device that can satisfactorily raise the temperature of the base metal in the area to be welded to the range that is specified in the WPS, approved **low hydrogen electrodes** that are in a hermetically sealed container or in an active electrode storage oven, **clamps or other equipment** that is necessary to properly cut, fit and assemble the material to be welded and clean the completed weld. Failure to produce this or other equipment that is needed to complete the work within specifications could result in the Welding Contractor not being permitted to start welding.

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION H-PILE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: Vertical – up

Root Treatment: Back Gouge with a grinder to sound metal prior to applying the back weld.

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Any distorted material in the web or flanges that was damaged by the pile driving process shall be removed.

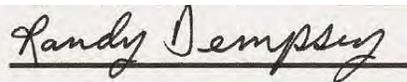
Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up.

The theoretical alignment of the pieces joined shall be within 10% of the thickness of the material, as required by the AWS D1.5 Bridge Welding Code.

Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description H-PILE

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

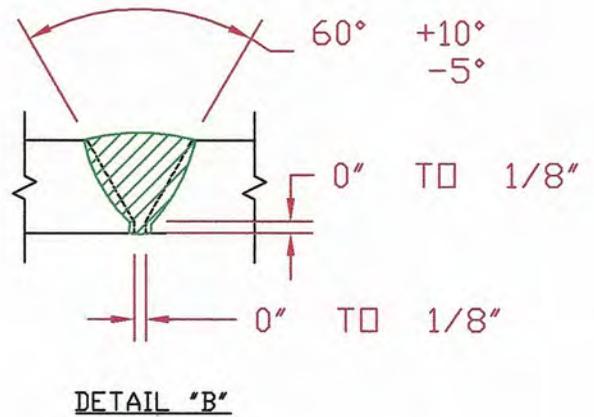
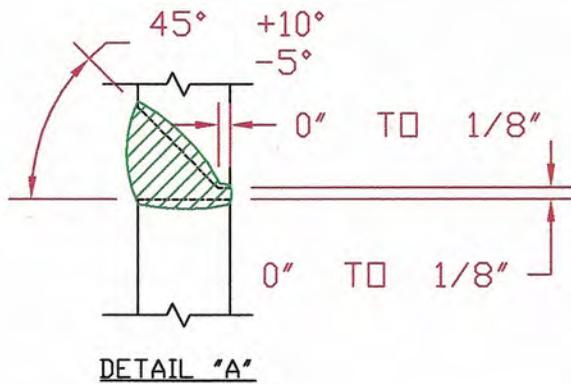
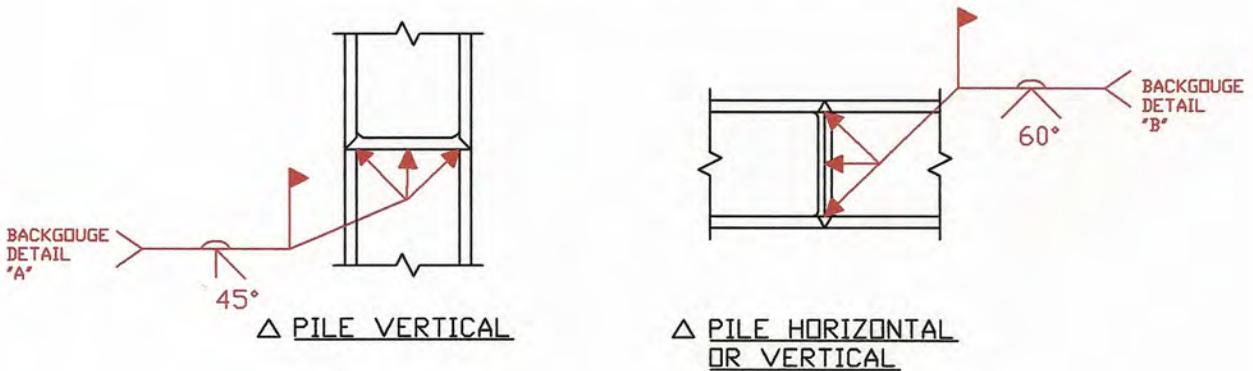
WPS #: 080508001

Authorized By: Steve Walton, Metals Engineer

Revision #: 4

Signature: 

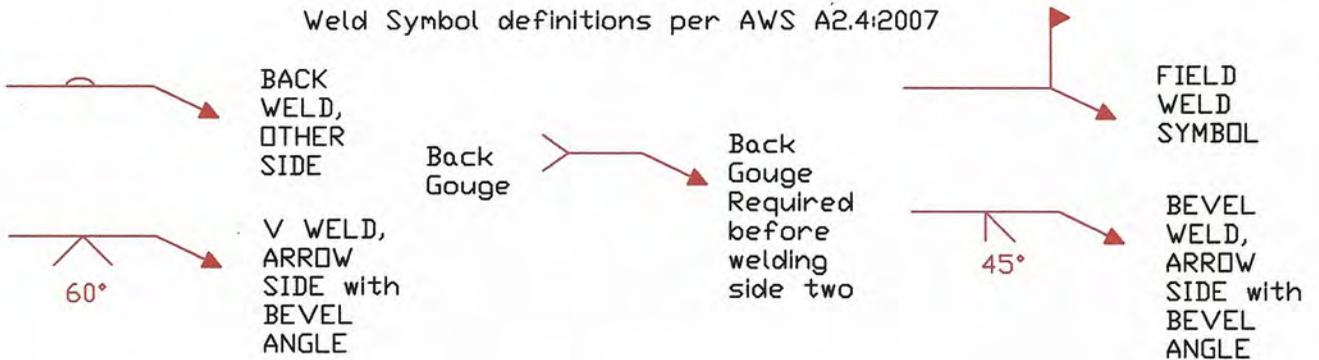
WPS H-PILE 080508001 R4 JOINT DETAIL ATTACHMENT



△ POSITION OF PILE DURING WELDING

H-PILE SPLICE DETAILS

Weld Symbol definitions per AWS A2.4:2007



Illustrations for H-Pile Fit-Up



45 degree bevel on inside of flange and right side of web, inspection of the bevel angle.



Runoff tabs are recommended but not required. The tabs make it easier to fill the groove at the end of the flanges.

Illustrations for H-Pile Welding



Unacceptable Weld (material was not beveled before fit-up, mis-alignment is greater than the allowable 10%, incomplete weld, incomplete fusion)



Acceptable (filled to full cross section, run-off tabs removed and edge was finished with a grinder)

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STEEL GIRDER BEARING PLATE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

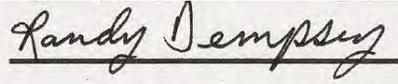
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

Care shall be taken to not exceed 250° in the proximity of the Elastomeric Bearing material.

WPS Description: Steel Girder Bearing Plate

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

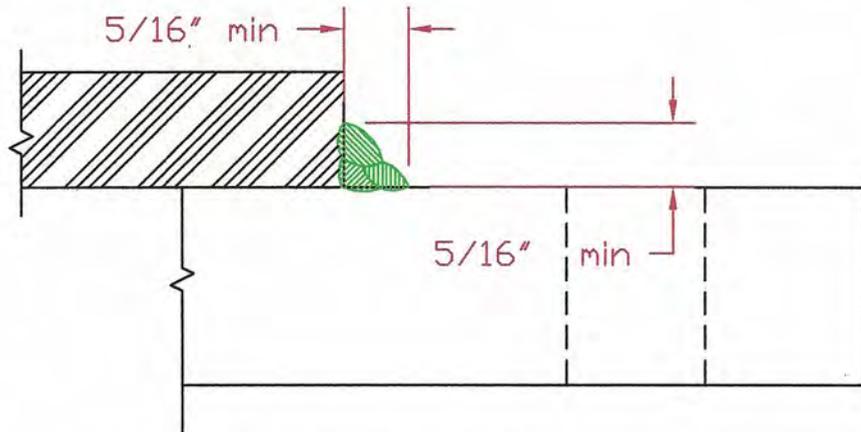
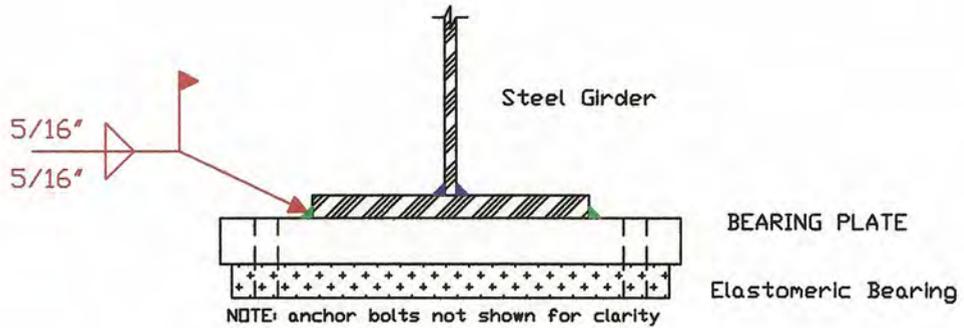
WPS #: 080708002

Authorized By: Steve Walton, Metals Engineer

Revision #: 4

Signature: 

WPS STEEL GIRDER BEARING PLATE 080708002 R4
JOINT DETAIL ATTACHMENT



STEEL GIRDER
BEARING PLATE DETAILS

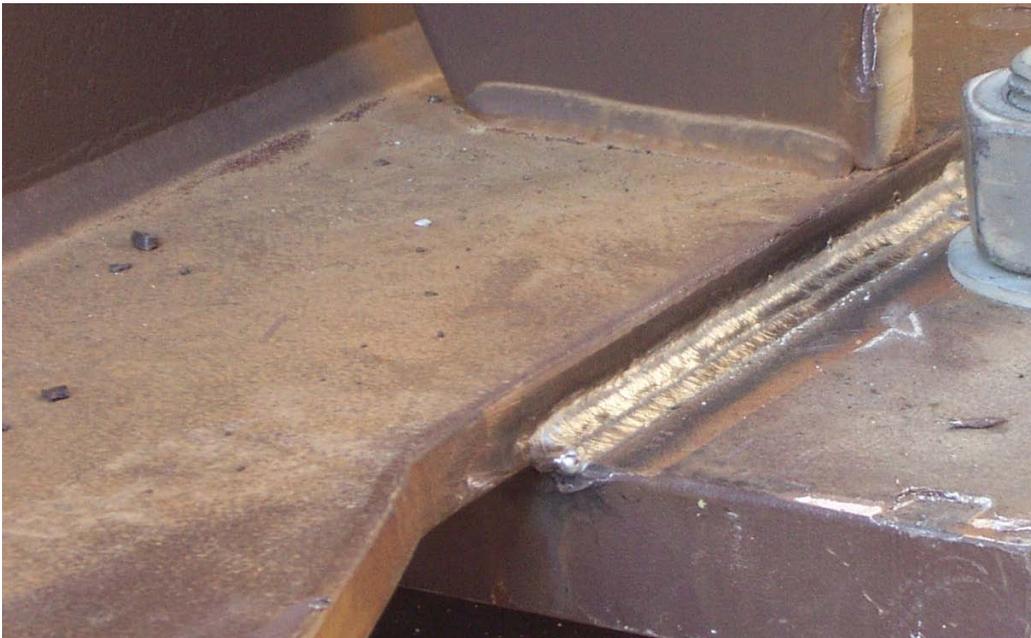
Weld Symbol definitions per AWS A2.4:2007



Illustrations for welding steel girders to a bearing plate.



Unacceptable weld (overlap at the bottom toe, undercut at the top toe, inadequate cleaning)



Acceptable weld (needs to be coated)

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION PIPE-PILE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.1

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.1, Sections 2 thru 6

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass: both Position of Weld: Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		Vertical Orientation, SEE ATTACHMENT 1 Horizontal Orientation, SEE ATTACHMENT 2

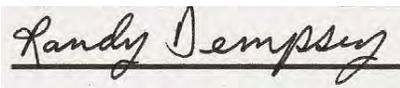
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: PIPE PILE

Written By: Randy Dempsey, CWI/CWE, TT IV

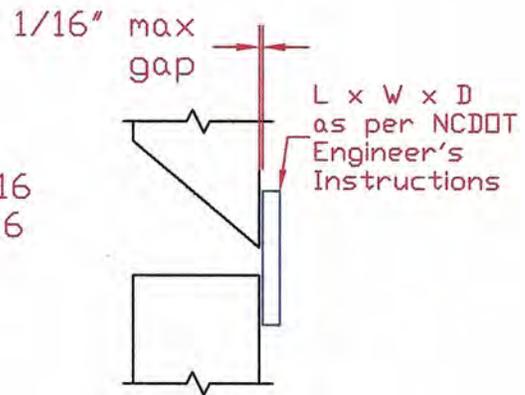
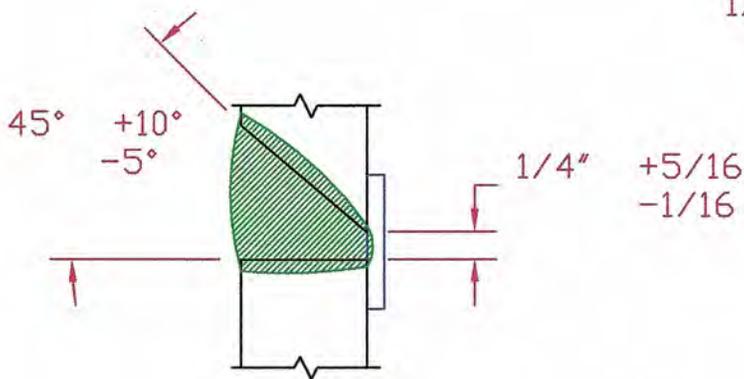
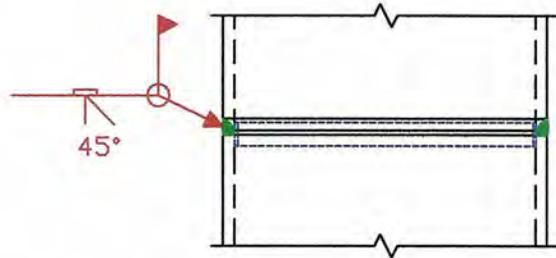
Signature: 

WPS #: 082508003

Authorized By: Steve Walton, Metals Engineer

Revision #: 5

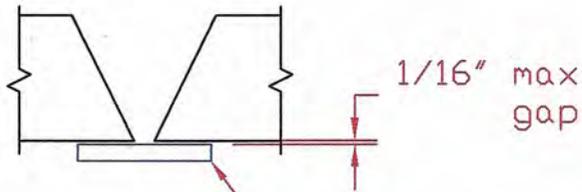
Signature: 



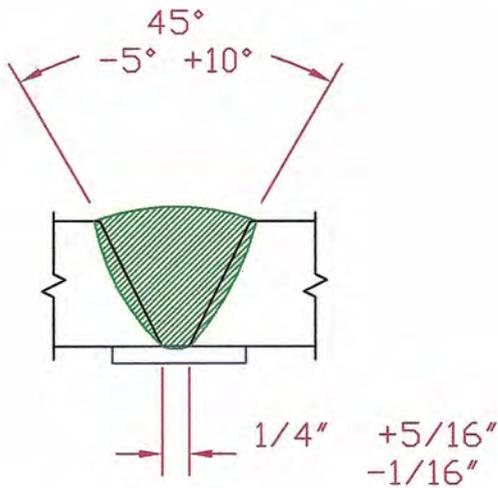
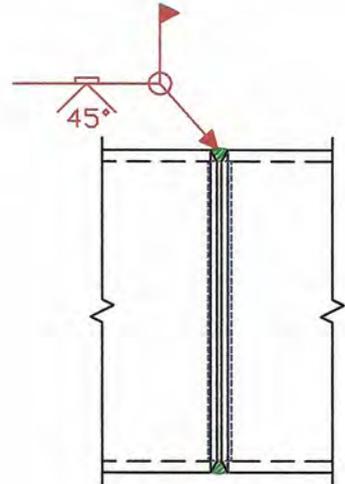
VERTICAL ORIENTATION PIPE-PILE SPLICE DETAILS

Weld Symbol definitions per AWS A2.4:2007





L x W x D
as per NCDOT
Engineer's
Instructions



HORIZONTAL ORIENTATION PIPE-PILE SPLICE DETAILS

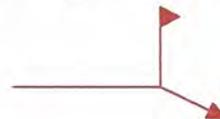
Weld Symbol definitions per AWS A2.4:2007



BACKING
BAR



WELD ALL
AROUND



FIELD WELD SYMBOL



BEVEL WELD, ARROW
SIDE with BEVEL
ANGLE

Illustrations for Pipe Pile Welding



Unacceptable weld (overlap at the bottom of the weld, undercut/underfill at the top)



Acceptable weld (arc strikes removed by grinding)

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION CONCRETE GIRDER SOLE PLATE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

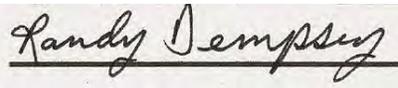
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

Care shall be taken to not exceed 250° in the proximity of the Elastomeric Bearing material and 300° in the proximity of the concrete.

WPS Description: Concrete Girder Sole Plate

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

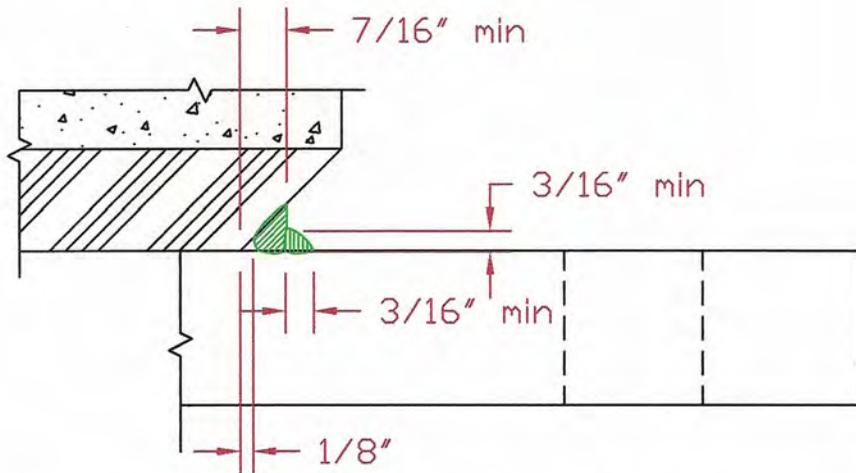
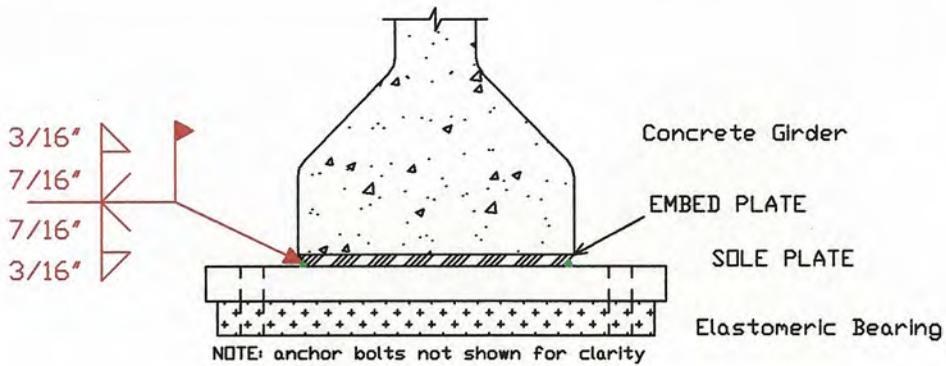
WPS #: 082508004

Authorized By: Steve Walton, Metals Engineer

Revision #: 4

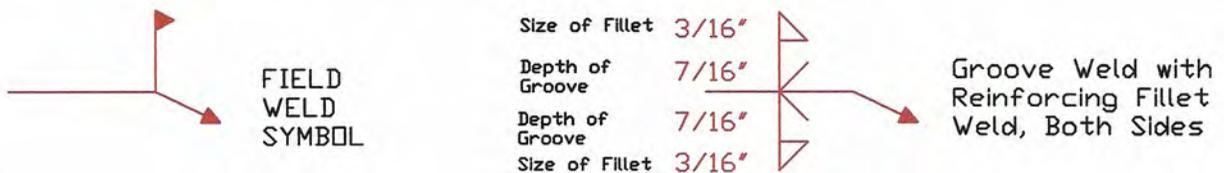
Signature: 

WPS CONCRETE GIRDER SOLE PLATE 082508004 R4
 JOINT DETAIL ATTACHMENT



CONCRETE GIRDER
 SOLE PLATE DETAILS

Weld Symbol definitions per AWS A2.4:2007



Illustrations of a pre-stressed concrete girder welded to a sole plate.



Unacceptable weld (too small, should have been coated before rusting)



Acceptable weld (still needs to be coated)

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STEEL GIRDER SIP ANGLE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass single Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

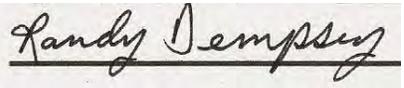
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Repair all weld discontinuities. Clean the completed weld of all debris, slag and spatter.

WPS Description: Steel Girder SIP Angle

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

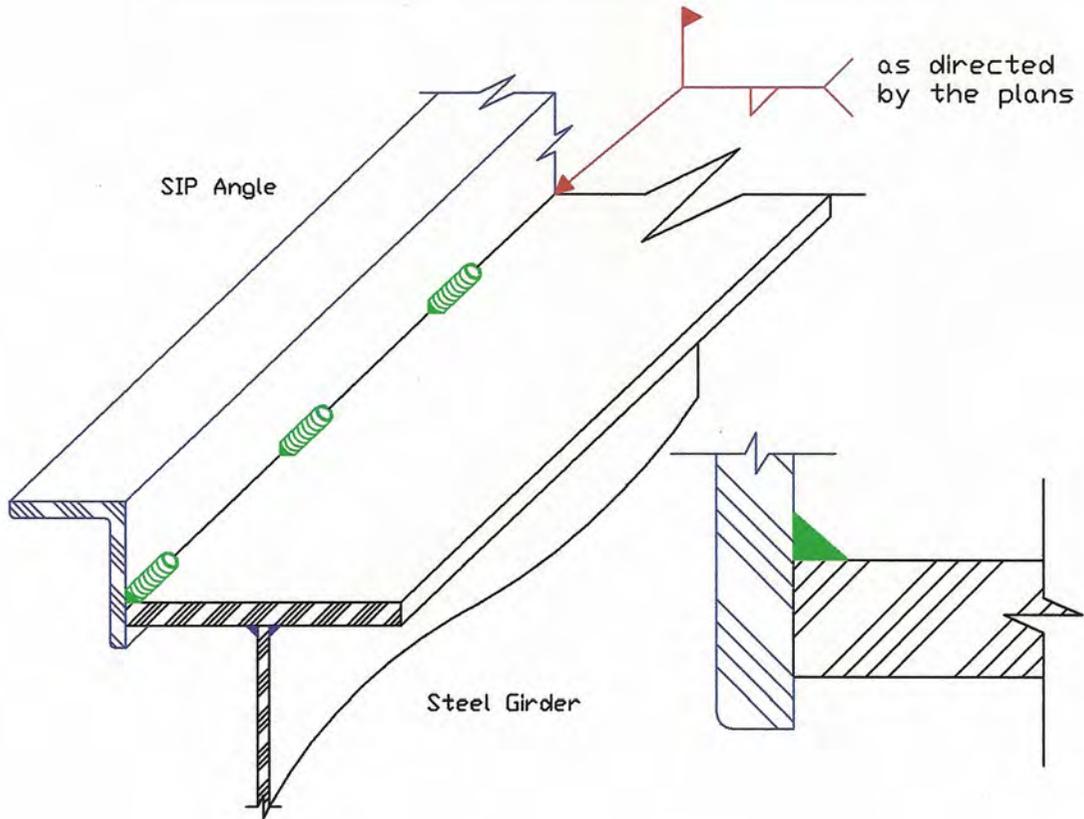
WPS #: 010909005

Authorized By: Steve Walton, Metals Engineer

Revision #: 5

Signature: 

WPS STEEL GIRDER SIP ANGLE 010909005 R5
JOINT DETAIL ATTACHMENT



STEEL GIRDER
SIP ANGLE DETAILS

Weld Symbol definitions per AWS A2.4:2007



Illustrations for welding a SIP angle to a steel girder.



Unacceptable weld (incomplete fusion at the top toe of weld)



Acceptable weld (slag needs to be removed)

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION CONCRETE GIRDER SIP ANGLE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass single Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

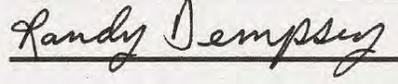
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°
Over 3/4" to 1 1/2"	70°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Repair all weld discontinuities. Clean the completed weld of all debris, slag and spatter.

WPS Description: Concrete Girder SIP Angle

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

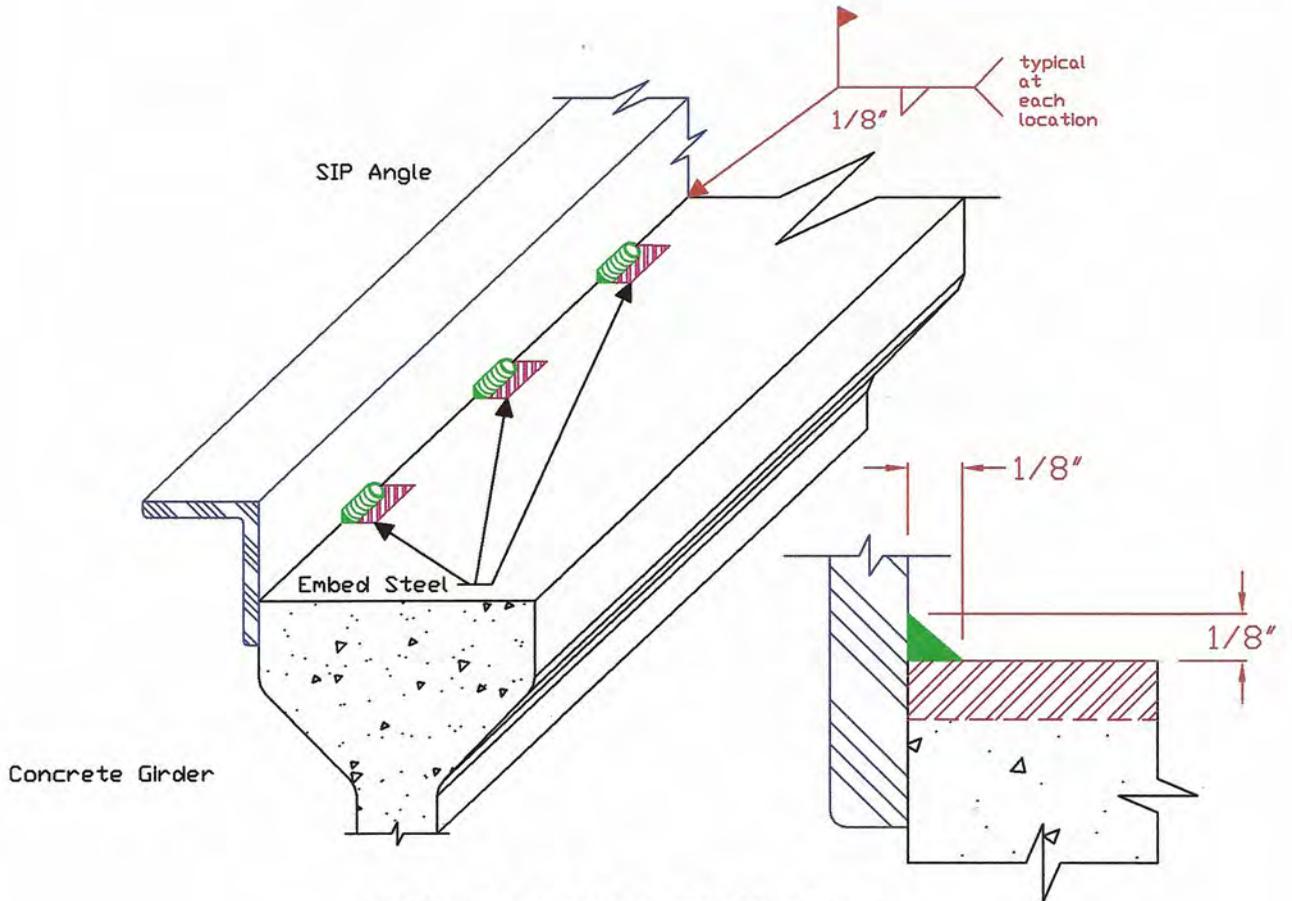
WPS #: 011609006

Authorized By: Steve Walton, Metals Engineer

Revision #: 4

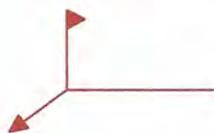
Signature: 

WPS CONCRETE GIRDER SIP ANGLE 011609006 R4
JOINT DETAIL ATTACHMENT

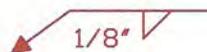


CONCRETE GIRDER
SIP ANGLE DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, ARROW
SIDE with WELD SIZE

Illustrations for welding SIP angle to the embed steel on pre-stressed concrete girders.



Unacceptable weld (inadequate length)



Acceptable weld (slag should be removed)

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STUD WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: Vertical up

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

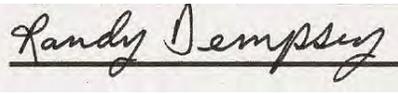
COMMENTS:
Remove the protrusion from the bottom of the stud and all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Stud Welding

WPS #: 012009007

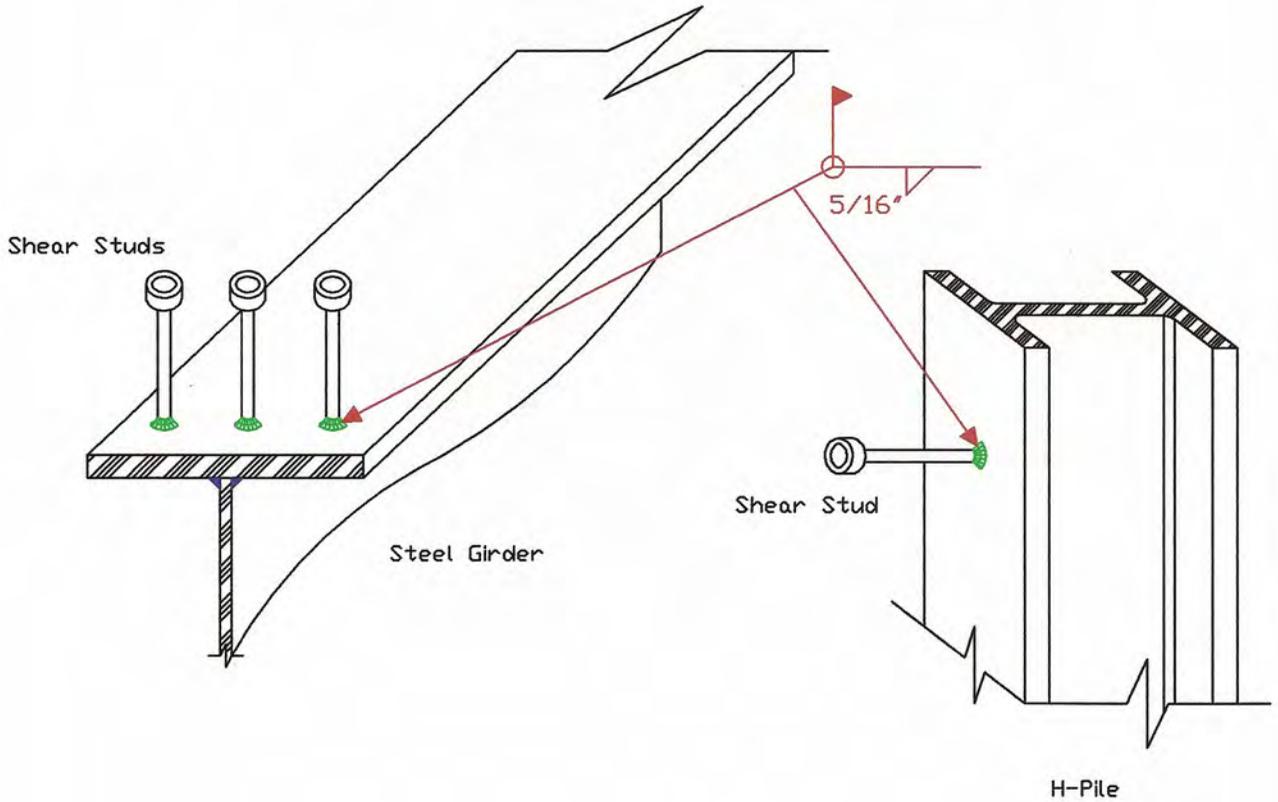
Revision #: 4

Written By: Randy Dempsey, CWI/CWE, Transportation Technician IV

Signature: 

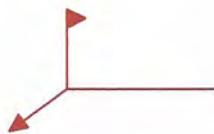
Authorized By: Steve Walton, Metals Engineer

Signature: 

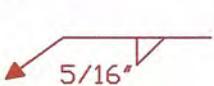


STUD WELDING DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD,
ARROW SIDE with
WELD SIZE



WELD ALL
AROUND

Illustrations for Stud Welding.



Unacceptable weld (too small)



Acceptable weld

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION FILLET WELD CERTIFICATION TEST (PREREQUISITE FOR GROOVE TEST) WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, 3/8" THICK

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Vertical

Welding Current: DC Polarity: Positive Progression: Vertical - up

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min Temp.
Up to 3/4"	50°

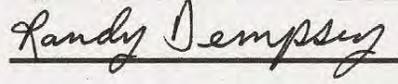
COMMENTS:

Remove all rust and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag and spatter between passes. Clean the completed weld of all debris, slag and spatter.

The fillet weld size shall be as directed by the examination proctor.

WPS Description Fillet Weld Certification Test

Written By: Randy Dempsey, CWI/CWE, Transportation Technician IV

Signature: 

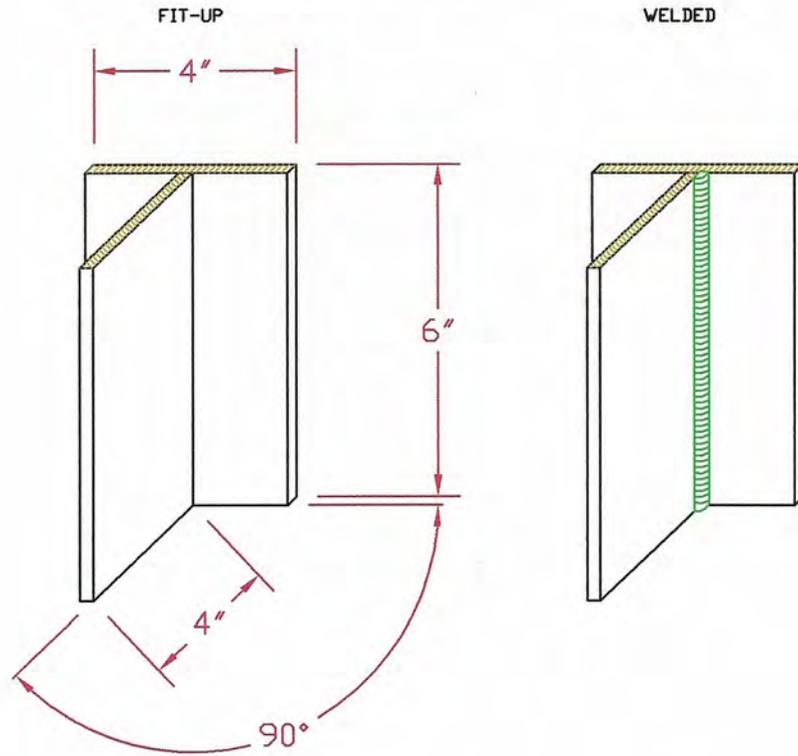
WPS #: 040209008

Authorized By: Steve Walton, Metals Engineer

Revision #: 3

Signature: 

WPS FILLET WELD CERTIFICATION TEST 040209008 R3
prerequisite for groove test
JOINT DETAIL ATTACHMENT



FILLET WELD
TEE JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



Illustrations for Fillet Weld Certification

(prerequisite for Bridge Welder and Pipe Welder Certification).



Coupon Fit-up.



Completed weld.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION 3G-4G PLATE CERTIFICATION TEST (BRIDGE WELDER) WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, 3/8" Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass Multiple Position of Weld Vertical & Overhead

Welding Current: DC Polarity: Positive Progression: Vertical – up

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°

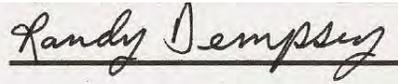
COMMENTS:

The backing bar must be in close contact with the test material.

Remove all rust and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag and spatter between passes. Clean the completed weld of all debris, slag and spatter.

Fill the groove to the full cross section of the member.

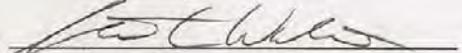
WPS Description 3G-4G Plate Certification Test

Written By: Randy Dempsey, CWI/CWE, Transportation Technician IV


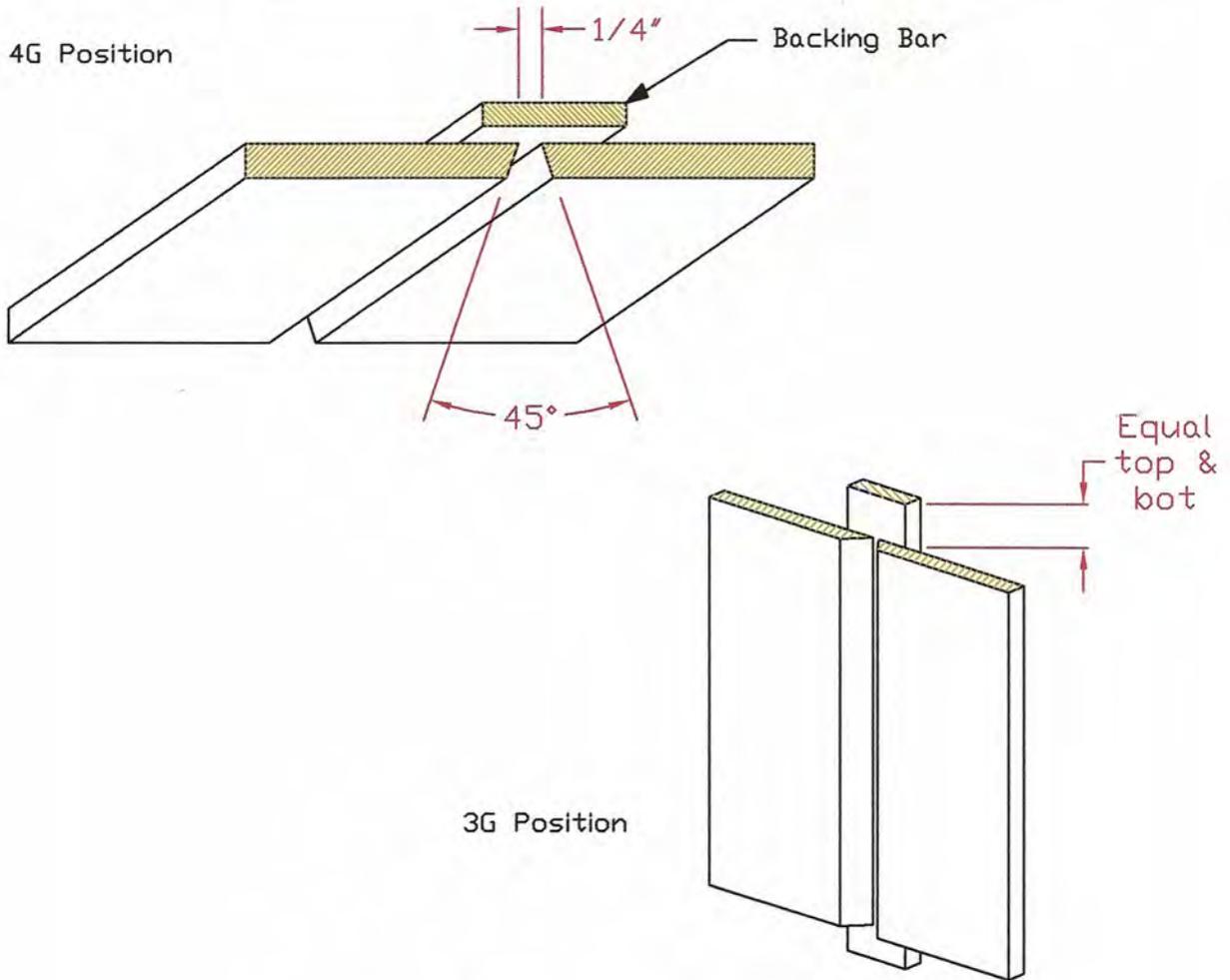
WPS #: 040209009

Signature: _____
 Authorized By: Steve Walton, Metals Engineer

Revision #: 3

Signature: 

WPS 3G-4G PLATE CERTIFICATION TEST 040209009 R3
JOINT DETAIL ATTACHMENT

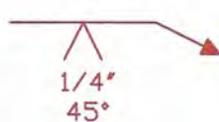


3G-4G GROOVE WELD
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



BACKING
BAR



BEVEL WELD, ARROW
SIDE with BEVEL ANGLE
& ROOT OPENING

Illustrations for 3G-4G Plate Certification (Bridge Welder)



Coupon Fit-up.



Completed weld.



NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

6G PIPE CERTIFICATION TEST (PIPE WELDER)

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.1

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.1, Sections 2 thru 6

Material Specifications: ASTM A-36

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass Multiple Position of Weld Flat, Horizontal Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: Vertical-up

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°

COMMENTS:

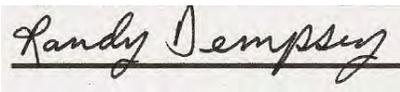
The backing ring must be in close contact with the test material.

Remove all rust and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag and spatter between passes. Clean the completed weld of all debris, slag and spatter.

Fill the groove to the full cross section of the member.

WPS Description: 6G Pipe Certification Test

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

WPS #: 040209010

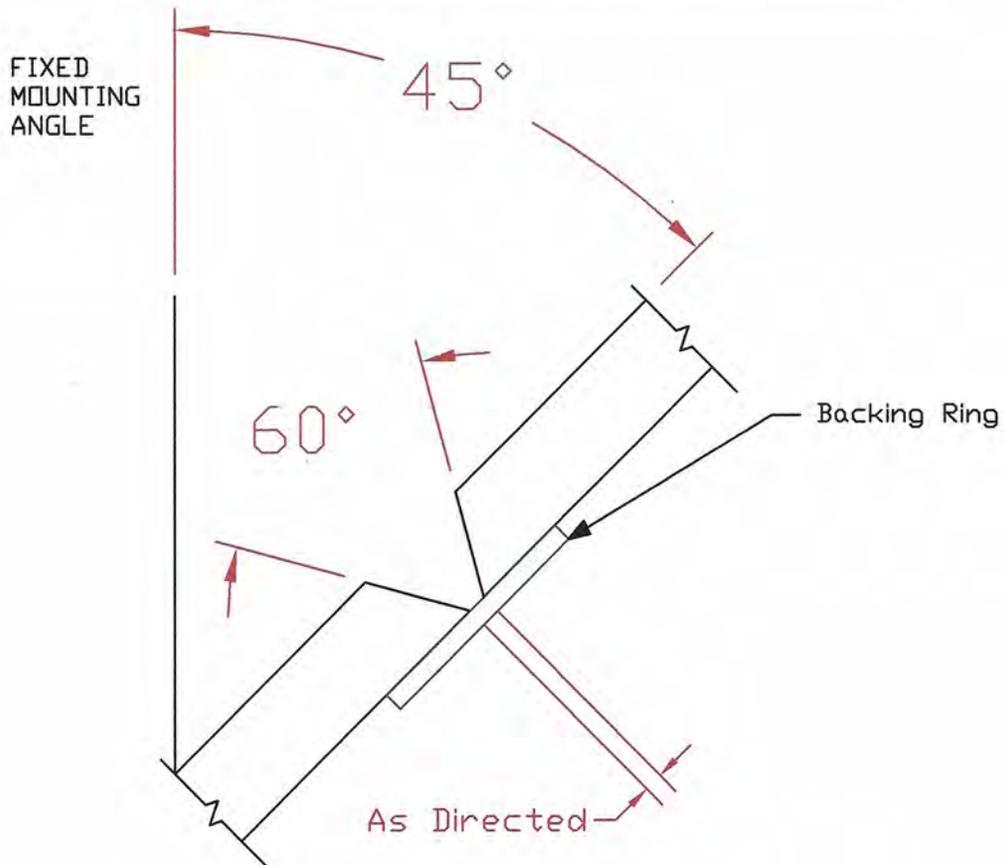
Steve Walton, Metals Engineer

Authorized By:

Revision #: 3

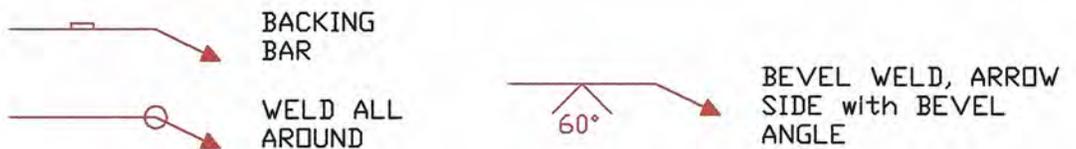
Signature: 

WPS 6G PIPE CERTIFICATION TEST 040209010
R3 JOINT DETAIL ATTACHMENT



6G PIPE JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



Illustrations 6G Pipe Certification Test.



Coupon fit-up (place the splice in backing ring at the top).



Completed coupon.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION SIP WELDER CERTIFICATION TEST WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, 3/8" THICK

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Joint Details	
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	SEE ATTACHMENT	

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°

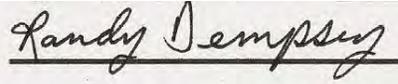
COMMENTS:

Remove all rust and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag and spatter between passes. Clean the completed weld of all debris, slag and spatter.

The fillet weld size shall be as directed by the examination proctor.

WPS Description: SIP Welder Certification Test

Written By: Randy Dempsey, CWI/CWE, Transportation Technician IV

Signature: 

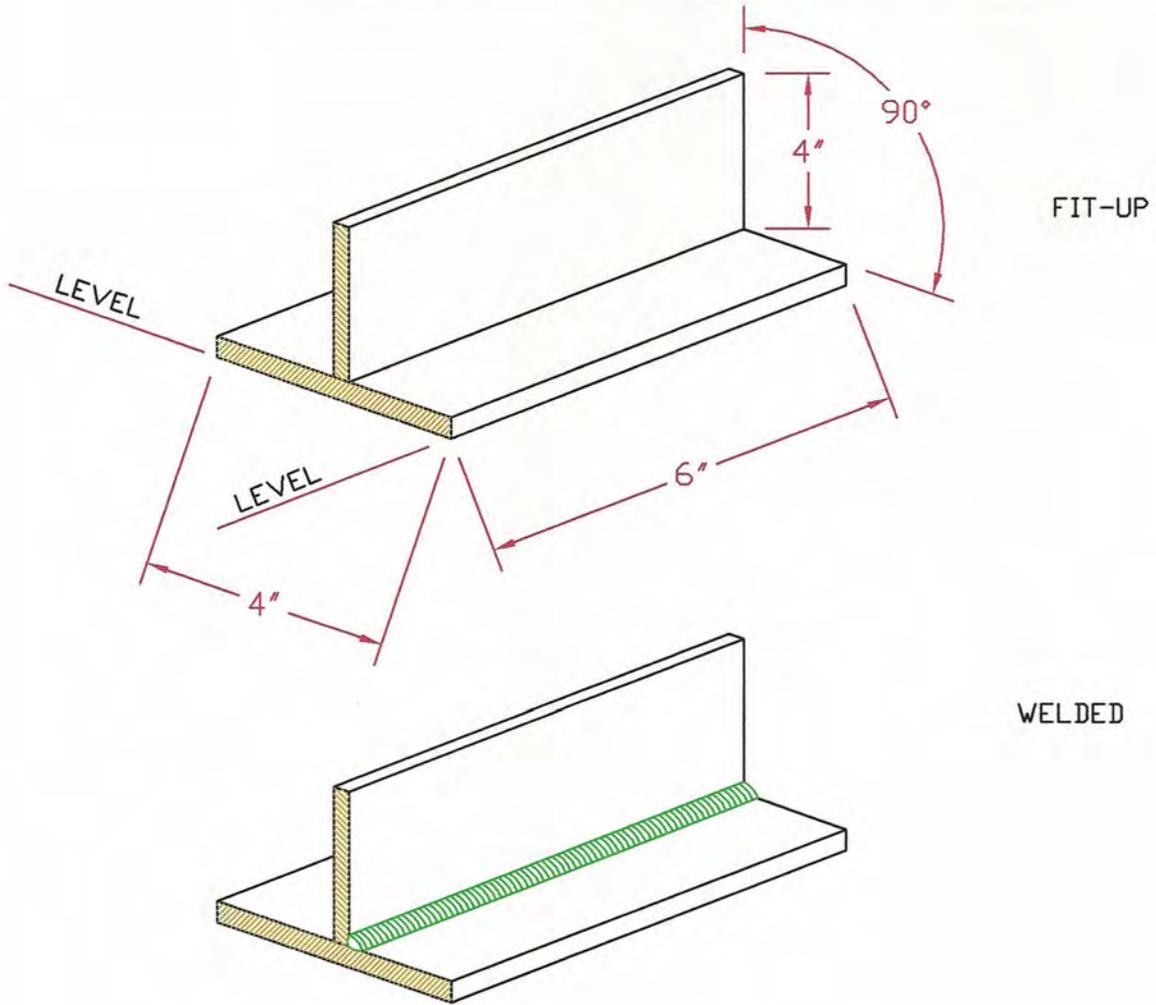
WPS #: 040209011

Authorized By: Steve Walton, Metals Engineer

Revision #: 3

Signature: 

WPS SIP WELDER CERTIFICATION TEST 0402090011 R3
JOINT DETAIL ATTACHMENT



SIP WELDER CERTIFICATION TEE
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



FILLET WELD, BOTH
SIDES OF ARROW

Illustrations for SIP Welder Certification



Coupon Fit-up



Completed Weld

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION ENCASEMENT PIPE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.1

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.1, Sections 2 thru 6

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

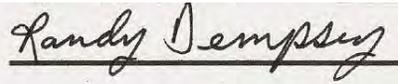
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Encasement-Pipe

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

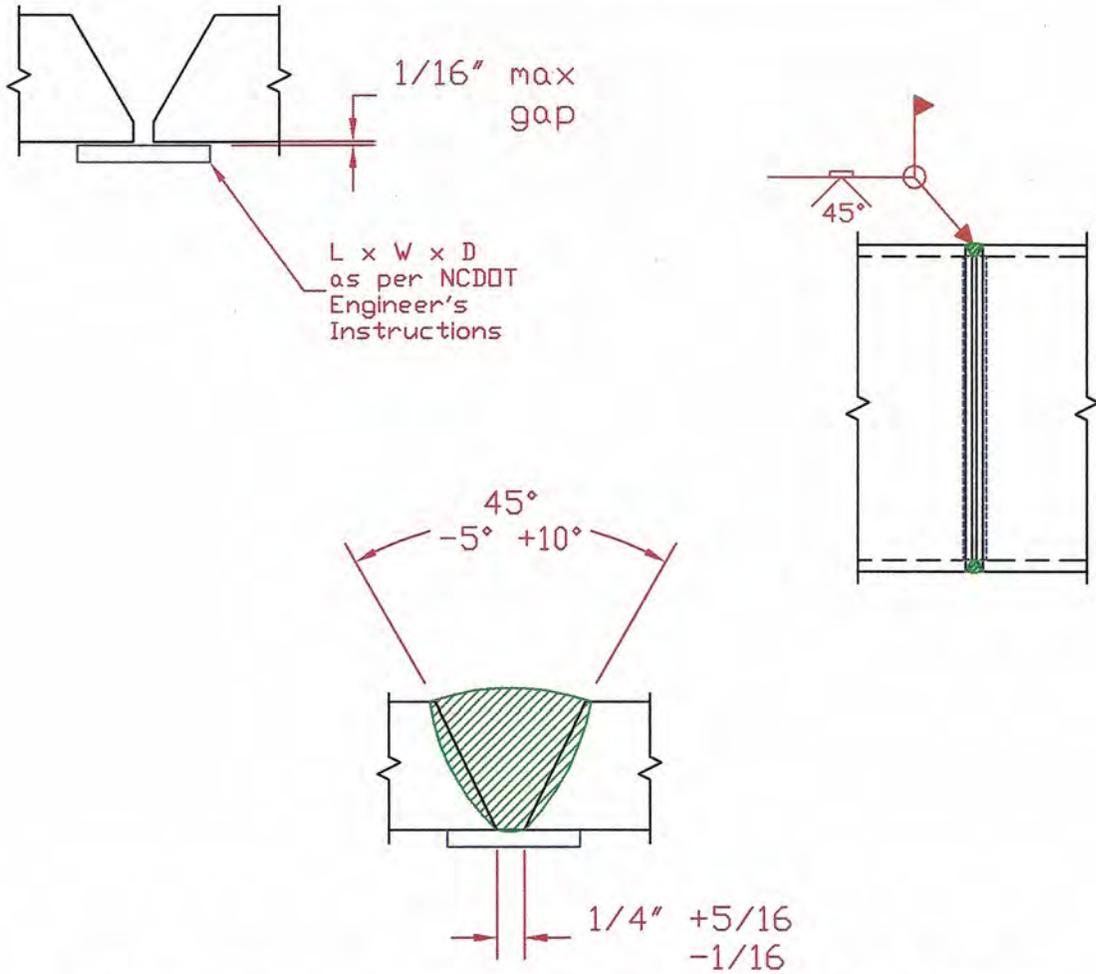
WPS #: 081109012

Authorized By: Steve Walton, Metals Engineer

Revision #: 3

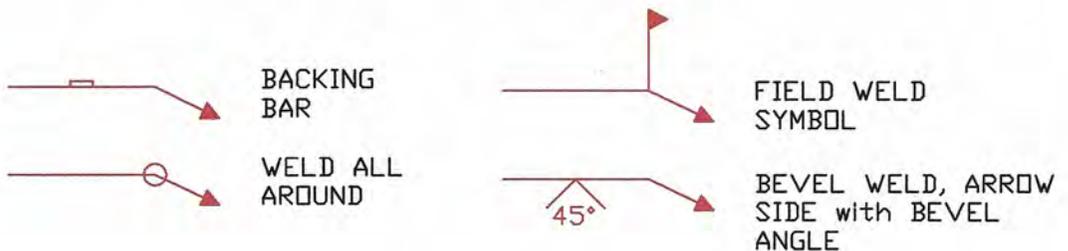
Signature: 

WPS ENCASEMENT-PIPE 081109012 R3
JOINT DETAIL ATTACHMENT



ENCASEMENT-PIPE SPLICE DETAILS

Weld Symbol definitions per AWS A2.4:2007



Illustrations for Encasement Pipe Welding



Unacceptable weld (interior of pipe not welded)



Acceptable weld (incomplete area cleaned and then welded)

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STEEL GIRDER BEARING PLATE WEATHERING STEEL (UNPAINTED) WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36W, A572W, (A709W-36, 50), (M270W-GR250, 345) Unlimited Thickness
[weathering steel]

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.5 Classification: E-8018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

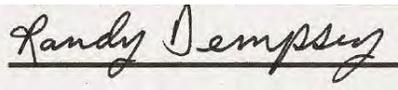
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

Care shall be taken to not exceed 250° in the proximity of the Elastomeric Bearing material.

WPS Description: Steel Girder Bearing Plate Weathering Steel (unpainted)

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

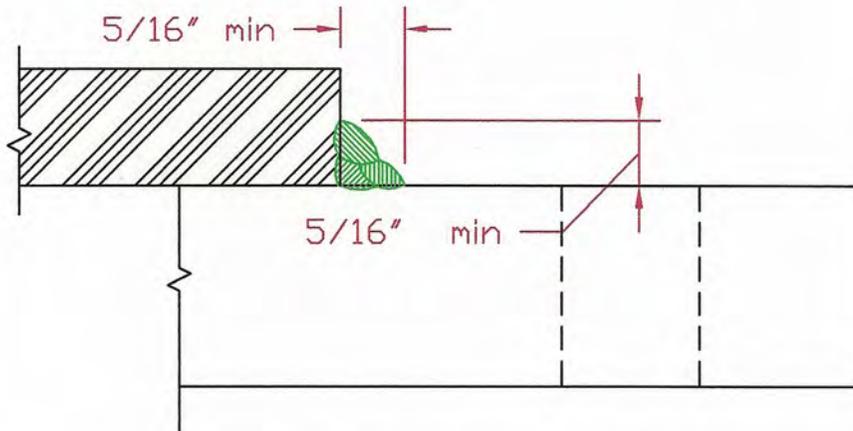
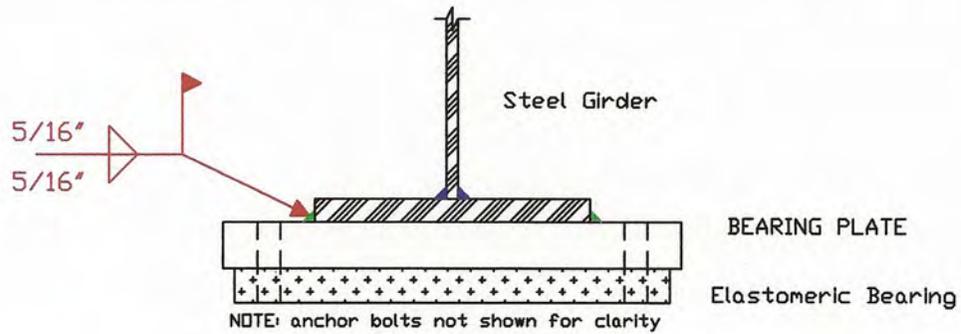
WPS #: 021510013

Authorized By: Steve Walton, Metals Engineer

Revision #: 2

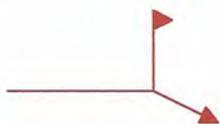
Signature: 

WPS STEEL GIRDER BEARING PLATE
 (weathering steel-unpainted)
 021510013 R2
 JOINT DETAIL ATTACHMENT



STEEL GIRDER
BEARING PLATE DETAILS
(weathering steel)

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, BOTH SIDES
 with WELD SIZE

Illustrations for welding unpainted steel girders to a bearing plate.



Unacceptable weld (overlap at the bottom toe, undercut at the top toe)



Acceptable weld

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION OVERHANG BRACKET WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass single Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-140 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

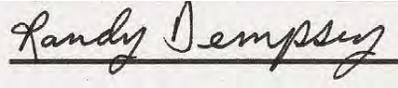
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:
Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Repair all weld discontinuities. Clean the completed weld of all debris, slag and spatter.

NO WELDING IS ALLOWED IN THE TENSION AREA OF THE FLANGE!!!

WPS Description: Overhang Bracket

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

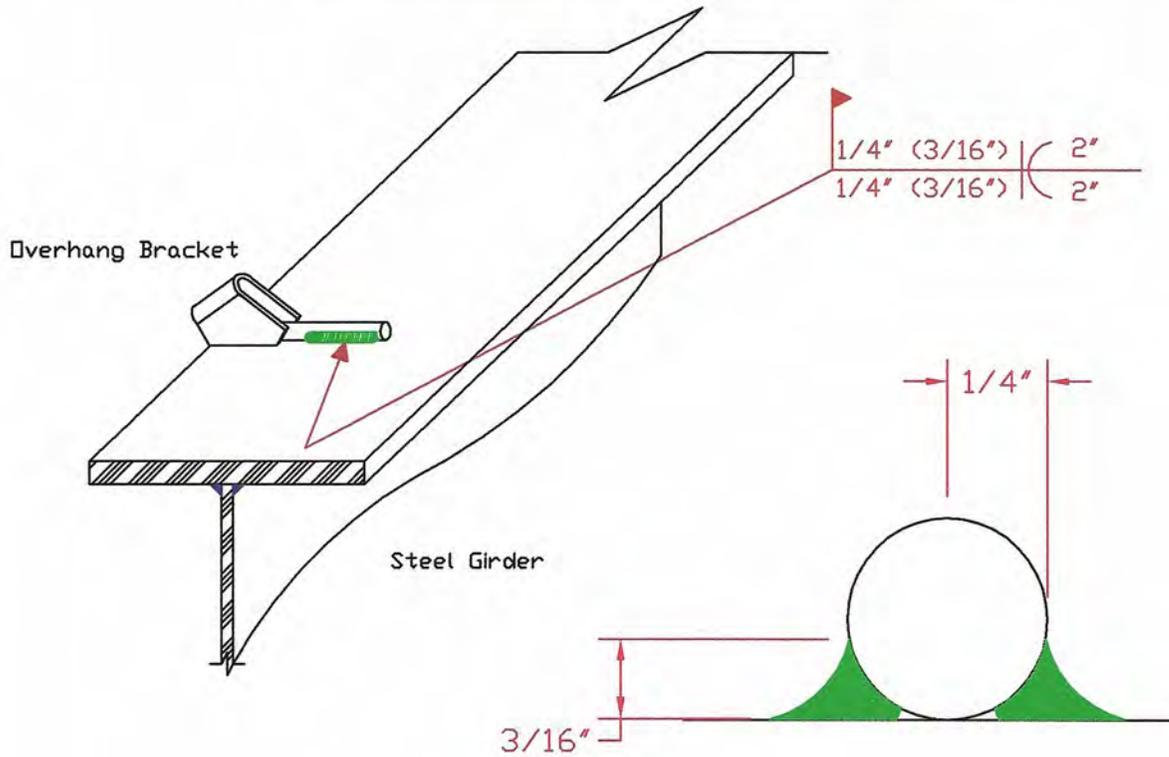
WPS #: 021510014

Authorized By: Steve Walton, Metals Engineer

Revision #: 2

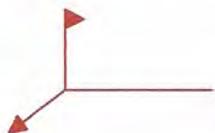
Signature: 

WPS OVERHANG BRACKET 021510014 R2
JOINT DETAIL ATTACHMENT

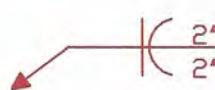


OVERHANG BRACKET
DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL

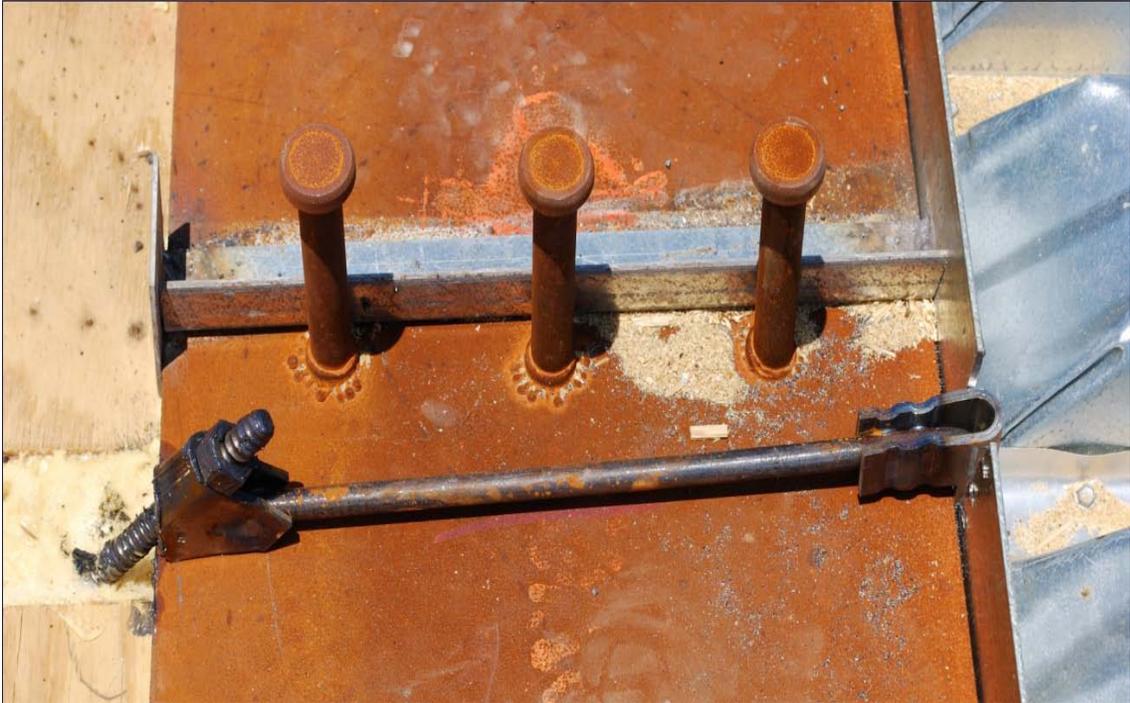


Double-Flare
Bevel-Groove with Weld
Length

Illustration for welding overhang brackets to steel girders.



Acceptable weld



No weld allowed in tension areas

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION SIP STRAP WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass single Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

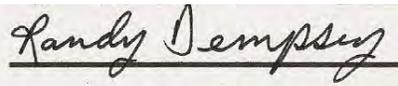
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°
Over 3/4" to 1 1/2"	70°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Repair all weld discontinuities. Clean the completed weld of all debris, slag and spatter.

WPS Description: SIP Strap

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

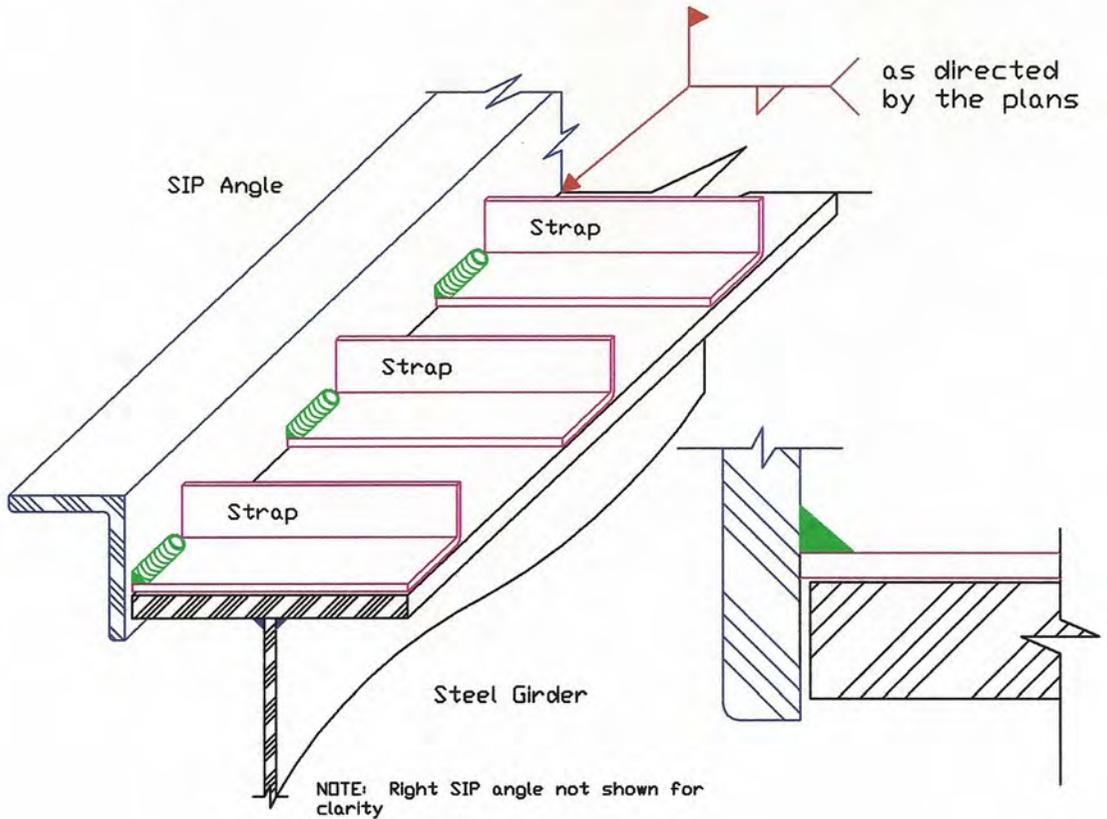
WPS #: 021510015

Authorized By: Steve Walton, Metals Engineer

Revision #: 2

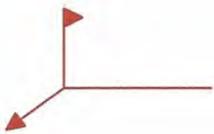
Signature: 

WPS STEEL GIRDER with SIP STRAP 021510015 R2
JOINT DETAIL ATTACHMENT



STEEL GIRDER
W/SIP STRAP DETAILS

Weld Symbol definitions per AWS A2.4:2007

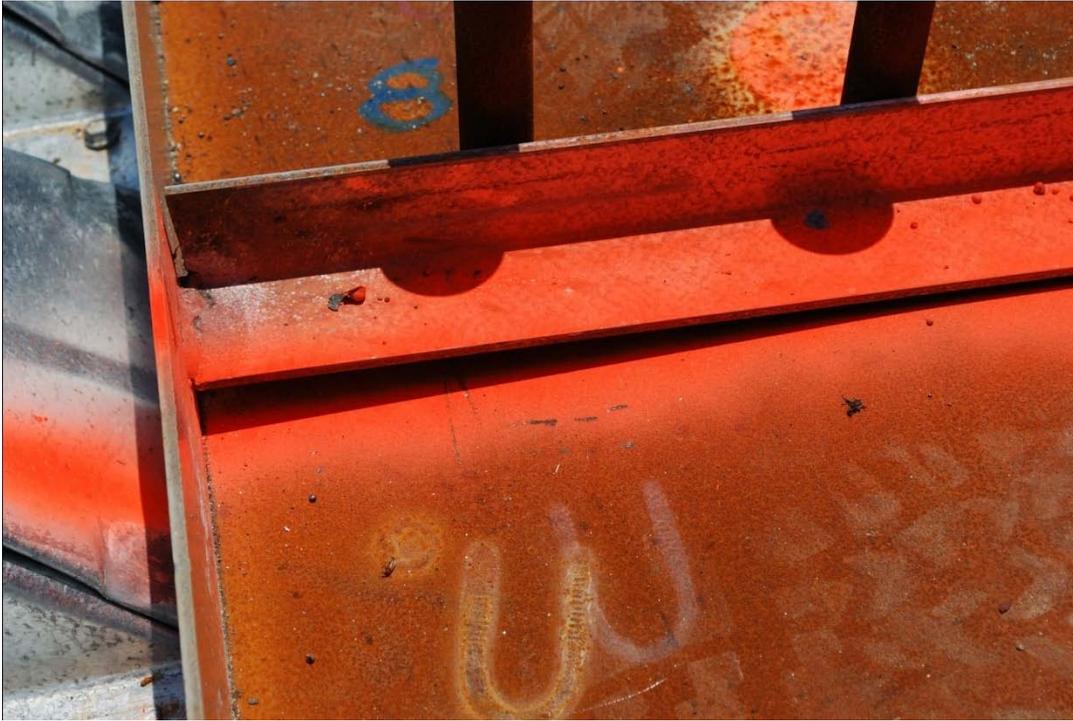


FIELD WELD SYMBOL



FILLET WELD, ARROW
SIDE

Illustrations for welding an SIP Strap over a steel girder.



Unacceptable placement (strap needs to be in contact with flange)



Acceptable

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION PIPE-PILE BOTTOM DRIVING PLATE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.1

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.1, Sections 2 thru 6

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

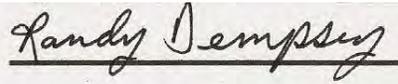
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: PIPE PILE BOTTOM DRIVING PLATE

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

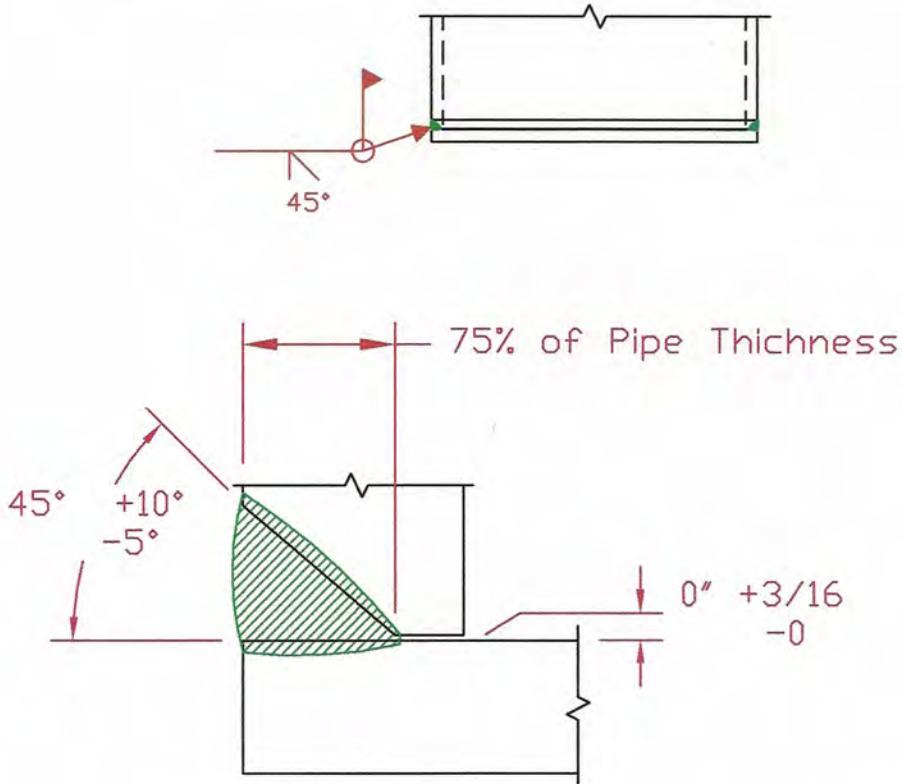
WPS #: 022511016

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

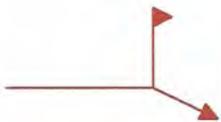
Signature: 

WPS PIPE-PILE BOTTOM DRIVING PLATE
022511016 R1 JOINT DETAIL ATTACHMENT



PIPE PILE BOTTOM DRIVING
PLATE SPLICE DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD
SYMBOL



WELD ALL
AROUND



BEVEL WELD, ARROW
SIDE with BEVEL
ANGLE

Illustrations for a pipe pile bottom driving plate.



Typical fit-up.



Root pass after cleaning.



Final pass before cleaning.



Final pass after cleaning

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STEEL GIRDER POT BEARING WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

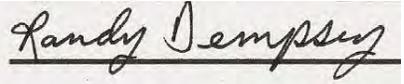
- 1. Bearing Assemblies shall not be lifted by their top plates. Any handling shall support the bearing unit from the underside.**
- 2. Bearings are to be protected from the dust during storage and erection.**
- 3. Remove keeper straps after the bearing has been positioned at its permanent location and prior to erection of the superstructure.**
- 4. When welding the top plate to the girder flange, use temperature indicating crayons or other suitable means to ensure that the bearing does not exceed 250°.**
- 5. Do not permit welding current to pass through the interior parts of the bearing. Arcing may occur which can permanently damage the bearing.**
- 6. Disassembly of the bearing unit is not permitted without written consent from the manufacturer. Unauthorized disassembly could result in bearing failure.**
- 7. The Contractor shall rotate the top plates of the bearing so that the alignment is parallel to the center line of the girder.**

WPS Description: Steel Girder Pot Bearing

WPS #: 022811017

Revision #: 1

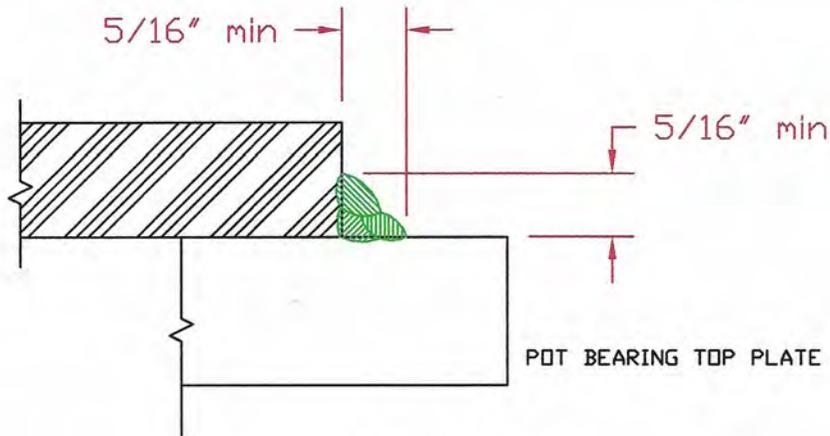
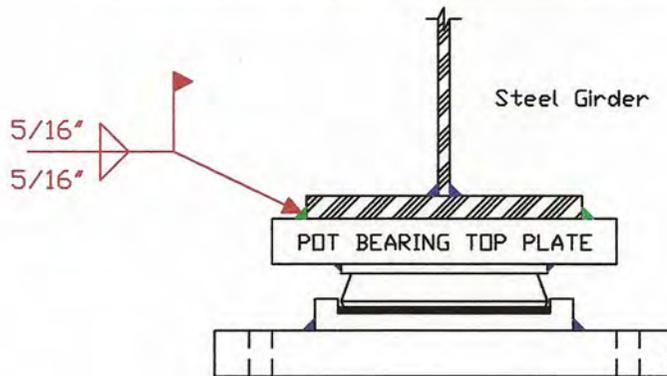
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

Authorized By: Steve Walton, Metals Engineer

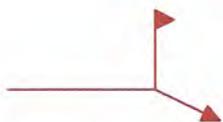
Signature: 

WPS STEEL GIRDER POT BEARING 022811017 R1
JOINT DETAIL ATTACHMENT

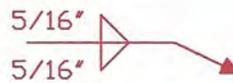


STEEL GIRDER
POT BEARING DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, BOTH
SIDES with WELD SIZE

Illustrations for Pot Bearing.



As Received



Installed

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION SOLDIER-PILE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: Vertical – up

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

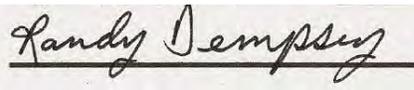
Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:
Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description SOLDIER-PILE

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

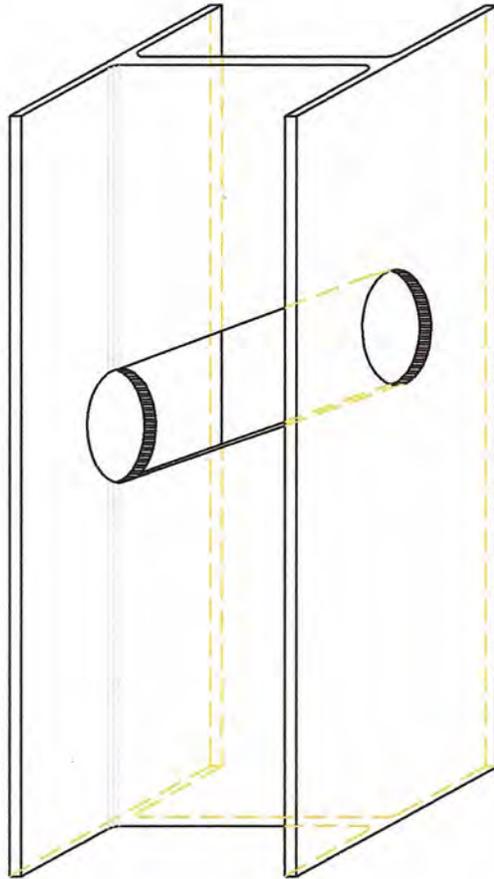
WPS #: 030811018

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

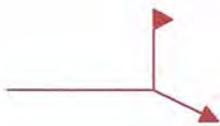
Signature: 

WPS SOLDIER-PILE 030811018 R1 JOINT DETAIL ATTACHMENT 1,
(cut holes in flange and remove web material)

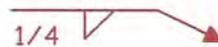


SOLDIER-PILE WEB DETAILS

Weld Symbol definitions per AWS A2.4:2007

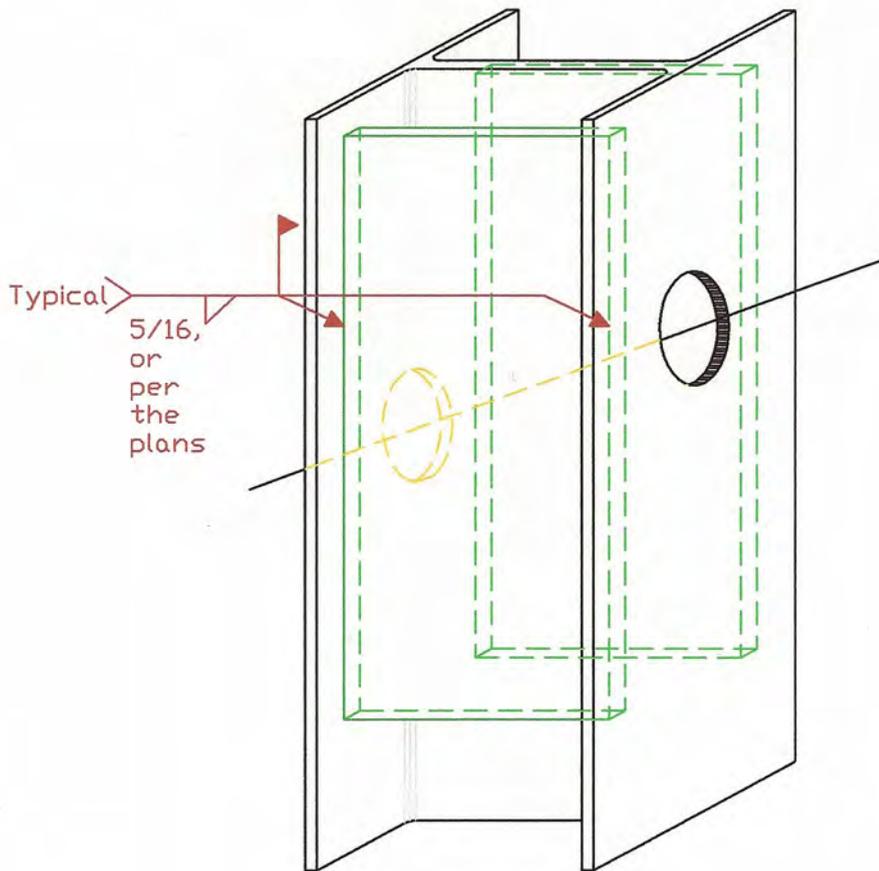


FIELD WELD SYMBOL



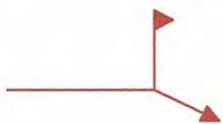
FILLET WELD, ARROW
SIDE with WELD SIZE

WPS SOLDIER-PILE 030811018 R1 JOINT DETAIL ATTACHMENT 2,
(install stiffener plates, near and far side)



SOLDIER-PILE STIFFENER DETAILS

Weld Symbol definitions per AWS A2.4:2007

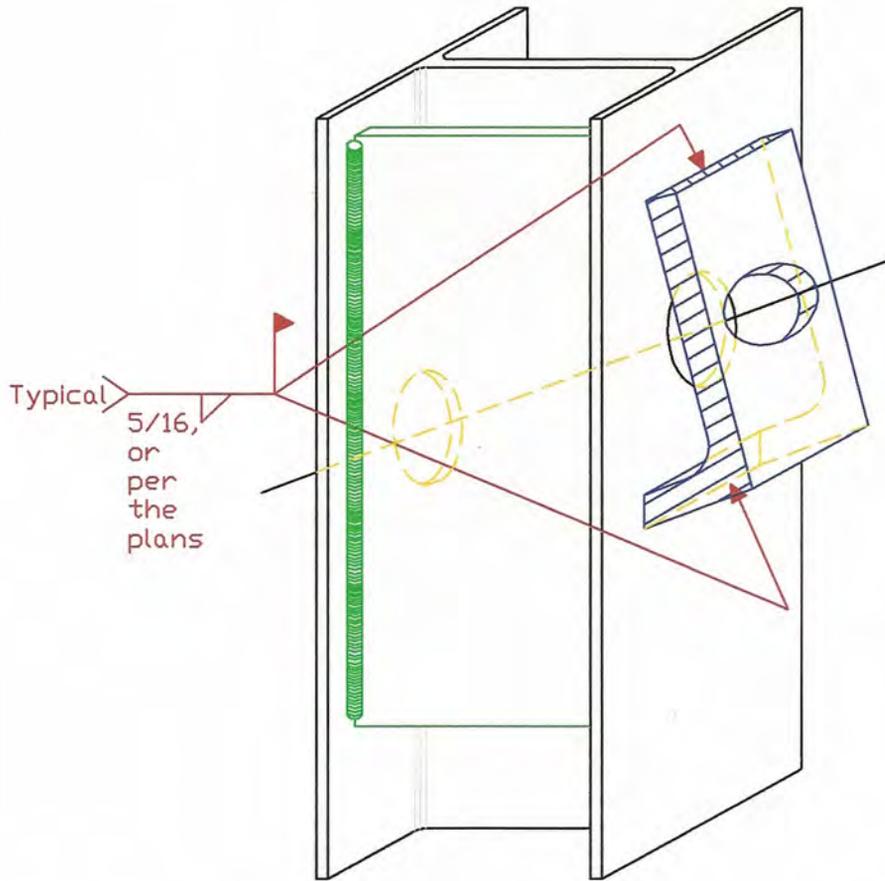


FIELD WELD SYMBOL



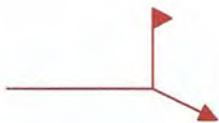
FILLET WELD, ARROW
SIDE with WELD SIZE

WPS SOLDIER-PILE 030811018 R1 JOINT DETAIL ATTACHMENT 3,
(install anchor angle)



SOLDIER-PILE ANCHOR DETAILS

Weld Symbol definitions per AWS A2.4:2007

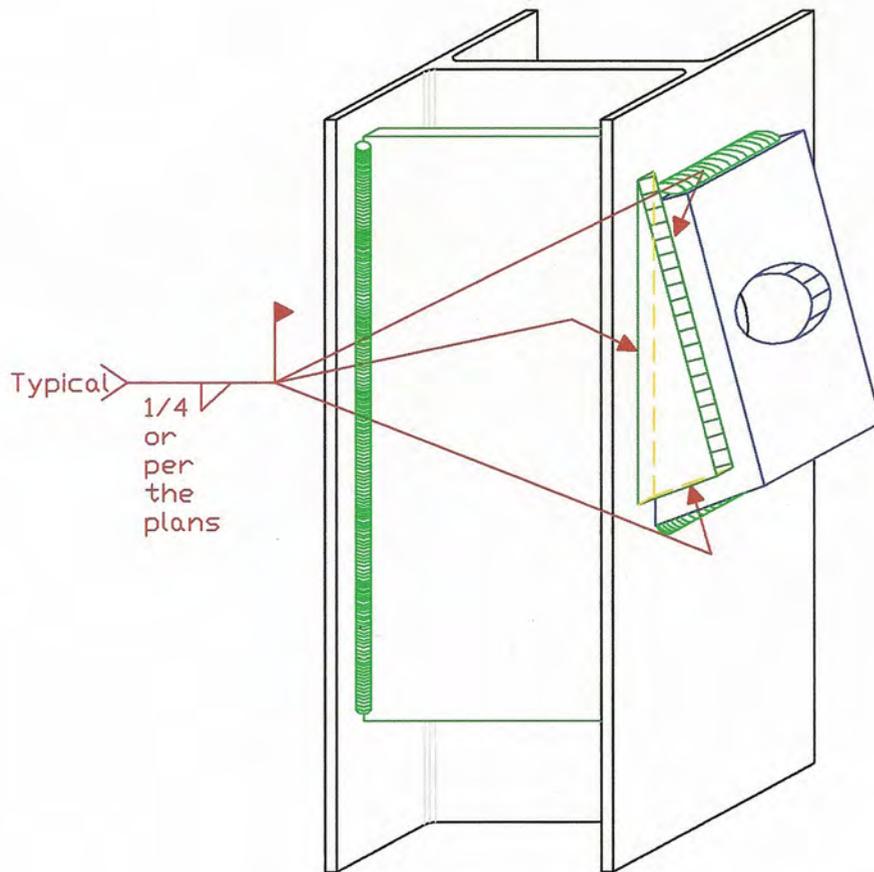


FIELD WELD SYMBOL



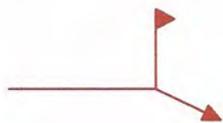
FILLET WELD, ARROW
SIDE with WELD SIZE

WPS SOLDIER-PILE 030811018 R1 JOINT DETAIL ATTACHMENT 4,
(install gusset, near and far side in line with stiffener)



SOLDIER-PILE ANCHOR DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, ARROW SIDE with WELD SIZE

Illustrations for soldier pile field welding.



Unacceptable (arc strikes need to be removed by grinding and base metal inspected for cracks, slag needs to be removed).



Completed Piles.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SINGLE V-GROOVE WITH BACKING

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All Flat, Horizontal	SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

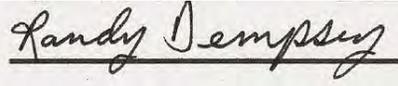
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

The backing material needs to be in intimate contact with the base metal, but in all cases shall have no more than 1/16" gap (see attachment).

WPS Description: Single V-Groove With Backing

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

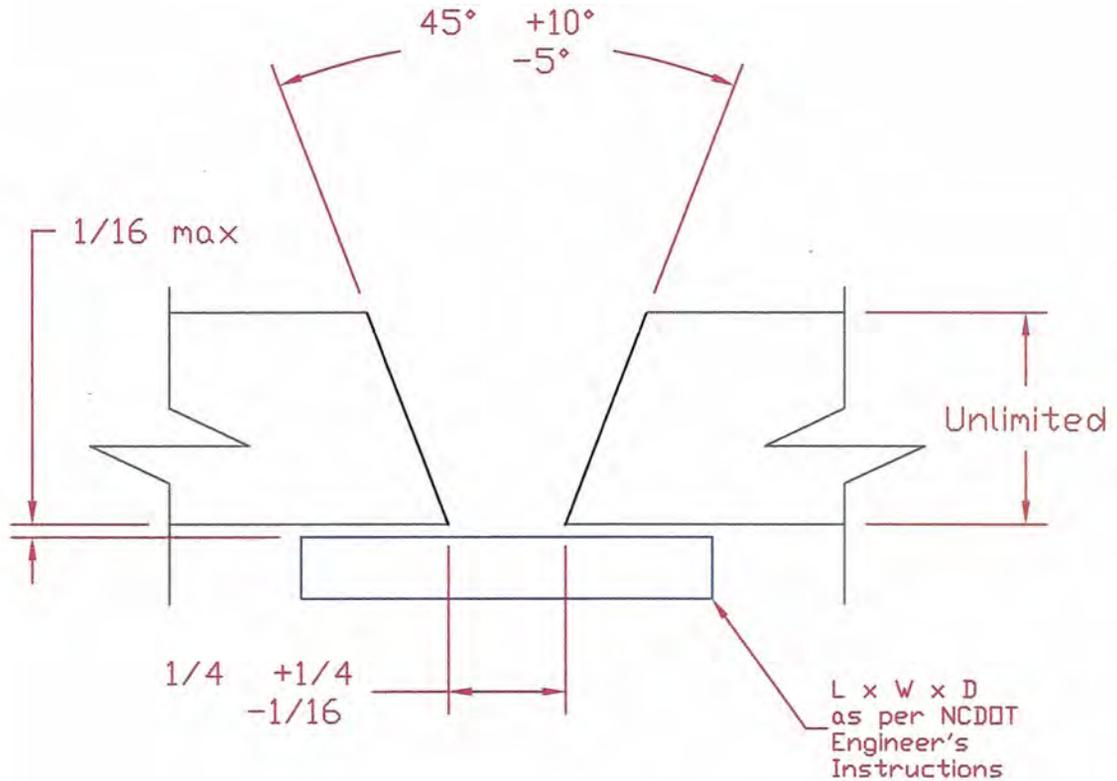
WPS #: 031711021

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

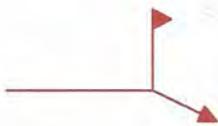
Signature: 

WPS SINGLE V GROOVE with Backing 031711021 R1
JOINT DETAIL ATTACHMENT

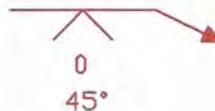


SINGLE V GROOVE with Backing
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD
WELD
SYMBOL

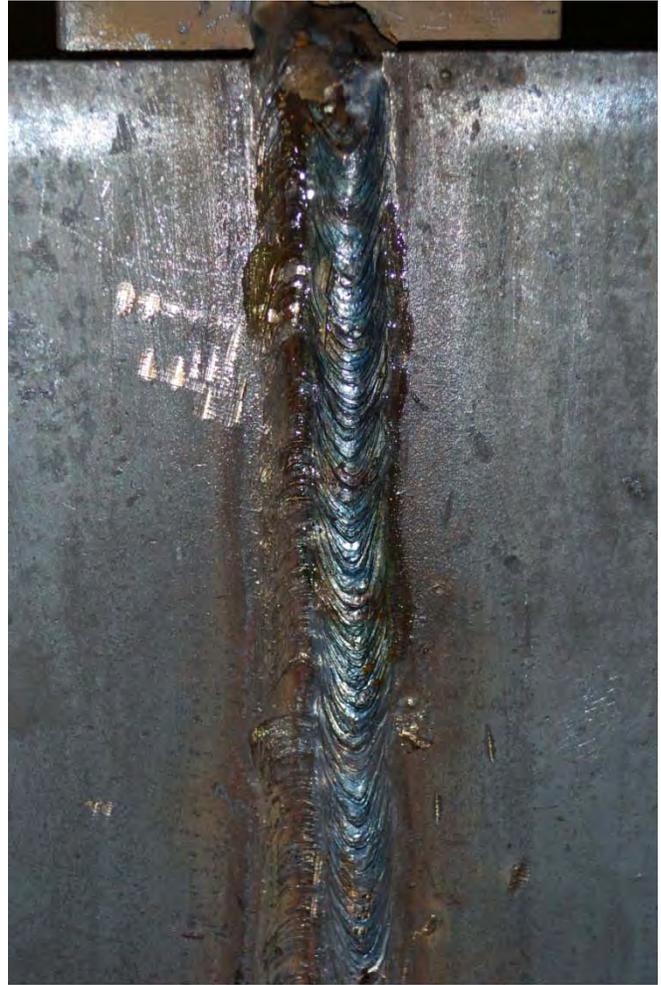


Single V Groove,
w/Root Opening and
Groove Angle

Illustrations for single V-Groove with backing.



Fit-up.



Completed weld.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SINGLE V-GROOVE WITH BACK GOUGE

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: Back Gouge with a grinder to sound metal prior to applying the back weld.

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All Flat, Horizontal	SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

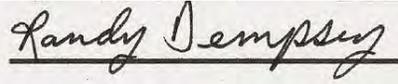
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Single V-Groove With Back Gouge

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

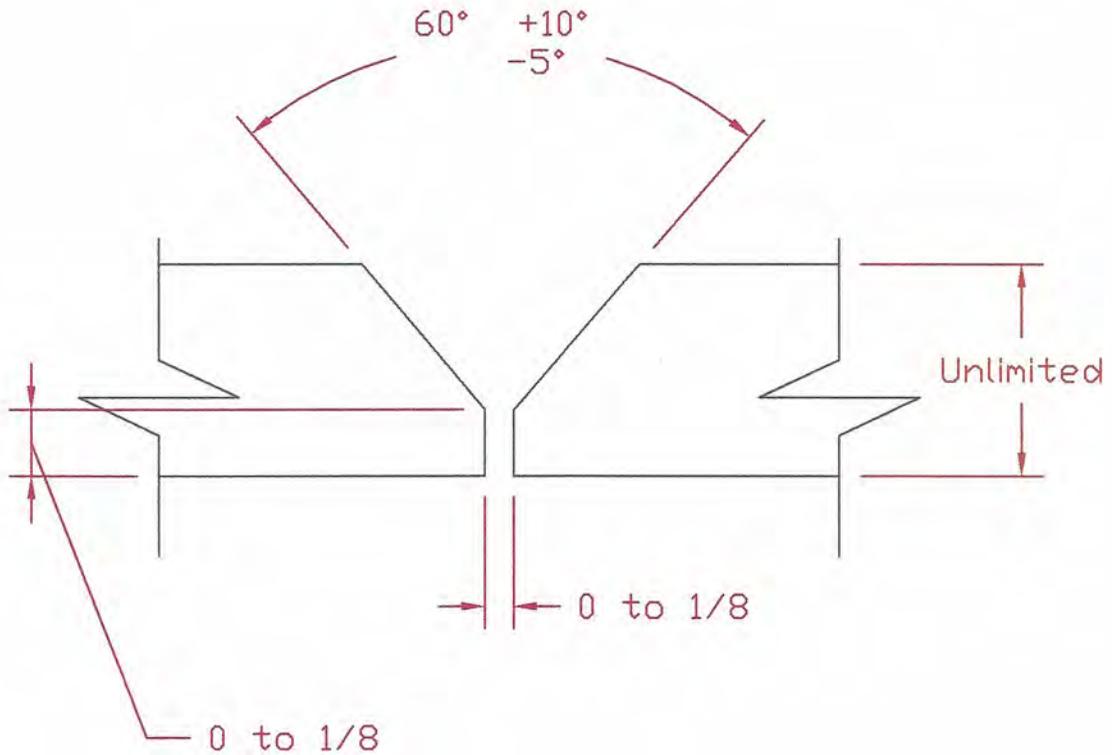
WPS #: 031711022

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

Signature: 

WPS SINGLE V GROOVE with Back Gouge 031711022 R1
 JOINT DETAIL ATTACHMENT



SINGLE V GROOVE with Back Gouge
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007

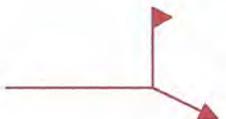


BACK
 WELD,
 OTHER
 SIDE



Back
 Gouge

Back Gouge
 Required before
 welding side two



FIELD
 WELD
 SYMBOL



60°

Single V Groove,
 w/ Groove Angle

Illustrations for a Single V-groove with Back Gouge.



Fit-up with a runoff tab.



Each pass is cleaned.



Completed Joint with edge finished with a grinder.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION DOUBLE BEVEL GROOVE WITH BACK GOUGE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: Back Gouge with a grinder to sound metal prior to applying weld to the second side.

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
All	5/32"	120-200	21-24	6-10 ipm		

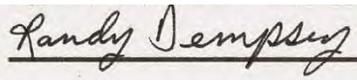
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Double Bevel Groove With Back Gouge

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

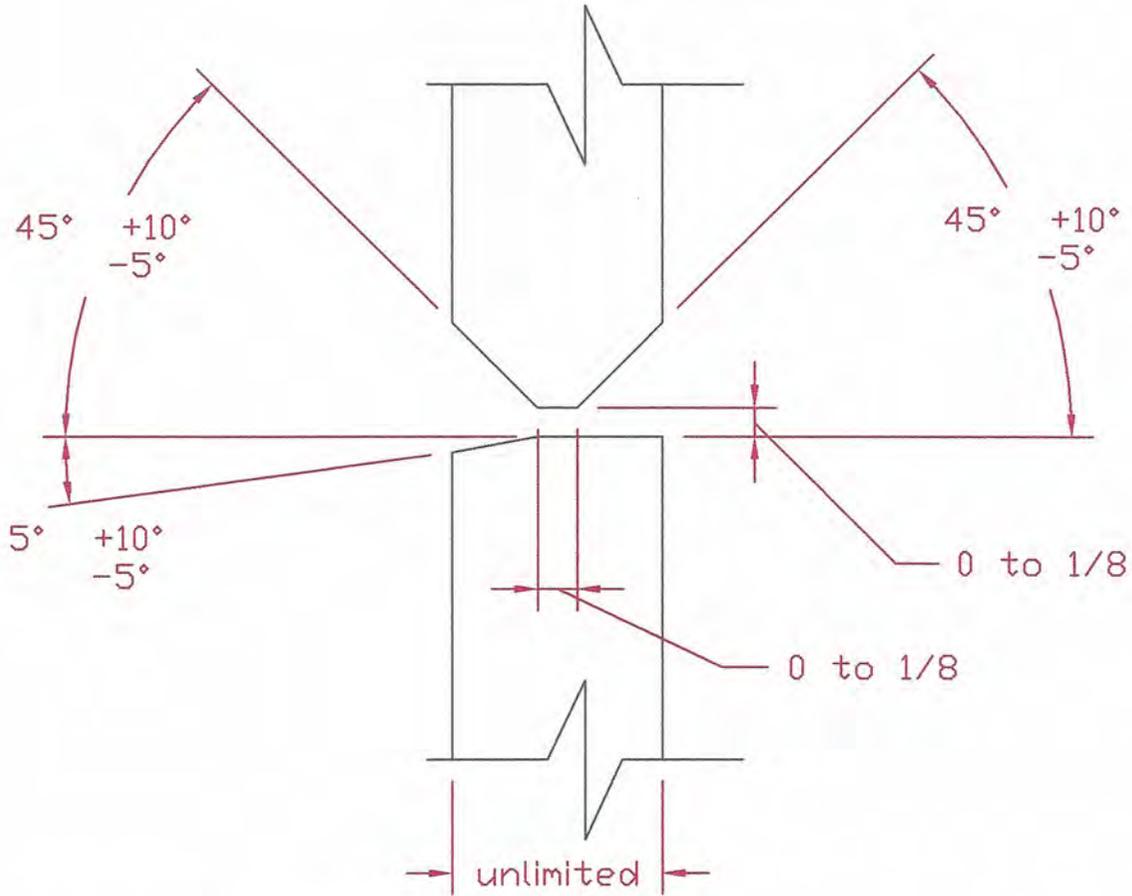
WPS #: 031711023

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

Signature: 

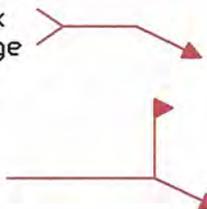
WPS DOUBLE BEVEL GROOVE with Back Gouge 031711023 R1
 JOINT DETAIL ATTACHMENT



DOUBLE BEVEL GROOVE with Back Gouge
JOINT DETAILS

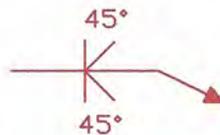
Weld Symbol definitions per AWS A2.4:2007

Back Gouge



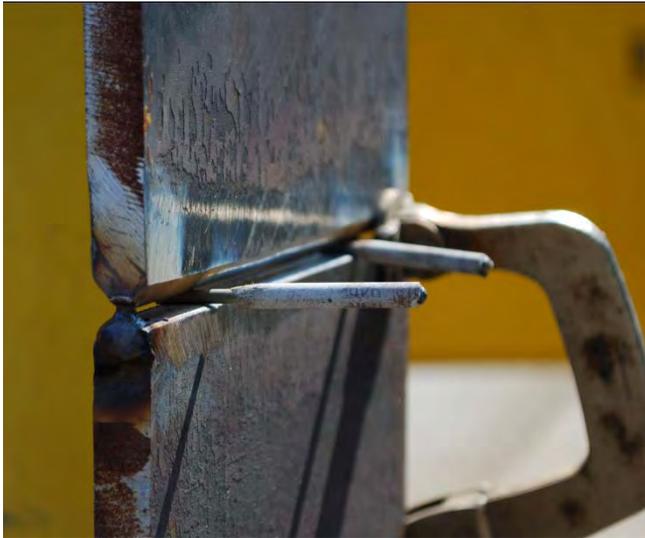
Back Gouge
 Required before
 welding side two

FIELD
 WELD
 SYMBOL



Double BEVEL Groove,
 w/ Groove Angle

Illustrations for a double bevel groove with back gouge.



Typical fit-up using 1/8" electrodes to set the root opening.



Root pass after cleaning.



Inadequate back gouge.



Adequate back gouge.



Completed weld.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

DOUBLE V GROOVE WITH BACK GOUGE

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: Back Gouge with a grinder to sound metal prior to applying weld to the second side.

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All	SEE ATTACHMENT
All	5/32"	120-200	21-24	6-10 ipm	All	

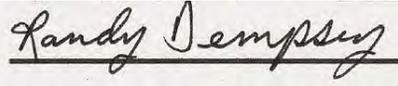
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Double V Groove With Back Gouge

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

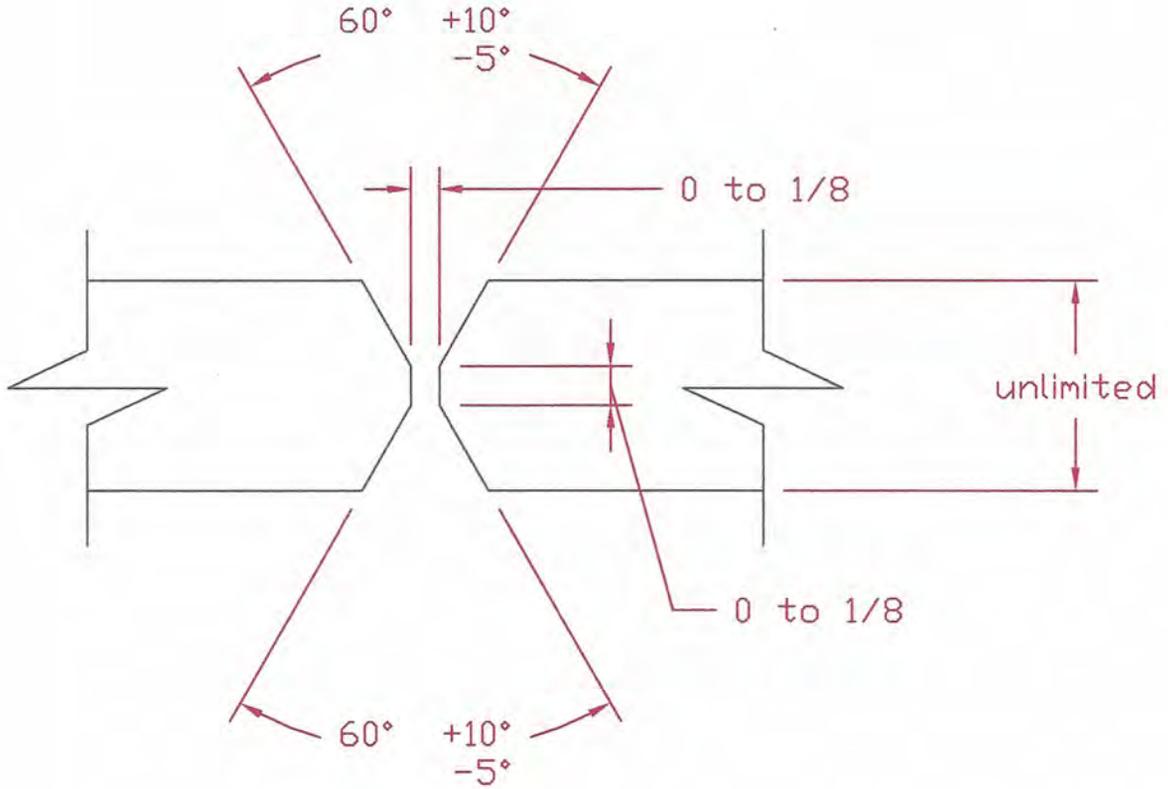
WPS #: 031711025

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

Signature: 

WPS DOUBLE V GROOVE with Back Gouge 031711025 R1
JOINT DETAIL ATTACHMENT

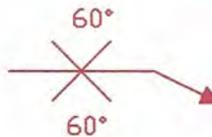
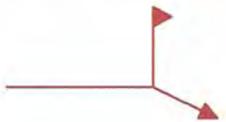


DOUBLE V GROOVE with Back Gouge
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



Back Gouge
Required before
welding side two



Double V Groove,
w/ Groove Angle

Illustrations for a Double V-Groove with Back Gouge.



Runoff tabs are used to help with fit-up.



Each pass is cleaned.



Side 2 before back gouge.



Back gouge on the right is Adequate, left is not.



Completed weld.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION FILLET WELD WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All Flat, Horizontal	SEE ATTACHMENT
	5/32"	120-200	21-24	5-10 ipm		
	3/16"	170-280	21-24	4-11 ipm		

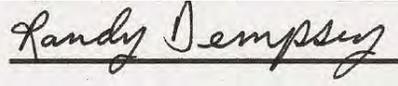
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description Fillet Weld

Written By: Randy Dempsey, CWI/CWE, TT IV

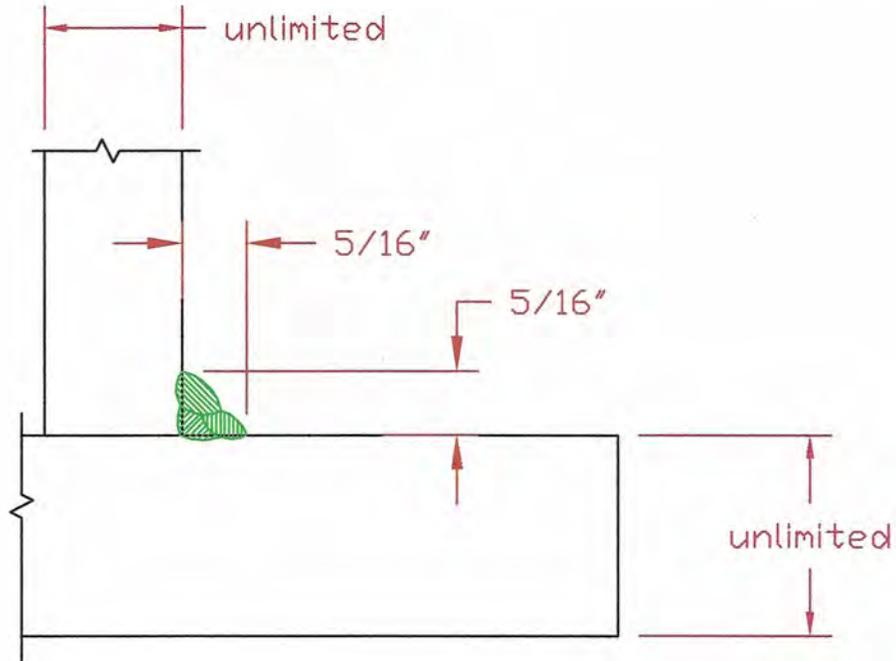
Signature: 

WPS #: 032811027

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

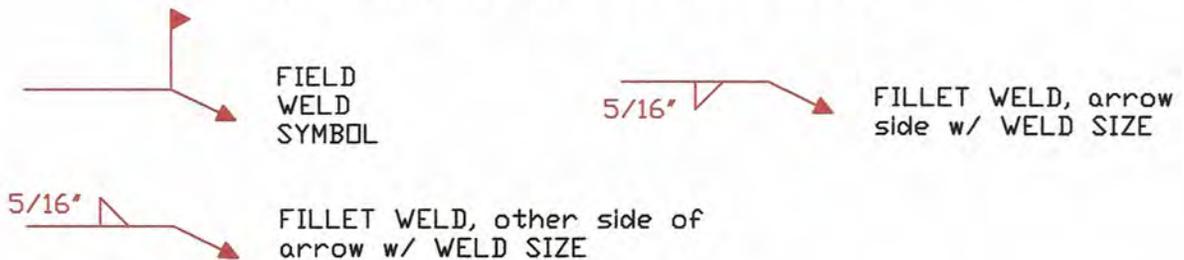
Signature: 

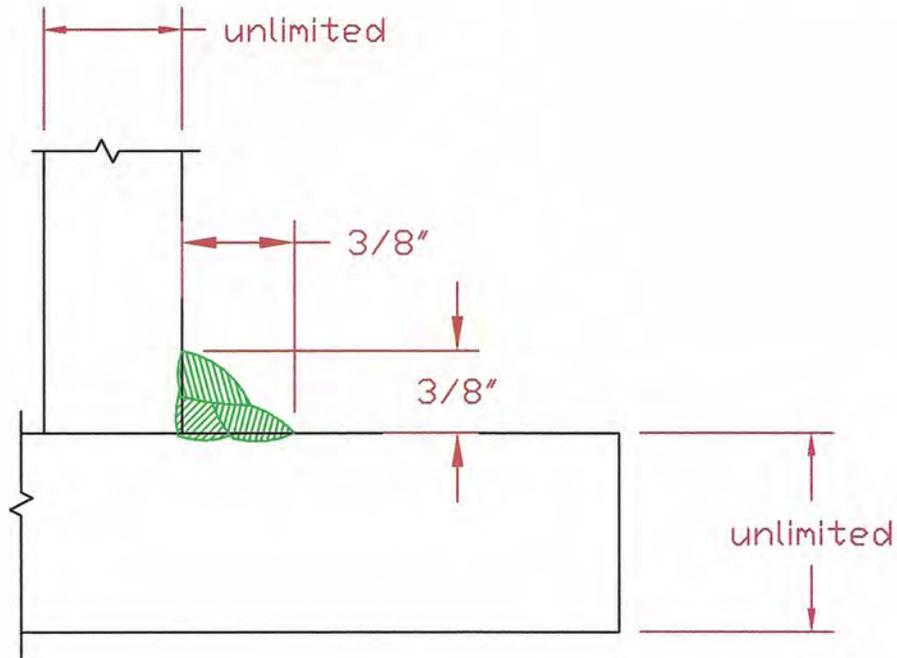


Typical weld size for 1/8" 7018 Electrode, Horizontal 3 passes

STANDARD FILLET WELD DETAILS

Weld Symbol definitions per AWS A2.4:2007

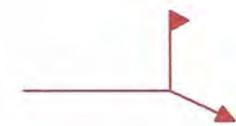




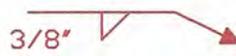
Typical weld size for $5/32"$ 7018 Electrode, Horizontal 3 passes

STANDARD FILLET WELD DETAILS

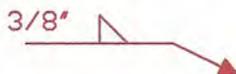
Weld Symbol definitions per AWS A2.4:2007



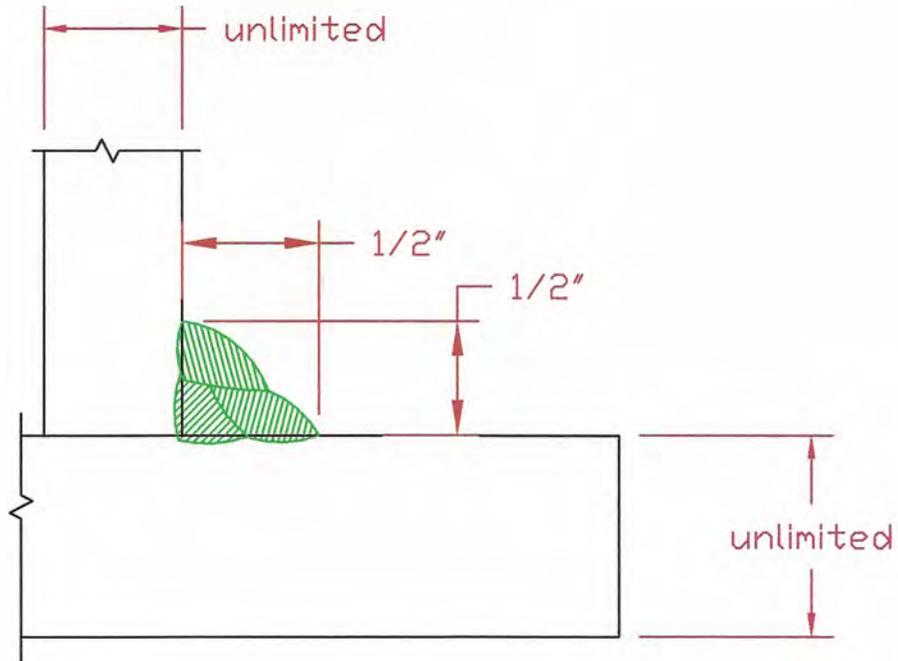
FIELD
WELD
SYMBOL



FILLET WELD, arrow
side w/ WELD SIZE



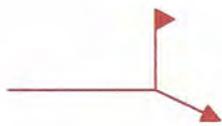
FILLET WELD, other side of
arrow w/ WELD SIZE



Typical weld size for 3/16" 7018 Electrode, Horizontal 3 passes

STANDARD FILLET WELD DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD
WELD
SYMBOL



FILLET WELD, arrow
side w/ WELD SIZE



FILLET WELD, other side of
arrow w/ WELD SIZE

Illustrations for fillet welds using various electrode sizes.



A 1/8" 7018 can potentially produce a 3/16" weld size with one pass and 5/16" with 3 passes.



A 5/32" 7018 can potentially produce a 1/4" weld size with one pass and 3/8" with 3 passes.



A 3/16" 7018 can potentially produce a 5/16" weld size with one pass and 1/2" with 3 passes.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

ARMOR ANGLE FIELD SPLICE

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

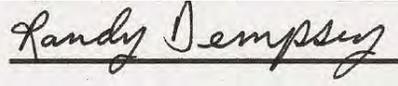
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Armor Angle Field Splice

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

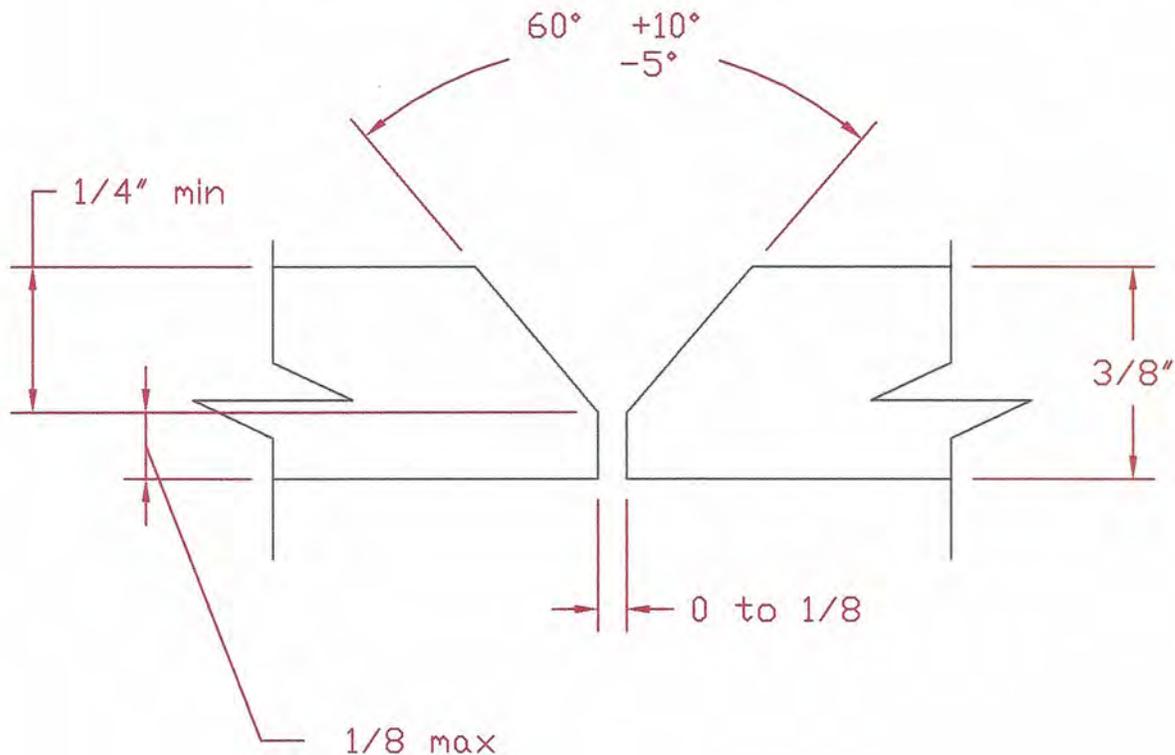
WPS #: 032811028

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

Signature: 

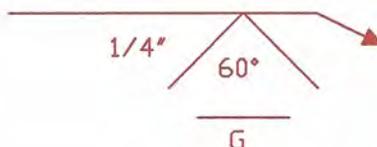
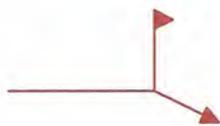
WPS ARMOR ANGLE Field Splice 032811028 R1
JOINT DETAIL ATTACHMENT



Bevel Horizontal Leg of Angle Only

ARMOR ANGLE Field Splice
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



Single V Groove,
w/ Depth of Groove,
Groove Angle and Grind
Flush Symbol

Illustrations Armor Angle Field Splice.



As received



Both pieces beveled and coating next to weld zone removed.



Each pass is cleaned.



The completed weld is grinded flush

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SINGLE U-GROOVE WITH BACK GOUGE

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All Flat, Horizontal	SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

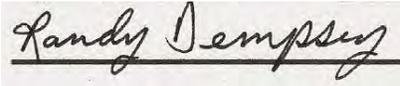
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. If the Air Arc process is used to develop the groove, ensure that all carbon deposits have been removed from the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Single U-Groove with Back Gouge

Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

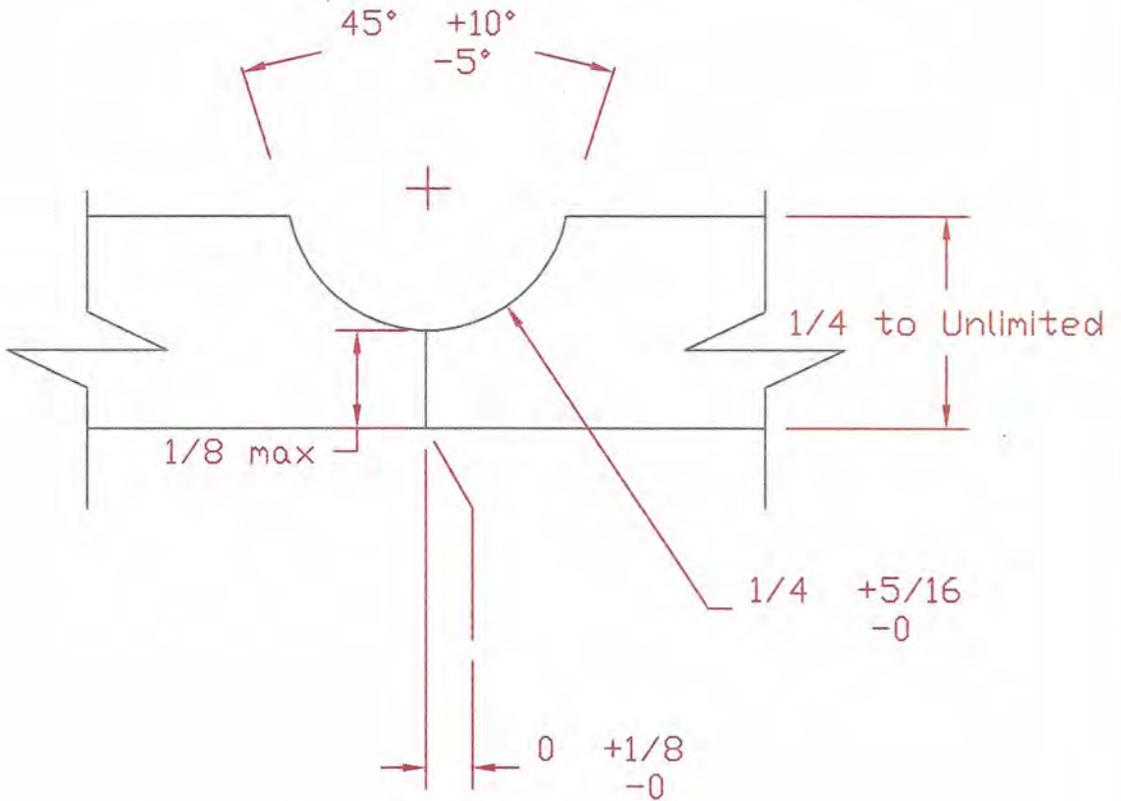
WPS #: 050511029

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

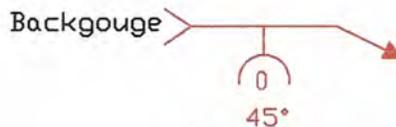
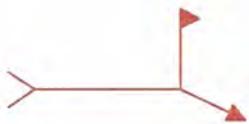
Signature: 

WPS SINGLE U GROOVE BACKGOUGE 050511029 R1
JOINT DETAIL ATTACHMENT 1



SINGLE U GROOVE BACKGOUGE
JOINT DETAIL

Weld Symbol definitions per AWS A2.4:2007



Single U Groove, w/Root Opening and Groove Angle

Illustrations for a Single U-groove with Back Gouge.



Fit-up of a groove joint developed with a grinder.



Completed Joint.

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)

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Appendix A WELDING TERMS AND DEFINITIONS

A

acceptable weld

A weld that meets the applicable requirements.

aligned porosity

A localized array of porosity oriented in a line.

arc blow

The deflection of an arc from its normal path due to magnetic forces.

arc strike

A discontinuity resulting from an arc, consisting of any localized re-melted metal, heat-affected metal, or change in the surface profile of any metal object.

B

backgouging

The removal of weld metal and base metal from the weld root side of a welded joint to facilitate complete fusion and complete joint penetration upon subsequent welding from that side.

backing

A material placed against the back side of the joint adjacent to the joint root to support and shield molten weld metal.

backing ring

Backing in the form of a ring, generally used in pipe welding (also referred to as a chill ring).

backing weld

Backing in the form of a weld (applied prior to the single groove weld which then requires backgouging to be performed from the groove side).

Not permitted unless used with an approved WPS.

back weld

A weld made at the back of a single groove weld.

base material

The material that is welded, brazed, soldered or cut (also referred to as ***base metal***).

bevel angle

The angle between the bevel of a joint member and a plane perpendicular to the surface of the member.

bevel face

The prepared surface of a bevel edge shape.

Appendix A WELDING TERMS AND DEFINITIONS

buildup

A surfacing variation in which surfacing material is deposited to achieve the required dimensions. See also buttering.

buttering

A surfacing variation that deposits surfacing metal [weld metal] on one or more surfaces to provide compatible material for the subsequent completion of the weld.

butt joint

A joint between two members aligned approximately in the same plane.

C

carbon arc cutting

An arc cutting process that uses a carbon electrode.

carbon electrode

A non-filler metal electrode used in arc welding and cutting, consisting of a carbon or graphic rod, which may be coated with copper or other materials.

caulking

Plastic deformation of weld and adjacent base metal surfaces by mechanical means to seal or obscure discontinuities.

chain intermittent weld

An intermittent weld on both sides of a joint in which the weld increments on one side are approximately opposite those on the other side.

chill ring

A nonstandard term when used for backing ring.

cluster porosity

A localized array of porosity having a random geometric distribution.

cold lap

A nonstandard term when used for incomplete fusion or overlap.

complete joint penetration (CJP)

A groove weld condition in which weld metal extends through the joint thickness.

continuous weld

A weld that extends continuously from one end of a joint to the other. Where the joint is essentially circular, it extends completely around the joint.

Appendix A WELDING TERMS AND DEFINITIONS

convexity

The maximum distance from the face of a convex fillet weld perpendicular to a line joining the weld toes.

crater

A depression in the weld face at the termination of a weld bead.

D

defect

A discontinuity or discontinuities that by nature or accumulated effect render a part or product unable to meet applicable acceptance standards or specifications. The term designates rejectability.

deposited metal

Filler metal that has been added during welding.

discontinuity

An interruption of the typical structure of a material, such as a lack of homogeneity in its mechanical, metallurgical, or physical characteristics. A discontinuity is not necessarily a defect.

E

effective throat

The minimum distance from the fillet weld face, minus any convexity, and the weld root.

electrode holder

A device used for mechanically holding and conducting current to an electrode during welding or cutting.

elongated porosity

A form of porosity having a length greater than its width that lies approximately parallel to the weld axis.

F

faying surface

the mating surface of a member that is in contact with or in close proximity to another member to which it is to be joined.

field weld

A weld made at a location other than a shop or the place of the initial construction.

Appendix A WELDING TERMS AND DEFINITIONS

filler material* or *filler metal

The material or metal to be added in making a weld.

fillet weld

A weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, T-joint, or corner joint.

fillet weld leg

The distance from the root to the toe of the fillet weld.

fillet weld size

For equal leg fillet welds, the leg lengths of the largest isosceles right triangle that can be inscribed within the fillet weld cross section. For unequal leg fillet welds, the leg lengths of the largest right triangle that can be inscribed within the fillet weld cross section.

flux

A material used to hinder or prevent the formation of oxides and other undesirable substances in molten metal and on solid metal surfaces.

fusion

The melting together of filler metal and base metal, or of base metal only, to produce a weld.

G

groove angle

The included angle between the groove faces of a weld groove.

groove face

Any surface in a weld groove prior to welding.

groove weld

A weld in a weld groove on a work piece surface, between work piece edges and surrounding surfaces.

H

heat affected zone

The portion of base metal whose mechanical properties or microstructure have been altered by the heat of the welding.

hermetically sealed container

A container that has been closed in a manner that provides a non-permeable barrier to the passage of air or gas in either direction.

Appendix A WELDING TERMS AND DEFINITIONS

I

inclusion

Entrapped foreign solid material, such as slag, flux, tungsten, or oxide.

incomplete fusion

A weld discontinuity in which fusion did not occur between weld metal and fusion faces or adjoining weld beads.

incomplete joint penetration

A joint root condition in a groove weld in which weld metal does not extend through the joint thickness.

interpass temperature

In a multi pass weld, the temperature of the weld area between weld passes.

J

joint design

The shape, dimensions, and configuration of the joint.

joint geometry

The shape, dimensions and configuration of a joint prior to welding.

joint penetration

The distance the weld metal extends from the weld face into a joint, exclusive of weld reinforcement.

K

kerf

The gap produced by a cutting process.

L

lamination

A type of discontinuity with separation or weakness generally aligned parallel to the worked surface of a metal.

longitudinal crack

A crack with its major axis orientation approximately parallel to the weld axis.

Appendix A WELDING TERMS AND DEFINITIONS

M

multi pass weld

A fusion weld produced by more than one progression of the arc along the joint.

O

overlap

The protrusion of weld metal beyond the weld toe.

P

peening

The mechanical working of metals using impact blows.

pipng porosity

A form of porosity having a length greater than its width that lies approximately perpendicular to the weld face.

porosity

Cavity type discontinuities formed by gas entrapment during solidification or in a thermal spray deposit.



preheat

The heat applied to the base metal or substrate to attain and maintain preheat temperature.

Appendix A WELDING TERMS AND DEFINITIONS

R

residual stress

Stress present in a joint member or material that is free of external forces or thermal gradients.

root face

That portion of the groove face within the joint root.

root opening

A separation at the joint root between the work pieces.

runoff weld tab

Additional material that extends beyond the end of the joint, on which the weld is started and terminated.

S

shielded metal arc welding (SMAW)

An arc welding process with an arc between a covered electrode and the weld pool.

slag inclusion

A discontinuity consisting of slag entrapped in weld metal or at the weld interface.

slugging

The unauthorized addition of metal, such as a length of rod, to a joint before welding or between passes, often resulting in a weld with incomplete fusion.

surface preparation

The operations necessary to produce a desired or specified surface condition.

T

theoretical throat

The distance from the beginning of the joint root perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the cross section of the fillet weld.

transverse crack

A crack with its major axis oriented approximately perpendicular to the weld axis.

Appendix A WELDING TERMS AND DEFINITIONS

U

undercut

A groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by the weld metal.

underfill

A groove weld condition in which the weld face or root surface is below the adjacent surface of the base metal.

W

weld

A localized coalescence of metals or nonmetals produced either by heating the materials to the welding temperature, with or without the application of pressure, or by the application of pressure alone and with or without the use of filler material.

weld face

The exposed surface of a weld on the side from which welding was done.

weld interface

The interface between weld metal and base metal in a fusion weld.

weld reinforcement

Weld metal in excess of the quantity required to fill a weld groove.

weld root

The points, shown in cross section, at which the weld metal intersects the base metal and extends furthest into the weld joint.

welding

A joining process that produces coalescence of materials by heating them to the welding temperature, with or without the application of pressure, or by the application of pressure alone and with or without the use of filler material.

weldment

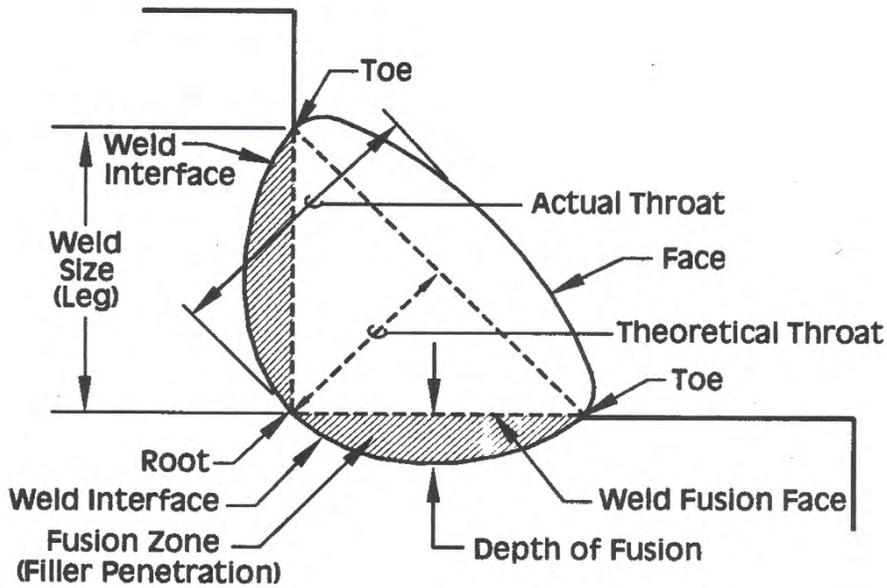
An assembly whose component parts are joined by welding.

weld toe

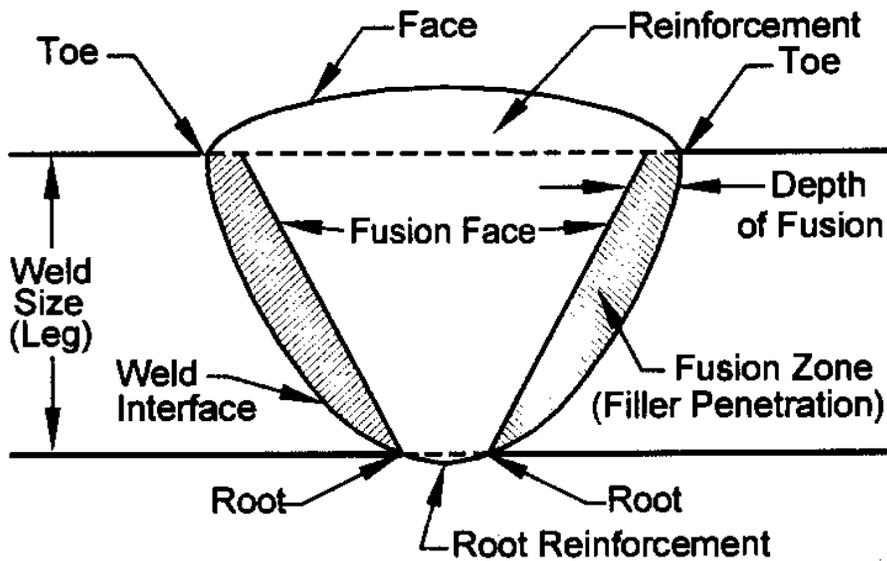
The junction of the weld face and the base metal.

Appendix A WELDING TERMS AND DEFINITIONS

Parts of a Fillet Weld



Parts of a Groove Weld



SSPC: The Society for Protective Coatings

SURFACE PREPARATION SPECIFICATION NO. 1

Solvent Cleaning

1. Scope

1.1 This specification covers the requirements for the solvent cleaning of steel surfaces.

2. Definition

2.1 Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants from steel surfaces.

2.2 It is intended that solvent cleaning be used prior to the application of paint and in conjunction with surface preparation methods specified for the removal of rust, mill scale, or paint.

3. Surface Preparation Before and After Solvent Cleaning

3.1 Prior to solvent cleaning, remove foreign matter (other than grease and oil) by one or a combination of the following: brush with stiff fiber or wire brushes, abrade, scrape, or clean with solutions of appropriate cleaners, provided such cleaners are followed by a fresh water rinse.

3.2 After solvent cleaning, remove dirt, dust, and other contaminants from the surface prior to paint application. Acceptable methods include brushing, blow off with clean, dry air, or vacuum cleaning.

4. Methods of Solvent Cleaning

4.1 Remove heavy oil or grease first by scraper. Then remove the remaining oil or grease by any of the following methods:

4.1.1 Wipe or scrub the surface with rags or brushes wetted with solvent. Use clean solvent and clean rags or brushes for the final wiping.

4.1.2 Spray the surface with solvent. Use clean solvent for the final spraying.

4.1.3 Vapor degrease using stabilized chlorinated hydrocarbon solvents.

4.1.4 Immerse completely in a tank or tanks of solvent. For the last immersion, use solvent which does not contain detrimental amounts of contaminant.

4.1.5 Emulsion or alkaline cleaners may be used in place of the methods described. After treatment, wash the surface with fresh water or steam to remove detrimental residues.

4.1.6 Steam clean, using detergents or cleaners and follow by steam or fresh water wash to remove detrimental residues.

5. Inspection

5.1 All work and materials supplied under this specification shall be subject to timely inspection by the purchaser or his authorized representative. The contractor shall correct such work or replace such material as is found defective under this specification. In case of dispute the arbitration or settlement procedure established in the procurement documents, if any, shall be followed. If no arbitration or settlement procedure is established, the procedure specified by the American Arbitration Association shall be used.

5.2 The procurement documents covering work or purchase should establish the responsibility for testing and for any required affidavit certifying full compliance with the specification.

6. Safety

6.1 All safety requirements stated in this specification and its component parts apply in addition to any applicable federal, state, and local rules and requirements. They also shall be in accord with instructions and requirements of insurance underwriters.

7. Notes*

7.1 While every precaution is taken to ensure that all information furnished in SSPC standards and specifications is as accurate, complete, and useful as possible, SSPC cannot assume responsibility nor incur any obligation resulting from the use of any materials, coatings, or methods specified herein, or of the standard itself.

7.2 A Commentary Section is available and contains additional information and data relative to this specification. The Surface Preparation Commentary, SSPC-SP COM, is not part of this specification. The table below lists the subjects discussed relevant to solvent cleaning and appropriate Commentary Section.

SSPC-SP 1
November 1, 1982
Editorial Changes September 1, 2000

Subject	SSPC-SP COM Section
Solvents and Cleaners	5.1.1 through 5.1.3
Steam Cleaning	5.1.4
Threshold Limit Values	5.1.5
Film Thickness	10

*Notes are not requirements of this specification.

SSPC: The Society for Protective Coatings

SURFACE PREPARATION SPECIFICATION NO. 2

Hand Tool Cleaning

1. Scope

1.1 This specification covers the requirements for the hand tool cleaning of steel surfaces.

2. Definitions

2.1 Hand tool cleaning is a method of preparing steel surfaces by the use of non-power hand tools.

2.2 Hand tool cleaning removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Mill scale, rust, and paint are considered adherent if they cannot be removed by lifting with a dull putty knife.

2.3 ISO 8501-1:1988 or other visual standards of surface preparation agreed upon by the contracting parties may be used to further define the surface.

3. Reference Standards

3.1 The standards referenced in this specification listed in Section 3.4 and form a part of the specification.

3.2 The latest issue, revision, or amendment of the reference standards in effect on the date of invitation to bid shall govern unless otherwise specified.

3.3 If there is a conflict between the requirements of any of the cited reference standards and the specification, the requirements of the specification shall prevail.

3.4 SSPC SPECIFICATIONS:

SSPC-SP 1 Solvent Cleaning

3.5 International Organization for Standardization (ISO):

850-1:1988 Preparation of steel substrates before application of paints and related products: visual assessment of surface cleanliness, Part I.

4. Surface Preparation Before and After Hand Tool Cleaning

4.1 Before hand tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP 1.

4.2 After hand tool cleaning and prior to painting, reclean the surface if it does not conform to this specification.

4.3 After hand tool cleaning and prior to painting, remove dirt, dust, or similar contaminants from the surface. Acceptable methods include brushing, blow off with clean, dry air, or vacuum cleaning.

5. Methods of Hand Tool Cleaning

5.1 Use impact hand tools to remove stratified rust (rust scale).

5.2 Use impact hand tools to remove all weld slag.

5.3 Use hand wire brushing, hand abrading, hand scraping, or other similar non-impact methods to remove all loose mill scale, all loose or non-adherent rust, and all loose paint.

5.4 Regardless of the method used for cleaning, if specified in the procurement documents, feather edges of remaining old paint so that the repainted surface can have a reasonably smooth appearance.

5.5 If approved by the owner, use power tools or blast cleaning as a substitute cleaning method for this specification.

6. Inspection

6.1 All work and materials supplied under this specification shall be subject to timely inspection by the purchaser or his authorized representative. The contractor shall correct such work or replace such material as is found defective under this specification. In case of dispute the arbitration or settlement procedure established in the procurement documents, if any, shall be followed. If no arbitration or settlement procedure is established, the procedure speci-

fied by the American Arbitration Association shall be used.

6.2 The procurement documents covering work or purchase should establish the responsibility for testing and for any required affidavit certifying full compliance with the specification.

7. Safety

7.1 All safety requirements stated in this specification and its component parts apply in addition to any applicable federal, state, and local rules and requirements. They also shall be in accord with instructions and requirements of insurance underwriters.

8. Notes*

8.1 While every precaution is taken to insure that all information furnished in SSPC specifications is as accurate, complete, and useful as possible, SSPC cannot assume responsibility or incur any obligation resulting from the use of any materials, paints, or methods specified therein, or of the specification itself.

8.2 A Commentary Section is available and contains additional information and data relevant to this specifica-

tion. The Surface Preparation Commentary, SSPC-SP COM, is not part of this specification. The table below lists the subjects discussed relevant to hand tool cleaning and appropriate Commentary Section.

	SSPC-SP COM Section
Film Thickness	10
Maintenance Painting	4.2
Rust Back	4.5
Visual Standards	11
Weld Spatter	4.4.1

8.3 Note that the use of visual standards in conjunction with this specification is required only when they are specified in the procurement documents (project specification) covering the work. It is recommended, however, that the use of visual standards be made mandatory in the procurement documents.

SSPC-VIS 3, "Visual Standard for Power- and Hand-Tool Cleaned Steel," provides color photographs for the various grades of surface preparation as a function of the initial condition of the steel. For more information about visual standards see SSPC-SP COM, Section 11.

*Notes are not requirements of this specification.

SSPC: The Society for Protective Coatings

SURFACE PREPARATION SPECIFICATION NO. 3

Power Tool Cleaning

1. Scope

1.1 This specification covers the requirements for power tool cleaning of steel surfaces.

2. Definition

2.1 Power tool cleaning is a method of preparing steel surfaces by the use of power assisted hand tools.

2.2 Power tool cleaning removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Mill scale, rust, and paint are considered adherent if they cannot be removed by lifting with a dull putty knife.

2.3 SSPC-VIS 3, ISO 8501-1:1988 or other visual standards of surface preparation agreed upon by the contracting parties may be used to further define the surface.

3. Reference Standards

3.1 The standards referenced in this specification are listed in Section 3.4 and form a part of the specification.

3.2 The latest issue, revision or amendment of the reference standards in effect on the date of invitation to bid shall govern unless otherwise specified.

3.3 If there is a conflict between the requirements of any of the cited reference standards and the specification, the requirements of the specification shall prevail.

3.4 SSPC SPECIFICATIONS:

SP 1	Solvent Cleaning
VIS 3	Visual Standard for Power- and Hand Tool Cleaned Steel

3.5 International Organization for Standardization (ISO):

8501-1:1988	Preparation of Steel Substrates Before Application of Paints and Related Products: Visual Assessment of Surface Cleanliness, Part I
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4. Surface Preparation Before and After Power Tool Cleaning

4.1 Before power tool cleaning, remove visible oil, grease, soluble welding residue, and salts by the methods outlined in SSPC-SP 1.

4.2 After power tool cleaning and prior to painting, reclean the surface if it does not conform to this specification.

4.3 After power tool cleaning and prior to painting, remove dirt, dust, or similar contaminants from the surface. Acceptable methods include brushing, blow off with clean, dry air, or vacuum cleaning.

5. Methods of Power Tool Cleaning

5.1 Use rotary or impact power tools to remove stratified rust (rust scale).

5.2 Use rotary or impact power tools to remove all weld slag.

5.3 Use power wire brushing, power abrading, power impact or other power rotary tools to remove all loose mill scale, all loose or non-adherent rust, and all loose paint. Do not burnish the surface.

5.4 Operate power tools in a manner that prevents the formation of burrs, sharp ridges, and sharp cuts.

5.5 Regardless of the method used for cleaning, if specified in the procurement documents, feather edges of remaining old paint so that the repainted surface can have a reasonably smooth appearance.

5.6 if approved by the owner, use blast cleaning as substitute cleaning method for this specification.

6. Inspection

6.1 All work and materials supplied under this specification shall be subject to timely inspection by the purchaser or his authorized representative. The contractor shall correct such work or replace such material as is found defective under this specification. In case of dispute the arbitration or settlement procedure established in the procure-

ment documents, if any, shall be followed. If no arbitration or settlement procedure is established, the procedure specified by the American Arbitration Association shall be used.

6.2 The procurement documents covering work or purchase should establish the responsibility for testing and for any required affidavit certifying full compliance with the specification.

7. Safety

7.1 All safety requirements stated in this specification and its component parts apply in addition to any applicable federal, state, and local rules and requirements. They also shall be in accord with instructions and requirements of insurance underwriters.

8. Notes*

8.1 While every precaution is taken to insure that all information furnished in SSPC specifications is as accurate, complete, and useful as possible, SSPC cannot assume responsibility or incur any obligation resulting from the use of any materials, paints, or methods specified therein, or of the specification itself.

8.2 A Commentary Section is available and contains additional information and data relevant to this specification.

The Surface Preparation Commentary, SSPC-SP COM, is not part of this specification. The table below lists the subjects discussed relevant to power tool cleaning and appropriate Commentary Section.

SSPC-SP COM	Section
Film Thickness	10
Rust Back	4.5
Visual Standards	11
Weld Spatter	4.4.1

8.3 Note that the use of visual standards in conjunction with this specification is required only when they are specified in the procurement documents (project specification) covering the work. It is recommended, however, that the use of visual standards be made mandatory in the procurement documents.

SSPC-VIS 3, "Visual Standard for Power- and Hand-Tool Cleaned Steel," provides color photographs for the various grades of surface preparation as a function of the initial condition of the steel. For more information about visual standards, see SSPC-SP COM, Section 11.

*Notes are not requirements of this specification.

Joint Surface Preparation Standard

SSPC-SP 6/NACE NO. 3

Commercial Blast Cleaning

This SSPC: The Society for Protective Coatings and NACE International standard represents a consensus of those individual members who have reviewed this document, its scope and provisions. Its acceptance does not in any respect preclude anyone, having adopted the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this standard. Nothing contained in this standard is to be construed as granting any right, by implication or otherwise, to manufacture, sell, or use in connection with any method, apparatus, or product covered by Letters Patent, or as indemnifying or protecting anyone against liability for infringement of Letters Patent. This standard represents minimum requirements and should in no way be interpreted as a restriction on the use of better procedures or materials. Neither is this standard intended to apply in all cases relating to the subject. Unpredictable circumstances may negate the usefulness of this standard in specific instances. SSPC and NACE assume no responsibility for the interpretation or use of this standard by other parties and accept responsibility for only those official interpretations issued by SSPC or NACE in accordance with their respective governing procedures and policies, which preclude the issuance of interpretations by individual volunteers.

Users of this standard are responsible for reviewing appropriate health, safety, and regulatory documents and for determining their applicability in relation to this standard prior to its use. This SSPC/NACE standard may not necessarily address all potential health and safety problems or environmental hazards associated with the use of materials, equipment and/or operations detailed or referred to within this standard. Users of this standard are also responsible for establishing appropriate health, safety, and environmental protection practices, in consultation with appropriate regulatory authorities, if necessary, to achieve compliance with any existing applicable regulatory requirements prior to the use of this standard.

CAUTIONARY NOTICE: SSPC/NACE standards are subject to periodic review and may be revised or withdrawn at any time without prior notice. SSPC and NACE require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of initial publication. The user is cautioned to obtain the latest edition. Purchasers may receive current information on all standards and other publications by contacting the organizations at the addresses below:

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Foreword

This joint standard covers the use of blast cleaning abrasives to achieve a defined degree of cleaning of steel surfaces prior to the application of a protective coating or lining system. This standard is intended for use by coating or lining specifiers, applicators, inspectors, or others whose responsibility it may be to define a standard degree of surface cleanliness.

The focus of this standard is commercial blast cleaning. White metal blast cleaning, near-white blast cleaning, industrial blast cleaning, and brush-off blast cleaning are addressed in separate standards.

Commercial blast cleaning provides a greater degree of cleaning than industrial blast cleaning (SSPC-SP 14/NACE No. 8), but less than near-white blast cleaning (SSPC-SP 10/NACE No. 2).

Commercial blast cleaning is used when the objective is to remove all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter, leaving staining or shadows on no more than 33 percent of each unit area of surface as described in Section 2.2.

The difference between a commercial blast and a near-white blast is in the amount of staining permitted to remain on the surface. Commercial blast allows stains or shadows on 33 percent of each unit area of surface. Near-white blast allows staining or shadows on only 5 percent of each unit area.

The difference between a commercial blast and an industrial blast is that a commercial blast removes all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter from all surfaces and allows stains to remain on 33 percent of each unit area of surface, while industrial blast allows defined mill scale, coating, and rust to remain on less than 10 percent of the surface and allows defined stains to remain on all surfaces.

This joint standard was prepared by the SSPC/NACE Task Group A on Surface Preparation by Abrasive Blast Cleaning. This joint Task Group includes members of both the SSPC Surface Preparation Committee and the NACE Unit Committee T-6G on Surface Preparation.

1. General

1.1 This joint standard covers the requirements for commercial blast cleaning of unpainted or painted steel surfaces by the use of abrasives. These requirements include the end condition of the surface and materials and procedures necessary to achieve and verify the end condition.

1.2 The mandatory requirements are described in Sections 1 to 9 as follows:

Section 1	General
Section 2	Definition
Section 3	References
Section 4	Procedures Before Blast Cleaning
Section 5	Blast Cleaning Methods and Operation
Section 6	Blast Cleaning Abrasives
Section 7	Procedures Following Blast Cleaning and Immediately Prior to Coating
Section 8	Inspection
Section 9	Safety and Environmental Requirements

NOTE: Section 10, "Comments" and Appendix A, "Explanatory Notes" are not mandatory requirements of this standard.

2. Definition

2.1 A commercial blast cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products, and other foreign matter, except for staining as noted in Section 2.2.

2.2 Random staining shall be limited to no more than 33 percent of each unit area of surface as defined in Section 2.6, and may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coating.

2.3 Acceptable variations in appearance that do not affect surface cleanliness as defined in Section 2.1 include variations caused by type of steel, original surface condition, thickness of the steel, weld metal, mill or fabrication marks, heat treating, heat affected zones, blasting abrasives, and differences due to blasting technique.

2.4 When a coating is specified, the surface shall be roughened to a degree suitable for the specified coating system.

2.5 Immediately prior to coating application, the entire surface shall comply with the degree of cleaning specified herein.

2.6 Unit area for determinations shall be approximately 5776 mm² (9 in²) (i.e., a square 76 x 76 mm [3 in x 3 in]).

2.7 SSPC-VIS 1-89 may be specified to supplement the written definition. In any dispute, the written standards shall take precedence over visual standards and comparators. Additional information on visual standards and comparators is available in Section A.4 of Appendix A.

3. References

3.1 The documents referenced in this standard are listed in Section 3.4.

3.2 The latest issue, revision, or amendment of the referenced standards in effect on the date of invitation to bid shall govern unless otherwise specified.

3.3 If there is a conflict between the requirements of any of the cited reference standards and this standard, the requirements of this standard shall prevail.

3.4 SSPC: THE SOCIETY FOR PROTECTIVE COATINGS STANDARDS:

AB 1	Mineral and Slag Abrasives
AB 2	Cleanliness of Recycled Ferrous Metallic Abrasives
AB 3	Newly Manufactured or Re-Manufactured Steel Abrasives
PA Guide 3	A Guide to Safety in Paint Application
SP 1	Solvent Cleaning
VIS 1-89	Visual Standard for Abrasive Blast Cleaned Steel

4. Procedures Before Blast Cleaning

4.1 Before blast cleaning, visible deposits of oil, grease, or other contaminants shall be removed in accordance with SSPC-SP 1 or other agreed upon methods.

4.2 Before blast cleaning, surface imperfections such as sharp fins, sharp edges, weld spatter, or burning slag should be removed from the surface to the extent required by the procurement documents (project specification). Additional information on surface imperfections is available in Section A.5 of Appendix A.

4.3 If a visual standard or comparator is specified to supplement the written standard, the condition of the steel prior to blast cleaning should be determined before the blasting commences. Additional information on visual standards and comparators is available in Section A.4 of Appendix A.

5. Blast Cleaning Methods and Operation

5.1 Clean, dry compressed air shall be used for nozzle blasting. Moisture separators, oil separators, traps, or other equipment may be necessary to achieve this requirement.

5.2 Any of the following methods of surface preparation may be used to achieve a commercial blast cleaned surface:

5.2.1 Dry abrasive blasting using compressed air, blast nozzles, and abrasive.

5.2.2 Dry abrasive blasting using a closed-cycle, recirculating abrasive system with compressed air, blast nozzle, and abrasive, with or without vacuum for dust and abrasive recovery.

5.2.3 Dry abrasive blasting using a closed cycle, recirculating abrasive system with centrifugal wheels and abrasive.

5.3 Other methods of surface preparation (such as wet abrasive blasting) may be used to achieve a commercial blast cleaned surface by mutual agreement between those responsible for performing the work and those responsible for establishing the requirements. NOTE: Information on the use of inhibitors to prevent the formation of rust immediately after wet blast cleaning is contained in Section A.9 of Appendix A.

6. Blast Cleaning Abrasives

6.1 The selection of abrasive size and type shall be based on the type, grade, and surface condition of the steel to be cleaned, type of blast cleaning system employed, the finished surface to be produced (cleanliness and roughness), and whether the abrasive will be recycled.

6.2 The cleanliness and size of recycled abrasives shall be maintained to ensure compliance with this specification.

6.3 The blast cleaning abrasive shall be dry and free of oil, grease, and other contaminants as determined by the test methods found in SSPC-AB 1, AB 2 and AB 3.

6.4 Any limitations on the use of specific abrasives, the quantity of contaminants, or the degree of allowable embedment shall be included in the procurement documents (project specification) covering the work, because abrasive embedment and abrasives containing contaminants may not be acceptable for some service requirements. NOTE: Additional information on abrasive selection is given in Section A.2 of Appendix A.

7. Procedures Following Blast Cleaning and Immediately Prior to Coating

7.1 Visible deposits of oil, grease, or other contaminants shall be removed according to SSPC-SP 1 or another method agreed upon by those parties responsible for establishing the requirements and those responsible for performing the work.

7.2 Dust and loose residues shall be removed from prepared surfaces by brushing, blowing off with clean, dry air, vacuum cleaning, or other methods agreed upon by those responsible for establishing the requirements and those responsible for performing the work. NOTE: The presence of toxic metals in the abrasives or paint being removed may place restrictions on the methods of cleaning permitted. Comply with all applicable regulations. Moisture separators, oil separators, traps, or other equipment may be necessary to achieve clean, dry air.

7.3 After blast cleaning, surface imperfections that remain (e.g., sharp fins, sharp edges, weld spatter, burning slag, scabs, slivers, etc.) shall be removed to the extent required in the procurement documents (project specification). Any damage to the surface profile resulting from the removal of surface imperfections shall be corrected to meet the requirements of Section 2.4. NOTE: Additional information on surface imperfections is contained in Section A.5 of Appendix A.

7.4 Any visible rust that forms on the surface of the steel after blast cleaning shall be removed by recleaning the rusted areas to meet the requirements of this standard before coating. NOTE: Information on rust-back (re-rusting) and surface condensation is contained in Sections A.6, A.7 and A.8 of Appendix A.

8. Inspection

8.1 Work and materials supplied under this standard are subject to inspection by a representative of those responsible for establishing the requirements. Materials and work areas shall be accessible to the inspector. The procedures and times of inspection shall be as agreed upon by those responsible for establishing the requirements and those responsible for performing the work.

8.2 Conditions not complying with this standard shall be corrected. In the case of a dispute, an arbitration or settlement procedure established in the procurement documents (project specification) shall be followed. If no arbitration or settlement procedure is established, then a procedure mutually agreeable to purchaser and supplier shall be used.

8.3 The procurement documents (project specification) should establish the responsibility for inspection and for any required affidavit certifying compliance with the specification.

9. Safety and Environmental Requirements

9.1 Because abrasive blast cleaning is a hazardous operation, all work shall be conducted in compliance with applicable occupational and environmental health and safety rules and regulations. NOTE: SSPC-PA Guide 3, "A Guide to Safety in Paint Application," addresses safety concerns for coating work.

10. Comments

10.1 Additional information and data relative to this standard are contained in Appendix A. Detailed information and data are presented in a separate document, SSPC-SP COM, "Surface Preparation Commentary." The recommendations contained in Appendix A and SSPC-SP COM are believed to represent good practice, but are not to be considered requirements of the standard. The sections of SSPC-SP COM that discuss subjects related to industrial blast cleaning are listed below.

<u>Subject</u>	<u>Commentary Section</u>
Abrasive Selection	6
Film Thickness	10
Wet Abrasive Blast Cleaning	8.2
Maintenance Repainting	4.2
Rust-back (Re-rusting)	8.3
Surface Profile	6.2
Visual Standards	11
Weld Spatter	4.4.1

Appendix A. Explanatory Notes

A.1 FUNCTION: Commercial blast cleaning (SSPC-SP 6/NACE No. 3) provides a greater degree of cleaning than brush-off blast cleaning (SSPC-SP 7/NACE No. 4), but less than near-white blast cleaning (SSPC-SP 10/NACE No. 2). It should be specified only when a compatible coating will be applied. The primary functions of blast cleaning before coating are: (a) to remove material from the surface that can cause early failure of the coating system and (b) to obtain a suitable surface roughness and to enhance the adhesion of the new coating system. The hierarchy of blasting standards is as follows: white metal blast cleaning, near-white blast cleaning, commercial blast cleaning, industrial blast cleaning, and brush-off blast cleaning.

A.2 ABRASIVE SELECTION: Types of metallic and non-metallic abrasives are discussed in the Surface Preparation Commentary (SSPC-SP COM). It is important to

recognize that blasting abrasives may become embedded in or leave residues on the surface of the steel during preparation. While normally such embedment or residues are not detrimental, care should be taken to ensure that the abrasive is free from detrimental amounts of water-soluble, solvent-soluble, acid-soluble, or other soluble contaminants (particularly if the prepared steel is to be used in an immersion environment). Criteria for selecting and evaluating abrasives are given in SSPC-AB 1, "Mineral and Slag Abrasives," SSPC-AB 2, "Cleanliness of Recycled Ferrous Metallic Abrasives," and SSPC-AB 3, "Newly Manufactured or Re-Manufactured Steel Abrasives."

A.3 SURFACE PROFILE: Surface profile is the roughness of the surface which results from abrasive blast cleaning. The profile depth (or height) is dependent upon the size, shape, type, and hardness of the abrasive, particle velocity and angle of impact, hardness of the surface, amount of recycling, and the proper maintenance of working mixtures of grit and/or shot.

The allowable minimum/maximum height of profile is usually dependent upon the thickness of the coating to be applied. Large particle sized abrasives (particularly metallic) can produce a profile that may be too deep to be adequately covered by a single thin film coat. Accordingly, it is recommended that the use of larger abrasives be avoided in these cases. However, larger abrasives may be needed for thick film coatings or to facilitate removal of thick coatings, heavy mill scale, or rust. If control of profile (minimum/maximum) is deemed to be significant to coating performance, it should be addressed in the procurement documents (project specification). Typical profile heights achieved with commercial abrasive media are shown in Table 5 of the Surface Preparation Commentary (SSPC-SP COM). Surface profile should be measured in accordance with NACE Standard RP0287 (latest edition), "Field Measurement of Surface Profile of Abrasive Blast Cleaned Steel Surfaces Using Replica Tape," or ASTM⁽¹⁾ D 4417 (latest edition), "Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel."

A.4 VISUAL STANDARDS: SSPC-VIS 1-89 (Visual Standard for Abrasive Blast Cleaned Steel) provides color photographs for the various grades of surface preparation as a function of the initial condition of the steel. The A-SP 6, B-SP 6, C-SP 6 and D-SP 6 series of photographs depict surfaces cleaned to a commercial blast. Other available visual standards are described in Section 11 of SSPC-SP COM.

A.5 SURFACE IMPERFECTIONS: Surface imperfections can cause premature failure when the service is severe. Coatings tend to pull away from sharp edges and projections, leaving little or no coating to protect the underlying steel. Other features that are difficult to properly cover and protect include crevices, weld porosities, laminations,

⁽¹⁾ ASTM, 100 Barr Harbor Drive, West Conshohocken PA 19428-2959.

etc. The high cost of the methods to remedy surface imperfections requires weighing the benefits of edge rounding, weld spatter removal, etc., versus a potential coating failure.

Poorly adhering contaminants, such as weld slag residues, loose weld spatter, and some minor surface laminations may be removed during the blast cleaning operation. Other surface defects (steel laminations, weld porosities, or deep corrosion pits) may not be evident until the surface preparation has been completed. Therefore, proper planning for such surface repair work is essential because the timing of the repairs may occur before, during, or after the blast cleaning operation. Section 4.4 of SSPC-SP COM and NACE Standard RP0178 (latest edition), "Fabrication Details, Surface Finish Requirements, and Proper Design Considerations for Tanks and Vessels to be Lined for Immersion Service" contain additional information on surface imperfections.

A.6 CHEMICAL CONTAMINATION: Steel contaminated with soluble salts (e.g., chlorides and sulfates) develops rust-back rapidly at intermediate and high humidities. These soluble salts can be present on the steel surface prior to blast cleaning as a result of atmospheric contamination. In addition, contaminants can be deposited on the steel surface during blast cleaning if the abrasive is contaminated. Therefore, rust-back can be minimized by removing these salts from the steel surface and eliminating sources of recontamination during and after blast cleaning. Wet methods of removal are described in SSPC-SP 12/NACE No. 5. Identification of the contaminants along with their concentrations may be obtained from laboratory and field tests as described in SSPC-TU 4, "Technology Update on Field Methods for Retrieval and Analysis of Soluble Salts on Substrates."

A.7 RUST-BACK: Rust-back (re-rusting) occurs when freshly cleaned steel is exposed to moisture, contamination, or a corrosive atmosphere. The time interval between blast cleaning and rust-back will vary greatly from one environment to another. Under mild ambient conditions, if chemical contamination is not present (see Section A.6), it is best to blast clean and coat a surface the same day. Severe conditions may require more expedient coating application to avoid contamination from fallout. Chemical contamination should be removed prior to coating (see Section A.6).

A.8 DEW POINT: Moisture condenses on any surface that is colder than the dew point of the surrounding air. It is, therefore, recommended that the temperature of the steel surface be at least 3 °C (5 °F) above the dew point during dry blast cleaning operations. It is advisable to visually inspect for moisture and periodically check the surface temperature and dew point during blast cleaning operations and to avoid the application of coating over a damp surface.

A.9 WET ABRASIVE BLAST CLEANING: Steel that is wet abrasive blast cleaned may rust rapidly. Clean water should be used for rinsing. It may be necessary that inhibitors be added to the water or applied to the surface immediately after blast cleaning to temporarily prevent rust formation. The use of inhibitors or the application of coating over slight discoloration should be in accordance with the requirements of the coating manufacturer. CAUTION: Some inhibitive treatments may interfere with the performance of certain coating systems.

A.10 FILM THICKNESS: It is essential that ample coating be applied after blast cleaning to adequately cover the peaks of the surface profile. The dry film thickness of the coating above the peaks of the profile should equal the thickness known to be needed for the desired protection. If the dry film thickness over the peaks is inadequate, premature rust-through or failure will occur. To assure that coating thicknesses are properly measured the procedures in SSPC-PA 2 (latest edition), "Measurement of Dry Coating Thickness with Magnetic Gauges" should be used.

A.11 MAINTENANCE AND REPAIR PAINTING: When this standard is used in maintenance painting, specific instructions should be given on the extent of surface to be blast cleaned or spot blast cleaned to this degree of cleanliness. In these cases, the cleaning shall be performed across the entire area specified. For example, if all weld seams are to be cleaned in a maintenance operation, this degree of cleaning shall be applied 100% to all weld seams. If the entire structure is to be prepared, this degree of cleaning shall be applied to 100% of the entire structure. SSPC-PA Guide 4 (latest edition), "Guide to Maintenance Repainting with Oil Base or Alkyd Painting Systems," provides a description of accepted practices for retaining old sound coating, removing unsound coating, feathering, and spot cleaning.

Standard Symbols for Welding, Brazing, and Nondestructive Examination

1. Scope

This standard presents a system for indicating welding, brazing, and nondestructive examination requirements. The system includes provisions for the graphical representation of welds, brazes, and nondestructive examination methods with conventions for specifying, at a minimum, the location and extent of their application. Optional elements and supplementary symbols provide a means for specifying additional requirements.

The figures included with the text are intended to show how the correct format and applications of symbols may be used to convey welding, brazing, and nondestructive examination information. They are not intended to represent recommended welding, brazing, nondestructive examination, or design practice.

The section addressing brazing uses the same symbols that are used for welding. The section on nondestructive examination symbols establishes the symbols to be used on drawings to specify nondestructive examination for determining the suitability of components. The nondestructive examination symbols included in this standard represent nondestructive examination methods as discussed in the latest edition of the AWS publication AWS B1.10, *Guide for the Nondestructive Examination of Welds*. Definitions and the details for the use of the various nondestructive examination methods are found in AWS B1.10.

For illustrative purposes, this standard makes use of both U.S. Customary and the International System of Units (SI). Examples featuring each system appear throughout the document.

Safety and health issues and concerns are beyond the scope of this standard, and therefore are not fully addressed herein. Safety and health information is available from other sources, including, but not limited to, ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, and applicable federal and state regulations.

The limitations included in specifications and codes are also beyond the scope of this standard.

2. Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this AWS standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this AWS standard are encouraged to investigate the possibility of applying the most recent editions of the documents shown below. For undated references, the latest edition of the standard referred to applies.

The following American Welding Society¹ standards are used in the mandatory sections of this document:

- (1) AWS A3.0:2001, *Standard Welding Terms and Definitions*;
- (2) AWS A5.30/A5.30M, *Specification for Consumable Inserts*; and
- (3) AWS B1.10, *Guide for the Nondestructive Examination of Welds*.

3. Basic Welding Symbols

3.1 Distinction between Weld Symbol and Welding Symbol. This standard makes a distinction between the terms *weld symbol* and *welding symbol*. The weld symbol indicates the type of weld and, when used, is a part of the welding symbol.

3.2 Basis of Reference. In the present system, the joint is the basis of reference. The *arrow side* is the side of the joint to which the arrow of the symbol points. The *other side* is the side of the joint opposite the arrow side.

3.3 Weld Symbols. Weld symbols shall be as shown in Figure 1. The symbols shall be drawn in contact with the reference line.

¹ AWS standards are published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

3.4 Supplementary Welding Symbols. Supplementary symbols to be used in connection with welding symbols shall be as shown in Figure 2.

3.5 Welding Symbols. A welding symbol may consist of several elements (see Figure 3). Only the reference line and the arrow are required elements. Additional elements may be included to convey specific welding information. Alternatively, welding information may be conveyed by other means such as by drawing notes or details, specifications, standards, codes, or other drawings, which eliminates the need to include the corresponding elements in the welding symbol.

The tail of the symbol is used for designating the welding, brazing, and cutting process as well as the welding or brazing specifications, procedures, or the supplementary information to be used in making the weld or braze. The process; identification of the filler metal that is to be used; whether peening, backgouging, or other operations

are required; and other pertinent data should be known. The notation to be placed in the tail of the symbol indicating these data is usually established by the user.

All elements, when used, shall have specific locations within the welding symbol as shown in Figure 3. Mandatory requirements regarding each element in a welding symbol refer to the location of the element and should not be interpreted as a necessity to include the element in every welding symbol.

3.6 Placement of the Welding Symbol. The arrow of the welding symbol shall point to a line, location, or area that conclusively identifies the joint, location, or area to be welded.

3.7 Illustrations. The examples given, including the dimensions, are illustrative only and are intended to demonstrate the proper application of drafting practices. They are not intended to represent design practices or to replace code or specification requirements.

GROOVE							
SQUARE	SCARF	V	BEVEL	U	J	FLARE-V	FLARE-BEVEL

FILLET	PLUG	SLOT	STUD	SPOT OR PROJECTION	SEAM	BACK OR BACKING	SURFACING	EDGE

NOTE: The reference line is shown as a dashed line for illustrative purposes.

Figure 1—Weld Symbols

WELD ALL AROUND	FIELD WELD	MELT-THROUGH	CONSUMABLE INSERT (SQUARE)	BACKING (RECTANGLE)	SPACER (RECTANGLE)	CONTOUR		
						FLUSH OR FLAT	CONVEX	CONCAVE

Figure 2—Supplementary Symbols

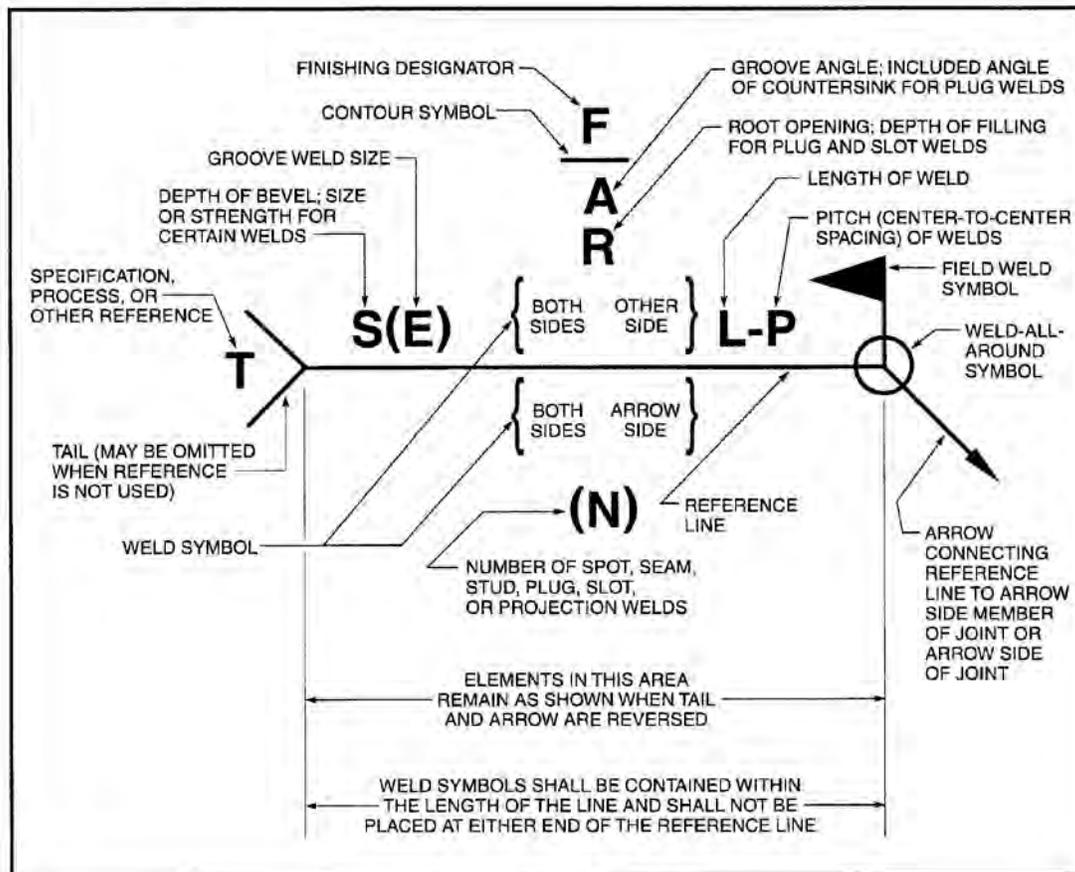


Figure 3—Standard Location of the Elements of a Welding Symbol

4. Joint Types

The basic welding joint types—butt, corner, T-, lap, and edge—are shown in Figure 4. Joint type designators are shown in Annex A, Table A.1.

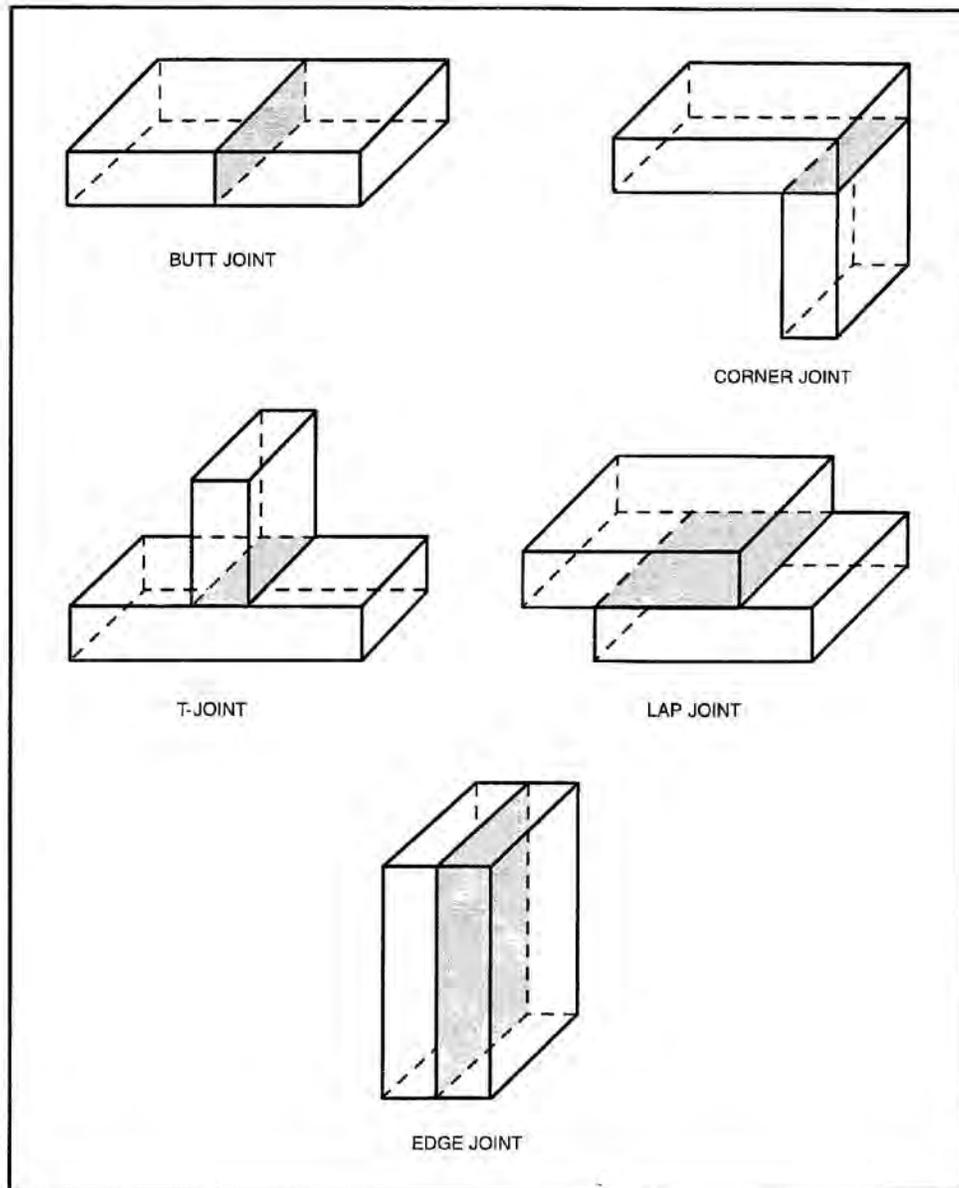
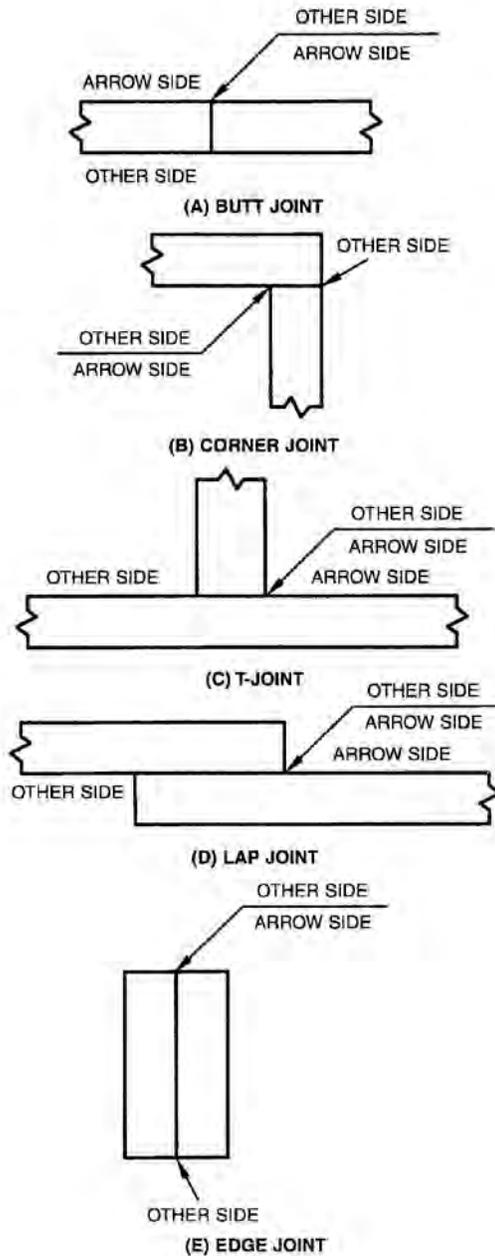


Figure 4—Joint Types

5. General Provisions for Welding Symbols

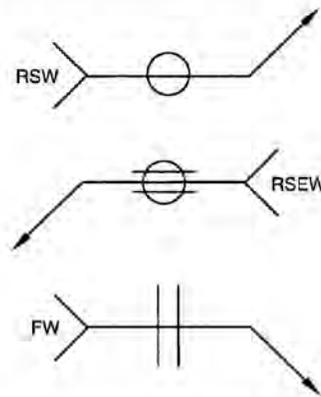
5.1 Location Significance of the Arrow. Information applicable to the arrow side of a joint shall be placed below the reference line. Information applicable to the other side of a joint shall be placed above the reference line.



5.1.1 Fillet, Groove, and Edge Weld Symbols. For these symbols, the arrow shall contact the outer surface of one of the joints, and this side shall be considered the arrow side of the joint. The side opposite the arrow side of the joint shall be considered the other side of the joint (see Figure 5).

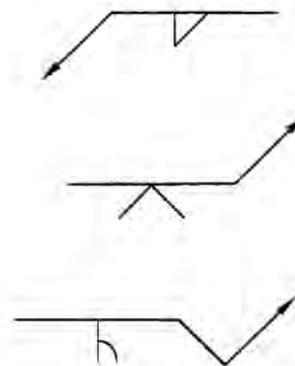
5.1.2 Plug, Slot, Spot, Projection, and Seam Weld Symbols. For these symbols, the arrow shall contact the outer surface of one of the joint members at the center-line of the desired weld. The member toward which the arrow points shall be considered the arrow-side member. The other joint member shall be considered the other-side member (see the figures cited in Clauses 8 through 11).

5.1.3 Symbols with No Side Significance. Some weld symbols have no arrow-side or other-side significance, although supplementary symbols used in conjunction with them may have such significance (see 10.1.2 and 10.1.4).



5.2 Location of the Weld with Respect to the Joint

5.2.1 Arrow Side. Welds on the arrow side of the joint shall be specified by placing the weld symbol below the reference line (see 5.1.1).



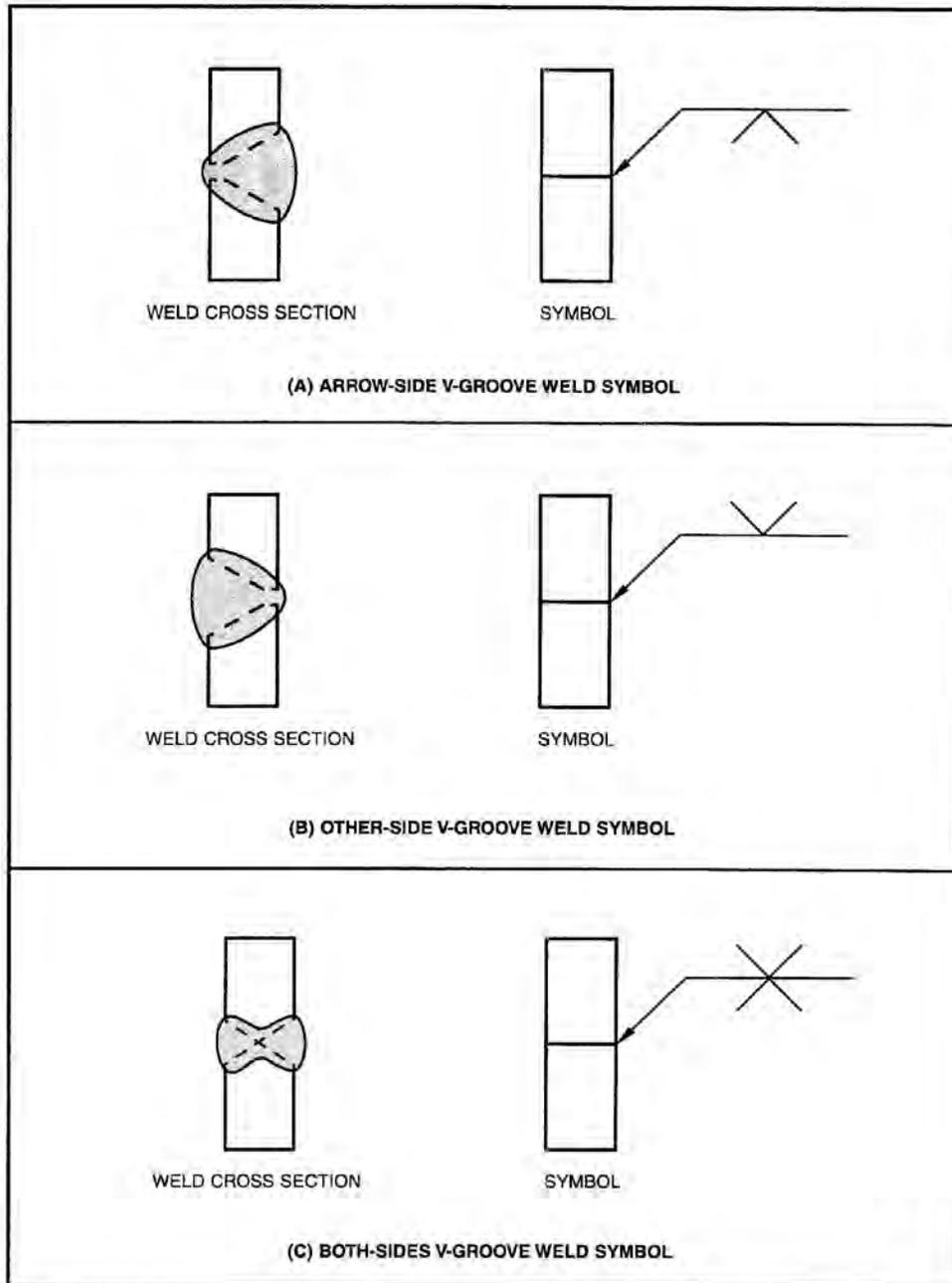
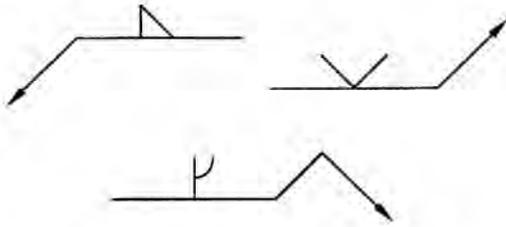


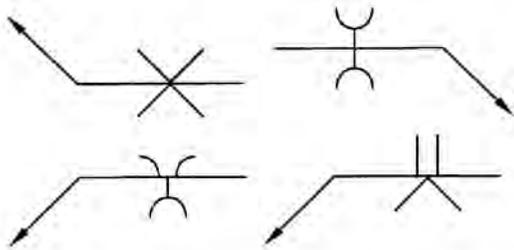
Figure 5—Application of Weld Symbols to Indicate the Arrow Side, the Other Side, and Both Sides

5.2.2 Other Side. Welds on the other side of the joint shall be specified by placing the weld symbol above the reference line (see 5.1.1).

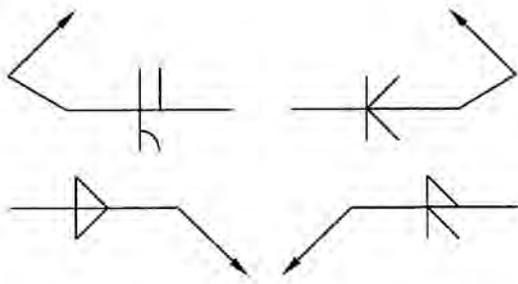


5.2.3 Both Sides. Welds on both sides of the joint shall be specified by placing weld symbols both below and above the reference line.

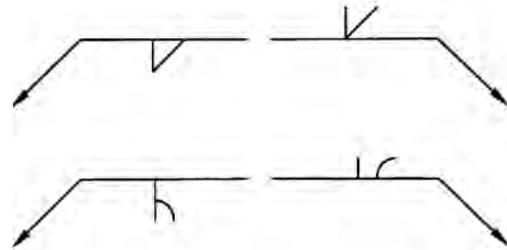
5.2.3.1 Symmetrical Weld Symbols. If the weld symbols used on both sides of the reference line have axes of symmetry that are perpendicular or normal to the reference line, these axes of the symbols shall be directly aligned across the reference line. Staggered intermittent welds are an exception.



5.2.3.2 Nonsymmetrical Weld Symbols. If either of the weld symbols used lacks an axis of symmetry perpendicular or normal to the reference line, the left sides of the weld symbols shall be directly aligned across the reference line. Staggered intermittent welds are an exception.

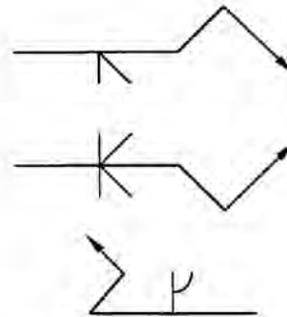


5.3 Orientation of Specific Weld Symbols. Fillet, bevel-groove, J-groove, and flare-bevel-groove weld symbols shall be drawn with the perpendicular leg always to the left.



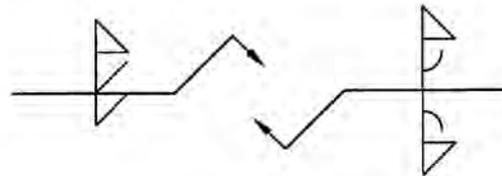
5.4 Break in the Arrow

5.4.1 Groove Welds. When only one joint member is to have a bevel-groove or a J-groove or both, the arrow shall have one break and point toward that member (see Figure 6). The arrow need not be broken if it is apparent which member is to have the bevel- or J-groove (see Figure 7). It shall not be broken if there is no preference as to which member is to have the bevel- or J-groove. A broken arrow need not be used for joints in which combined welds are to be specified and it is apparent which member is to be beveled.



5.4.2 Fillet Welds. The arrow may or may not be broken to indicate fillet weld locations [see Figures 9 and 33(A)].

5.5 Combination Weld Symbols. For joints requiring more than one weld type, a symbol shall be used to specify each weld (see Figure 7).



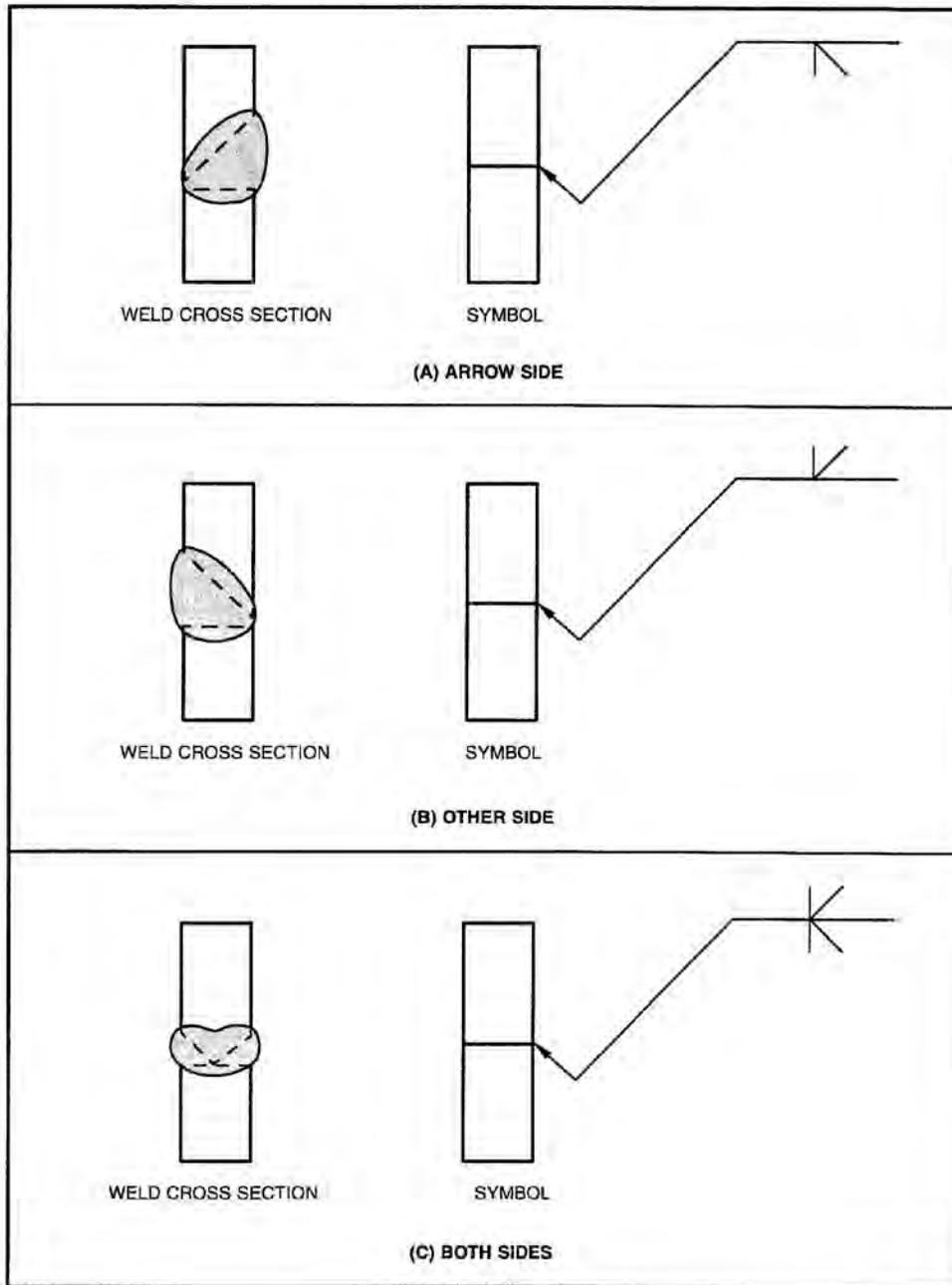


Figure 6—Applications of the Break in the Arrow of the Welding Symbol

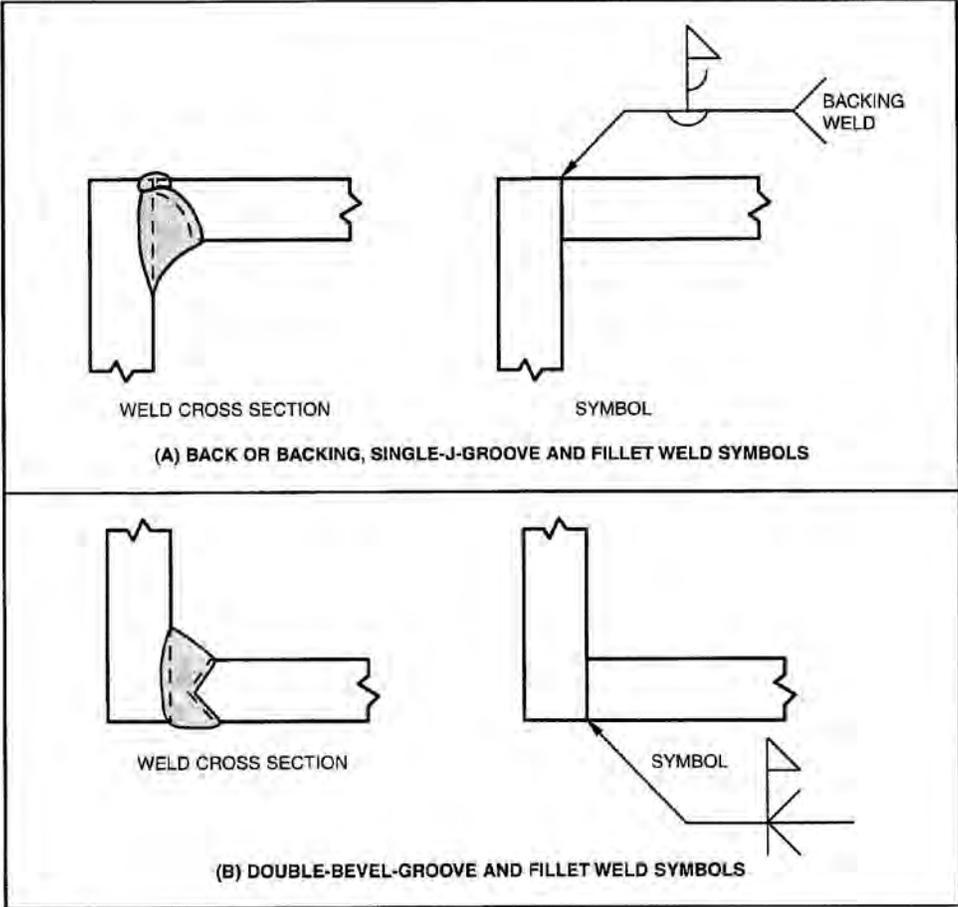


Figure 7—Combination Weld Symbols

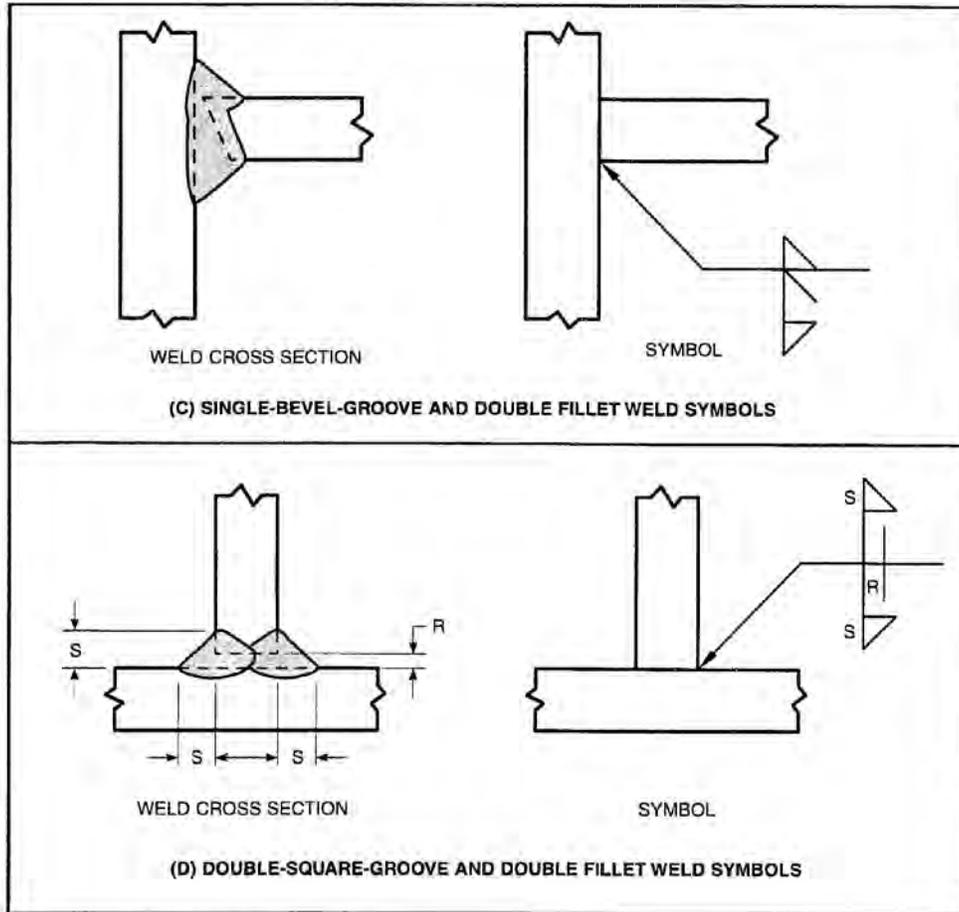
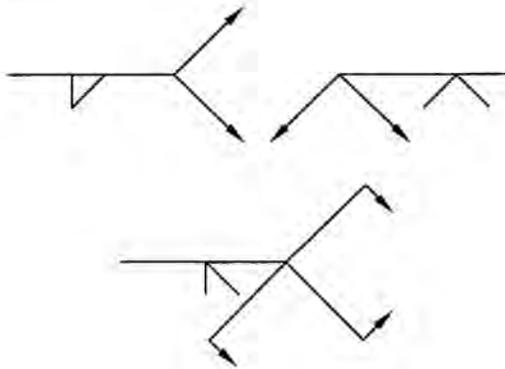


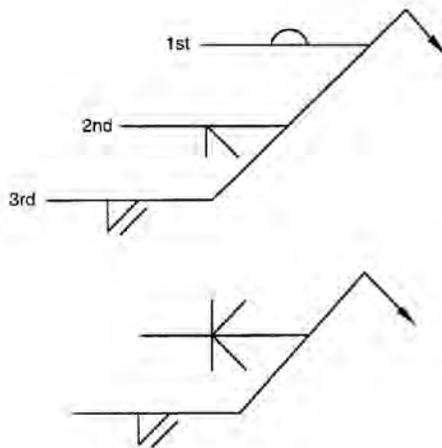
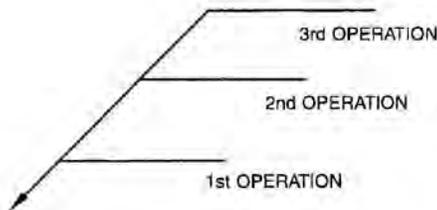
Figure 7 (Continued)—Combination Weld Symbols

5.6 Multiple Arrow Lines. Two or more arrows may be used with a single reference line to point to locations where identical welds are specified [see Figures 9(A) and 10].

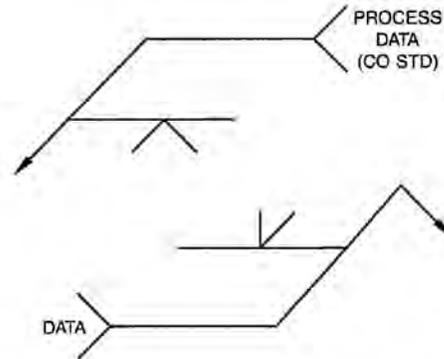


5.7 Multiple Reference Lines

5.7.1 Sequence of Operations. Two or more reference lines may be used to indicate a sequence of operations. The first operation is specified on the reference line nearest the arrow. Subsequent operations are specified sequentially on additional reference lines.

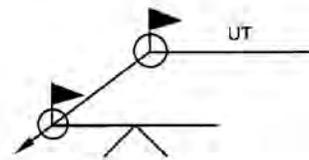


5.7.2 Supplementary Data. The tail of additional reference lines may be used to specify data supplementary to welding symbol information.

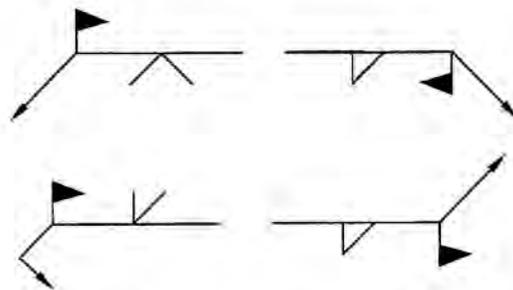


5.7.3 Field Weld and Weld-All-Around Symbols.

When required, the weld- (or examine-) all-around symbol shall be placed at the junction of the arrow and the reference line for each operation to which it is applicable. The field weld symbol may also be applied to the same location.



5.8 Field Weld Symbol. A flag is used to specify a field weld. The flag shall be placed at a right angle to, and on either side of, the reference line at the junction with the arrow (see Annex D5.8).



5.9 Extent of Welding Denoted by Symbols

5.9.1 Weld Continuity. Unless otherwise indicated, welding symbols shall denote continuous welds.

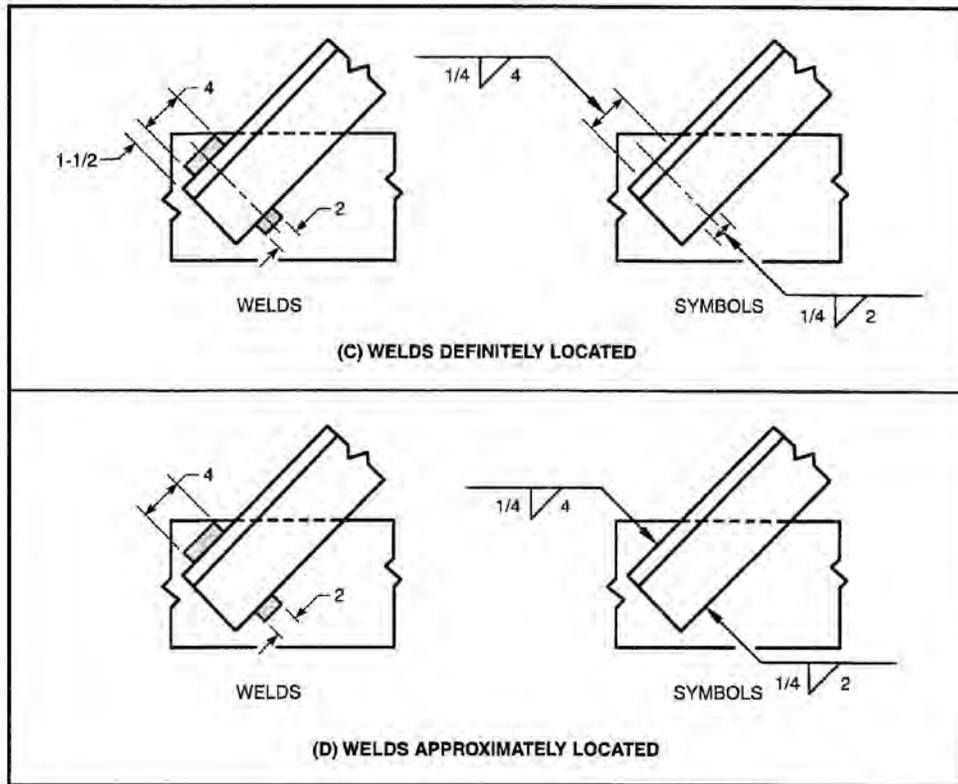


Figure 8 (Continued)—Specification of the Location and Extent of Fillet Welds

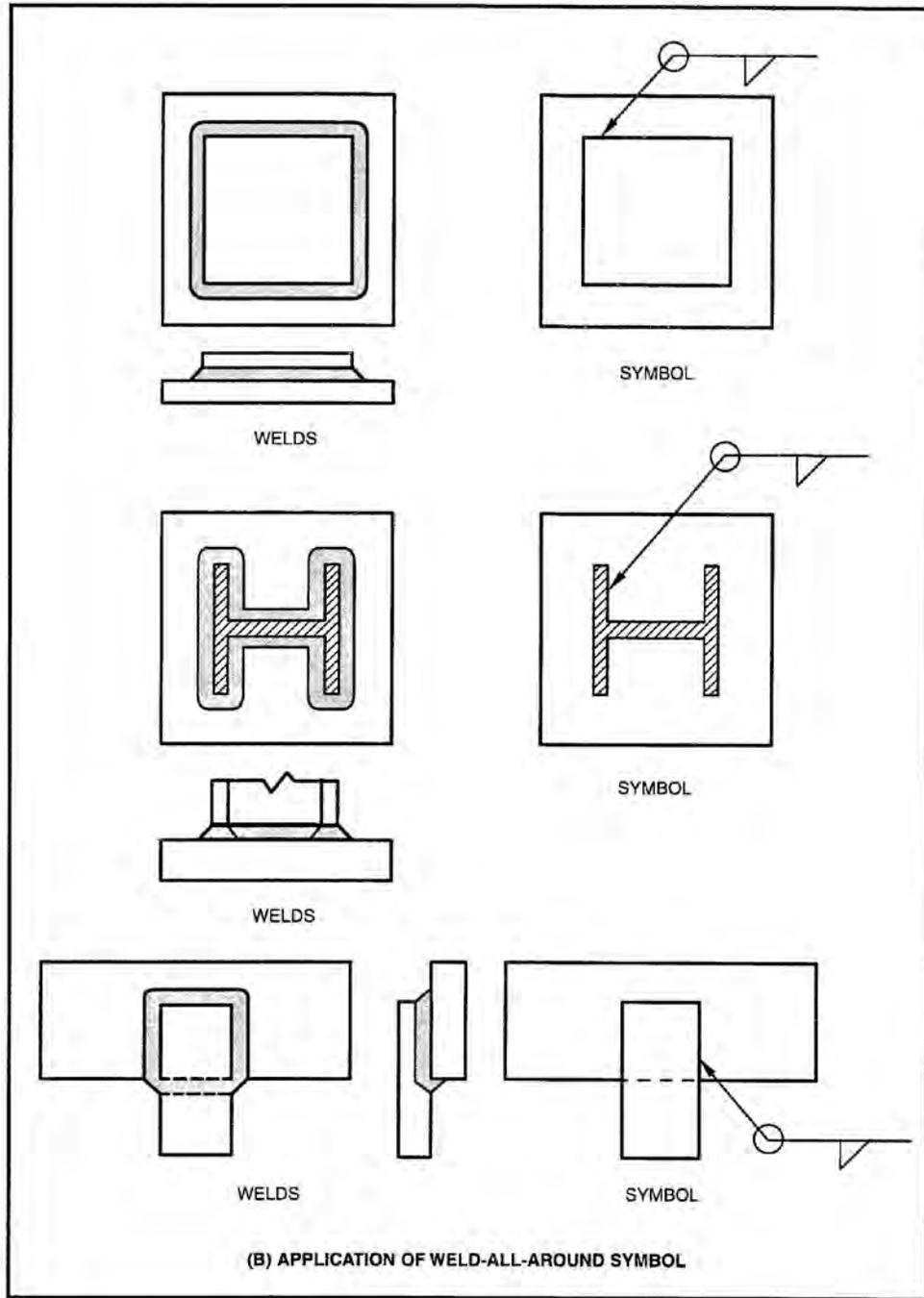


Figure 9 (Continued)—Application of the Symbol for the Specification of the Extent of Welding

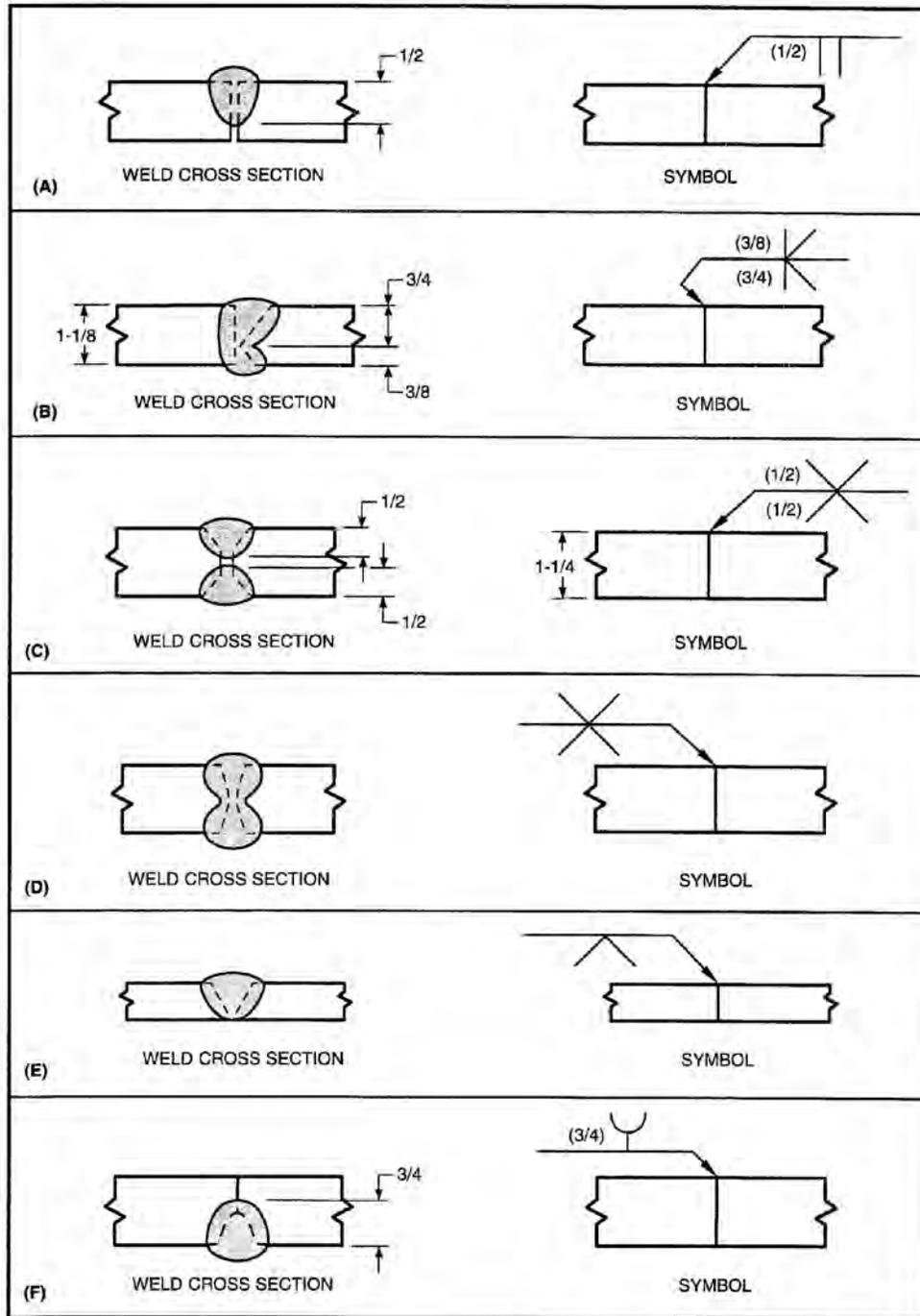


Figure 12—Specification of Groove Weld Size, Depth of Bevel Not Specified

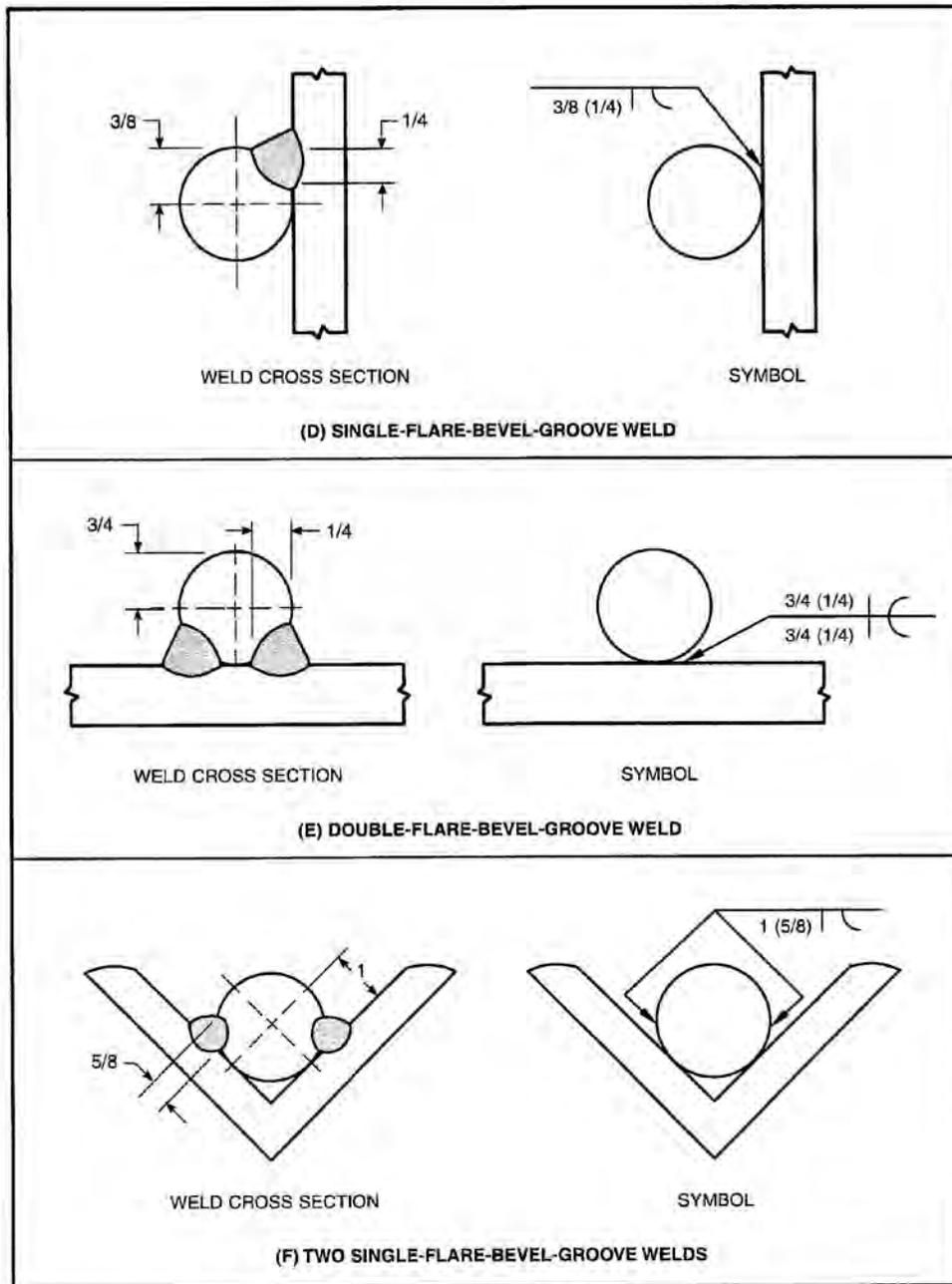


Figure 22 (Continued)—Applications of Flare-Bevel and Flare-V-Groove Weld Symbols

7.3.2 Changes in Direction of Welding. Symbols for fillet welds involving changes in the direction of welding shall be in accordance with 5.9.2 [see Figure 9(A)].

7.4 Intermittent Fillet Welds

7.4.1 Pitch. The pitch of intermittent fillet welds shall be the distance between the centers of adjacent weld segments on one side of the joint [see Figure 33(A)].

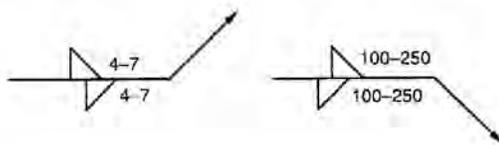
7.4.2 Pitch Dimension Location. The pitch of intermittent fillet welds shall be specified to the right of the length dimension following a hyphen (see Figure 33).



7.4.3 Chain Intermittent Fillet Welds. Dimensions of chain intermittent fillet welds shall be specified on both sides of the reference line. The segments of chain intermittent fillet welds shall be opposite one another across the joint [see Figure 33(B)].



7.4.4 Staggered Intermittent Fillet Welds. The dimensions of staggered intermittent fillet welds shall be specified on both sides of the reference line, and the fillet weld symbols shall be offset on opposite sides of the reference line as shown below. The segments of staggered intermittent fillet welds shall be symmetrically spaced on both sides of the joint as shown in Figure 33(C).



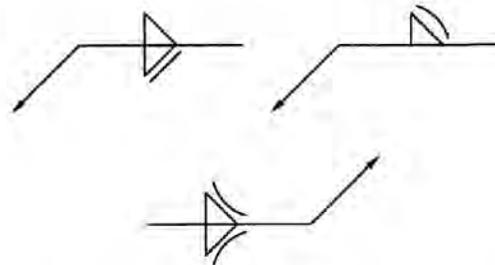
7.4.5 Extent of Welding. In the case of intermittent fillet welds, additional weld lengths that are intended at the ends of the joint shall be specified by separate welding symbols and dimensioned on the drawing [see Figure 33(D)]. When no weld lengths are intended at the ends of the joint, the unwelded lengths should not exceed the clear distance between weld segments and be so dimensioned on the drawing [see Figure 33(E)].

7.4.6 Location of Intermittent Welds. When the location of intermittent welds is not obvious, such as on a circular weld joint, it will be necessary to provide specific segment locations by dimension lines (see 6.4.1.2 and 7.3.1.2) or by hatching (see 6.4.1.3 and 7.3.1.3).

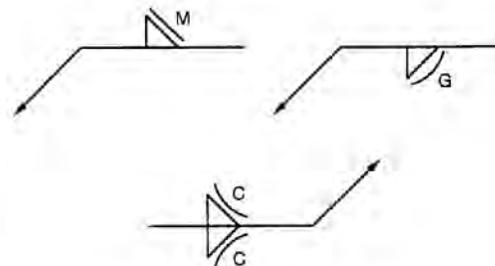
7.5 Fillet Welds in Holes and Slots. Fillet welds in holes and slots shall be specified by the use of fillet weld symbols [see Figure 34(A)].

7.6 Contours and Finishing of Fillet Welds

7.6.1 Contours Obtained by Welding. Fillet welds that are to be welded with approximately flat, convex, or concave faces without postweld finishing shall be specified by adding the flat, convex, or concave contour symbol to the welding symbol (see 5.12.1).



7.6.2 Contours Obtained by Postweld Finishing. Fillet welds that are to be finished approximately flat, convex, or concave by postweld finishing shall be specified by adding both the appropriate contour symbol and finishing designator to the welding symbol (see 5.12.2).



7.7 Skewed Joints. When the angle between the fusion faces is such that the identification of the weld type and thus the proper weld symbol may be in question, the detail of the desired joint and weld configuration shall be shown on the drawing (see 6.13 and Figure 31).

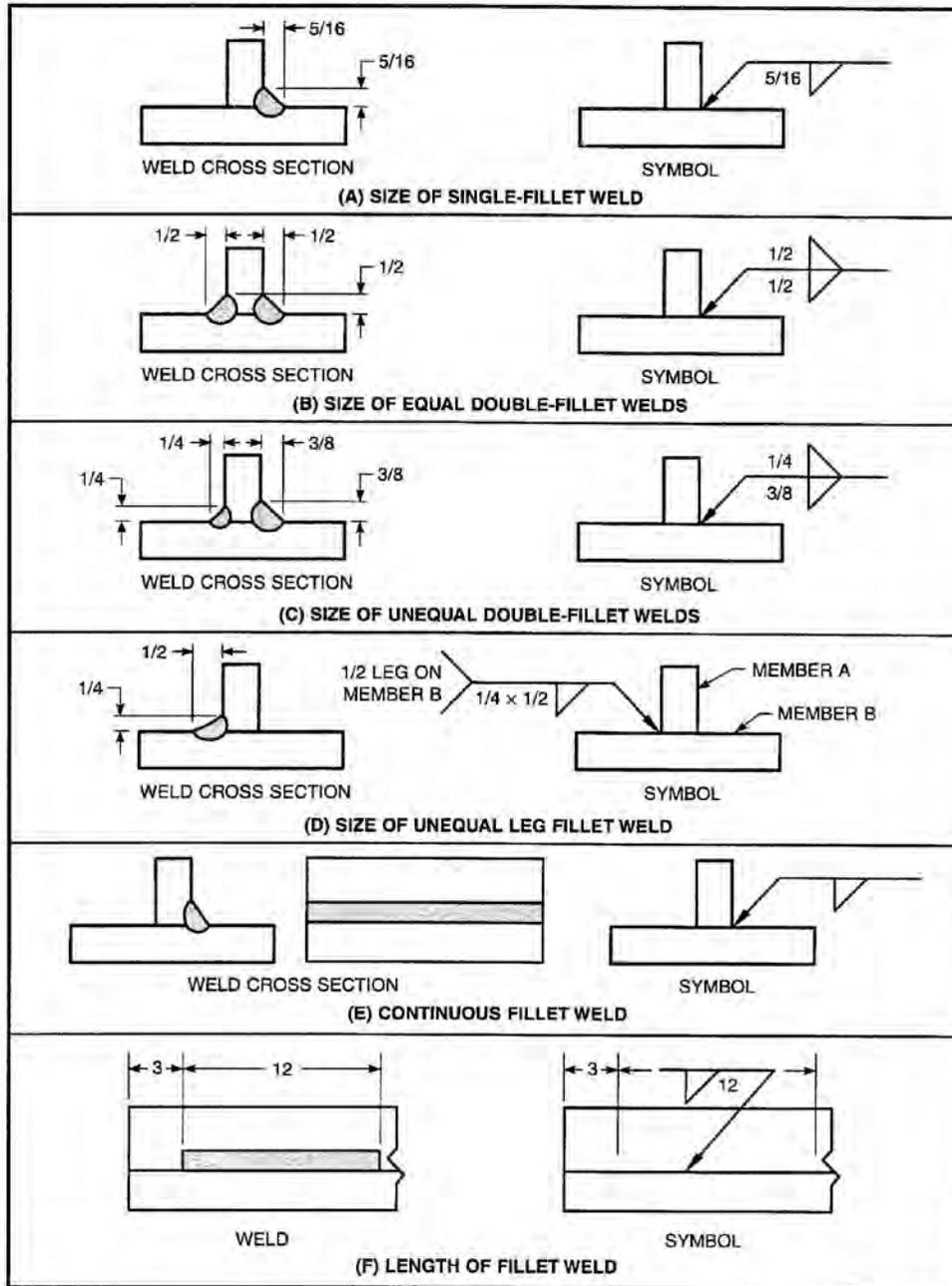


Figure 32—Application of the Symbols for the Size and Length of Fillet Welds

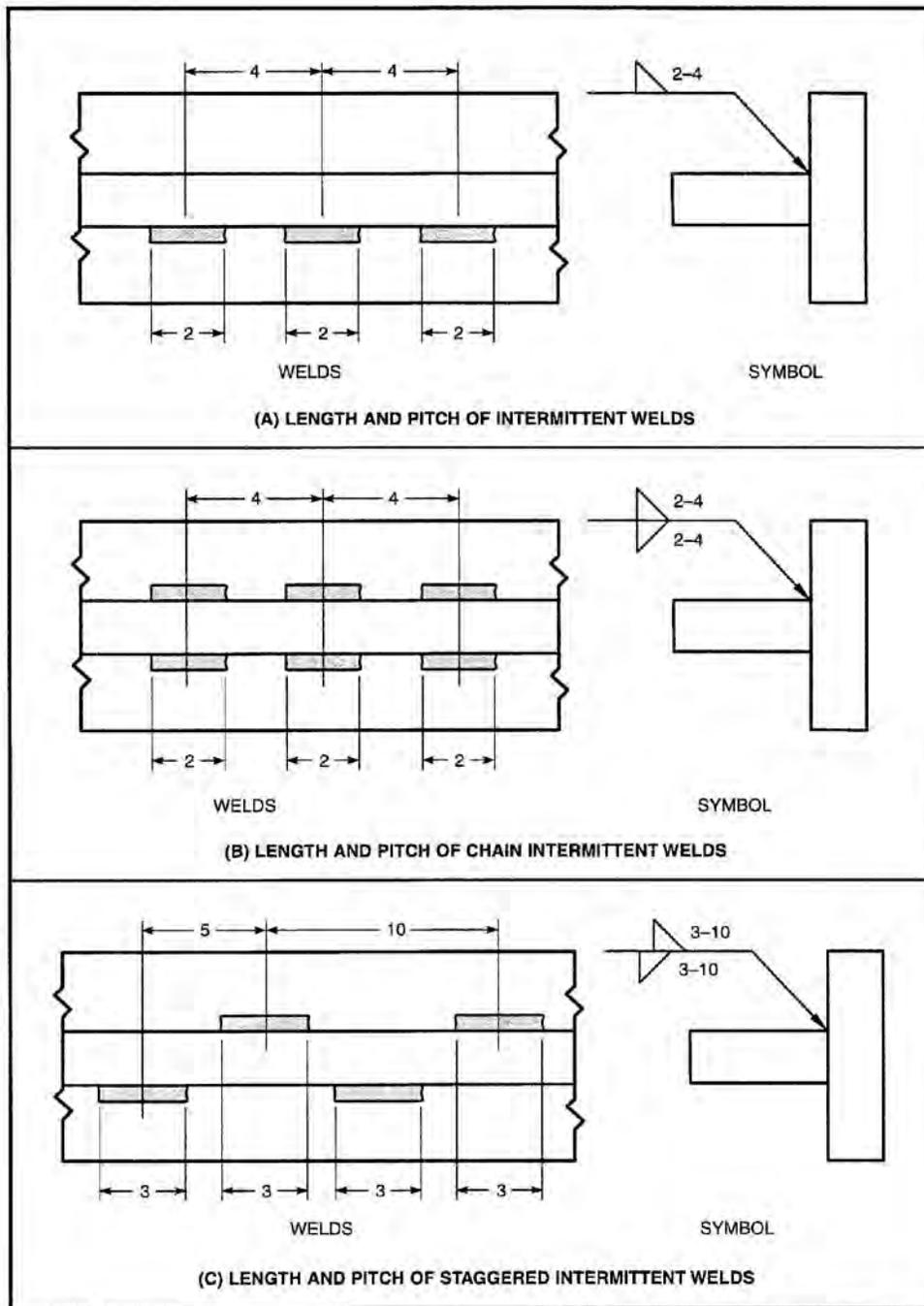


Figure 33—Application of the Intermittent Fillet Weld Symbol

Appendix D

References

AASHTO/AWS D1.5M/D1.5: Bridge Welding Code
AASHTO/AWS D1.1M/D1.1: Structural Welding Code
AWS A2.4: Standard Symbols for Welding, Brazing, and Nondestructive Examination
AWS A3.0: Standard Welding Terms and Definitions
North Carolina Department Of Transportation Standard Specifications for Roads and Structures
SSPC (Steel Structures Painting Council) Painting Manual Volume 2 Eighth Edition

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Appendix E

List of Revisions

The revisions from the May 2010 edition to the 2011 edition of the NCDOT Field Welding Procedures Manual are as follows:

1. **Front Cover**-Change all photos.
2. **Cover Sheet**-Change the edition date from "May 2010" to "4th Edition-June 2011".
3. **Table of Contents**-Change the line spacing and indentation. Add: "Cover Sheet", "Table of Contents", the topics that are presented in the General Information, welding procedures 16 thru 28 (procedures 19 and 20 are only on S drive under Structural Members), Appendix E.
4. **Introduction**-Add: " Additional information and procedures have been included to assist Bridge Maintenance Personnel with "Repair of Existing Structures". Add information about previous editions.
5. **General Information**- Reference Standards (note)-Change the letter from "A" to "B" for the appendix reference . Added: AWS D-1.5 Sections 1.1.1 3.2.2, 3.2.4, 3.6.1.1, 3.6.2, 3.6.5, 3.7.2, 3.7.2.1, 3.7.2.2, 3.7.2.3, 3.7.2.4, 3.11.1, 3.11.2, 3.13.5, 4.2.7, 4.5.2 (second portion of the paragraph), 6.26.1, 6.26.1.1, 6.26.1.2, 6.26.1.3, 6.26.1.4, 6.26.1.5, comment about 6.26.1.6, 6.26.1.7, C-6.26.1, C-6.5, a comment about stud welding using automatic equipment, 7.4.1, 7.4.2, 7.5.5, 7.5.5.3, 7.5.5.4.
6. **WPS 001**-Add the parameters for a 5/32" electrode, changed the interpass maximum to 450°, changed the revision number to 4, changed the bevel angle tolerance from -0° to -5°.
7. **WPS 002**-Change the interpass maximum to 450°, change the revision number to 4.
8. **WPS 003**- Change the interpass maximum to 450°, change the revision number to 5, add the parameters for a 5/32" electrode, changed the bevel angle tolerance from -0° to -5°, omit the root face dimension, change the root opening to 1/4" +5/16" -1/16", change the bevel angle on the horizontal detail to 45°.
9. **WPS 004**-Change the interpass maximum to 450°, change the revision number to 4.
10. **WPS 005**-Change the interpass maximum to 450°, change the revision number to 5.
11. **WPS 006**-Change the interpass maximum to 450°, change the revision number to 4.
12. **WPS 007**-Change the interpass maximum to 450°, change the revision number to 4, add the statement in the comments "Remove the protrusion from the bottom of the stud".
13. **WPS 008**- Change the interpass maximum to 450°, change the revision number to 3.
14. **WPS 009**- Change the interpass maximum to 450°, change the revision number to 3, omit the tolerance for the bevel angle.
15. **WPS 010**- Change the interpass maximum to 450°, change the revision number to 3, Change the bevel angle to 60°.
16. **WPS 011**- Change the interpass maximum to 450°, change the revision number to 3.
17. **WPS 012**- Change the interpass maximum to 450°, change the revision number to 3, add the parameters for a 5/32" electrode, changed the bevel angle tolerance from -0° to -5°, omit the root face dimension, change the root opening to 1/4" +5/16" -1/16", change the bevel angle to 45°.
18. **WPS 013**- Change the interpass maximum to 450°, change the revision number to 2.
19. **WPS 014**- Change the interpass maximum to 450°, change the revision number to 2.
20. **WPS 015**- Change the interpass maximum to 450°, change the revision number to 2.

Appendix E

List of Revisions (cont.)

21. Add welding procedures 016 through 029.
22. **Appendix A**-Add the following terms and definitions: convexity, porosity, weld, welding. Add a photo for porosity and the figures for "Parts of a Weld".
23. **Appendix D**-Add D1.1 reference, a paragraph for credits and a table for steel section contact information.
24. Add appendix E, list of revisions.
25. Change all welding parameters from Hobart recommendations to Lincoln recommendations.
26. Add page numbering to the TOC, Introduction, General Information, Welding Procedures, Appendix A and D.
27. Make numerous changes to fonts, spacing, etc. to improve the consistency of the manual.
28. Add photographic illustrations to the welder certification procedures.
29. Add fit-up photographic illustrations for the H-Pile Welding Procedure.
30. A contractor version has been generated that does not include the photo cover, welding procedure photographic illustrations or, due to copy write issues, sspc standards (Appendix B).