

Specification for Welding of Tanks, Vessels, and Other Equipment in Sanitary (Hygienic) Applications



American Welding Society



Key Words—Visual examination acceptance criteria, food processing equipment, qualification, sanitary application, stainless steel

**AWS D18.3/D18.3M:2005
An American National Standard**

**Approved by
American National Standards Institute
August 25, 2005**

Specification for Welding of Tanks, Vessels, and Other Equipment in Sanitary (Hygienic) Applications

Prepared by
AWS D18 Committee on Welding in Sanitary Applications

Under the Direction of
AWS Technical Activities Committee

Approved by
AWS Board of Directors

Abstract

This specification provides the requirements for welding of tanks, vessels, and other equipment used in food processing plants and other areas where sanitary (hygienic) applications are required. The document addresses qualification, fabrication, extent of visual examination, acceptance criteria, and documentation requirements.



American Welding Society

550 N.W. LeJeune Road, Miami, Florida 33126

Statement on Use of AWS American National Standards

All standards (codes, specifications, recommended practices, methods, classifications, and guides) of the American Welding Society (AWS) are voluntary consensus standards that have been developed in accordance with the rules of the American National Standards Institute (ANSI). When AWS standards are either incorporated in, or made part of, documents that are included in federal or state laws and regulations, or the regulations of other governmental bodies, their provisions carry the full legal authority of the statute. In such cases, any changes in those AWS standards must be approved by the governmental body having statutory jurisdiction before they can become a part of those laws and regulations. In all cases, these standards carry the full legal authority of the contract or other document that invokes the AWS standards. Where this contractual relationship exists, changes in or deviations from requirements of an AWS standard must be by agreement between the contracting parties.

International Standard Book Number: 0-87171-734-4

American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126

© 2005 by American Welding Society. All rights reserved

Printed in the United States of America

AWS American National Standards are developed through a consensus standards development process that brings together volunteers representing varied viewpoints and interests to achieve consensus. While AWS administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its standards.

AWS disclaims liability for any injury to persons or to property, or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this standard. AWS also makes no guaranty or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this standard available, AWS is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is AWS undertaking to perform any duty owed by any person or entity to someone else. Anyone using these documents should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances.

This standard may be superseded by the issuance of new editions. Users should ensure that they have the latest edition.

Publication of this standard does not authorize infringement of any patent or trade name. Users of this standard accept any and all liabilities for infringement of any patent or trade name items. AWS disclaims liability for the infringement of any patent or product trade name resulting from the use of this standard.

Finally, AWS does not monitor, police, or enforce compliance with this standard, nor does it have the power to do so.

On occasion, text, tables, or figures are printed incorrectly, constituting errata. Such errata, when discovered, are posted on the AWS web page (www.aws.org).

Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, to the Managing Director, Technical Services Division, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126 (see Annex A). With regard to technical inquiries made concerning AWS standards, oral opinions on AWS standards may be rendered. However, such opinions represent only the personal opinions of the particular individuals giving them. These individuals do not speak on behalf of AWS, nor do these oral opinions constitute official or unofficial opinions or interpretations of AWS. In addition, oral opinions are informal and should not be used as a substitute for an official interpretation.

This standard is subject to revision at any time by the AWS D18 Committee on Welding in Sanitary Applications. It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn. Comments (recommendations, additions, or deletions) and any pertinent data that may be of use in improving this standard are required and should be addressed to AWS Headquarters. Such comments will receive careful consideration by the AWS D18 Committee on Welding in Sanitary Applications and the author of the comments will be informed of the Committee's response to the comments. Guests are invited to attend all meetings of the AWS D18 Committee on Welding in Sanitary Applications to express their comments verbally. Procedures for appeal of an adverse decision concerning all such comments are provided in the Rules of Operation of the Technical Activities Committee. A copy of these Rules can be obtained from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

Photocopy Rights

Authorization to photocopy items for internal, personal, or educational classroom use only, or the internal, personal, or educational classroom use only of specific clients, is granted by the American Welding Society (AWS) provided that the appropriate fee is paid to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: 978-750-8400; online: <http://www.copyright.com>.

Dedication

The D18 Committee on Welding in Sanitary Applications dedicates this edition of the D18.3/D18.3M:2005, *Specification for Welding of Austenitic Stainless Steel Tube and Pipe Systems in Sanitary (Hygienic) Applications*, to Mr. Garrett M. Naughton, a charter member of the D18 Committee.

Garrett was a true friend and advocate of the American Welding Society. His dedicated efforts did much to advance the art and science of welding stainless steel materials for the food and food processing industry, as well as the education and training of welders for the welding industry.

This page is intentionally blank.

Personnel

AWS D18 Committee on Welding in Sanitary Applications

<i>J. E. Campbell, Chair</i>	WeldTech Solutions Corporation
<i>W. L. Roth, 2nd Vice Chair</i>	Proctor & Gamble, Incorporated
<i>H. Ellison, Secretary</i>	American Welding Society
<i>R. E. Avery</i>	Nickel Institute
<i>R. D. Campbell</i>	Purity Systems, Incorporated
<i>J. R. Hannahs</i>	Edison Community College
<i>L. Hanson</i>	CIP Concepts
<i>R. Howard</i>	Carrier Vibrating Equipment
<i>E. K. Johnson</i>	SWECO Division of M-1 LLC
<i>M. P. Lang</i>	United Association, Local 501
<i>M. J. LeRoy</i>	Swagelock Corporation
<i>J. McSwiggin</i>	Rodem, Incorporated
<i>J. R. Miller</i>	International Training Institute
<i>J. Williams</i>	James Williams, PC
<i>*L. P. Connor</i>	Consultant
<i>*M. Gagne</i>	AlphaBio, Incorporated
<i>*R. K. Smith</i>	Richard K. Smith

AWS D18A Subcommittee on Qualification

<i>J. E. Campbell, Chair</i>	WeldTech Solutions Corporation
<i>H. Ellison, Secretary</i>	American Welding Society
<i>J. Brook</i>	Miller Electric Manufacturing Company
<i>R. D. Campbell</i>	Purity Systems, Incorporated
<i>J. R. Hannahs</i>	Edison Community College
<i>R. Huette</i>	Liburdi Dimetrics, Incorporated
<i>J. R. Miller</i>	International Training Institute

AWS D18B Subcommittee on Inspection

<i>R. E. Avery, Chair</i>	Nickel Institute
<i>J. McSwiggin, 1st Vice Chair</i>	Rodem, Incorporated
<i>H. Ellison, Secretary</i>	American Welding Society
<i>*J. Friend</i>	Sanovo-Seymour USA, Incorporated
<i>*A. S. Gallant</i>	Elite Inspection Services Company
<i>L. Hanson</i>	Sani-Matic Systems, Incorporated
<i>B. K. Henon</i>	Arc Machines, Incorporated
<i>R. Howard</i>	Carrier Vibrating Equipment
<i>M. Krieger</i>	Ecolab
<i>M. P. Lang</i>	United Association, Local 501
<i>M. J. LeRoy</i>	Swagelock Corporation
<i>W. L. Roth</i>	Proctor & Gamble, Incorporated
<i>*R. K. Smith</i>	Richard K. Smith
<i>*W. W. Werner</i>	Brenner Tank, Incorporated
<i>J. Williams</i>	James Williams, PC

*Advisor

This page is intentionally blank.

Copyright American Welding Society
Provided by IHS under license with AWS
No reproduction or networking permitted without license from IHS

Foreword

(This Foreword is not a part of AWS D18.3/D18.3M:2005, *Specification for Welding of Tanks, Vessels, and Other Equipment in Sanitary (Hygienic) Applications*, but is included for informational purposes only.)

The formation of D18 Committee was approved in October and November 1995 by the Technical Activities Committee and the Board of Directors, respectively. The Committee was formed to respond to the request of the 3-A Sanitary Standards Committee for help in preparing welding standards for use in the manufacture and construction of dairy and food product processing plants. The 3-A Sanitary Standards Committees develop and promulgate sanitary design standards for dairy and food processing, packaging and handling equipment and systems. Several members of the Committee are active members of 3-A, and the Committee has maintained liaison with 3-A.

This is the first edition of D18.3. D18.3 was prepared because a need was seen by the D18 Committee to address welding issues on tanks, vessels, and other equipment in sanitary applications not addressed by D18.1, *Specification for Welding Austenitic Stainless Steel Tube and Pipe Systems in Sanitary (Hygienic) Applications*.

Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, AWS D18 Committee on Welding in Sanitary Applications, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, following the guidelines in Annex A of this document, to the Managing Director, Technical Services Division, American Welding Society. A formal reply will be issued after it has been reviewed by the appropriate personnel following established procedures.

This page is intentionally blank.

Table of Contents

	Page No.
<i>Personnel</i>	v
<i>Foreword</i>	vii
<i>List of Tables</i>	x
<i>List of Figures</i>	x
1. Scope and Responsibilities.....	1
1.1 Scope.....	1
1.2 Owner’s Responsibility	1
2. Normative References	1
3. Definitions.....	2
4. Qualification.....	2
4.1 Procedure Qualification	2
4.2 Performance Qualification.....	3
5. Fabrication Practices	8
5.1 Mandatory Standard Practices	8
5.2 Nonmandatory Standard Practices.....	8
6. Visual Examination Requirements.....	8
6.1 Extent of Examination	8
6.2 Visual Examination Acceptance Criteria.....	10
6.3 Finished Weld Acceptance Criteria.....	10
7. Documentation	13
<i>Nonmandatory Annexes</i>	15
<i>Annex A—Guidelines for Preparation of Technical Inquiries for AWS Technical Committees</i>	15
<i>Annex B—Weld and Adjacent Zone Finishes</i>	17
<i>Annex C—Sample Forms</i>	19
<i>List of AWS Documents on Welding in Sanitary Applications</i>	27

Copyright American Welding Society
Provided by IHS under license with AWS
No reproduction or networking permitted without license from IHS

List of Tables

Table	Page No.
1 Essential and Nonessential Variables for Procedure Qualification	4
2 Essential and Nonessential Variables for Performance Qualification	9
3 Weld Reinforcement—Groove Welds	10

List of Figures

Figure	Page No.
1 Acceptable and Unacceptable Weld Profiles	11
2 Schematic Example of Surface Classification Zones	12

Specification for Welding of Tanks, Vessels, and Other Equipment in Sanitary (Hygienic) Applications

1. Scope and Responsibilities

1.1 Scope. This specification covers the requirements for welding of carbon steels, stainless steels, and nickel alloys in sheet, plate, bar, and other forms for the fabrication and construction of new tanks, vessels, and other equipment in sanitary (hygienic) applications. The welding of pipe or tubing to a tank, vessel, or other piece of sanitary equipment, for use as a nozzle or other opening, is included in this specification. This specification excludes the welding of tube and pipe for the transportation of sanitary (hygienic) system products and cleaning or sanitizing solutions. Pipe and tube welding for sanitary (hygienic) systems is covered in AWS D18.1, *Specification for Welding of Austenitic Stainless Steel Tube and Pipe Systems in Sanitary (Hygienic) Applications*.

This specification is intended for new construction. However, the requirements may also be applied to maintenance and repair of food processing equipment. When there is a conflict between this specification and a structural design specification to which the equipment is being constructed, the structural code shall govern on issues that apply to structural design or structural integrity. This specification does not address requirements designed to prevent corrosion damage during service. This specification also does not cover the design aspects of components or systems used for sanitary (hygienic) applications.

Sanitary processing systems are intended to include those systems handling products for human and animal consumption, or for cleaning and sanitizing solutions used in these systems. Such products include dairy, meat, poultry, vegetable, beverage, personal care items (such as shampoo, soap, toothpaste, cosmetics), and other products consumed or used by humans and animals.

This specification addresses welding qualification and visual examination requirements for as-welded surfaces as well as finished surfaces.

This specification makes use of both U.S. Customary Units and the International System of Units (SI). These measurements may not be exact equivalents; therefore

each system must be used independently of the other without combining in any way. The specification with the designation D18.3 uses U.S. Customary Units. The specification D18.3M uses SI Units. The latter are shown in appropriate columns in tables or within brackets [] when used in the text.

Safety and health issues 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 federal, state, and local regulations as well as other safety standards such as ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*.

1.2 Owner's Responsibility. The Owner or their representatives shall provide a complete specification for the equipment that the specification applies and shall identify surface classification zones (product-contact surface zones and nonproduct-contact surface zones) and weld finishes for each classification zone. Owners should use Annex B to designate the required weld finish of each zone.

2. Normative References

The following AWS standards contain provisions which, through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the standard referred to applies.

2.1 AWS Documents¹

- (1) ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*
- (2) AWS A3.0, *Standard Welding Terms and Definitions*
- (3) AWS B2.1, *Specification for Welding Procedure and Performance Qualification*

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

(4) AWS D18.1, *Specification for Welding of Austenitic Stainless Steel Tube and Pipe Systems in Sanitary (Hygienic) Applications*

3. Definitions

Welding terms used in this specification are defined in AWS A3.0, *Standard Welding Terms and Definitions*. Other terms not defined in AWS A3.0 are defined in this section.

Contractor. Includes manufacturers, contractors, sub-contractors, fabricators, erectors, or other organizations that fabricate weldments that are intended to meet the requirements of this specification.

essential variable. A variable in which a change beyond that described in 4.1.5, Welding Variables, is considered to affect the mechanical properties of the weldment, and shall require requalification of the Welding Procedure Specification (WPS).

nonessential variable. A variable in which a change, as described in 4.1.5, Welding Variables, may be made in the WPS without requalification.

nonproduct contact surface (NPCS). A surface other than a product contact surface.

overlap. The protrusion of weld metal beyond the weld toe or weld root.

Owner. Organization that will operate the sanitary (hygienic) processing system, or the organization's authorized representative.

pit. A surface imperfection the depth of which exceeds 25% of the smallest surface dimension, and whose length does not exceed three (3) times its width.

product. Any material in any form (liquid, powder, solid, slurry, etc.) for which the tank, vessel, or other piece of sanitary equipment is designed to store, contain, or process.

product contact surface (PCS). Any surface that is exposed to the product or any surface from which materials may drain, drop, or be drawn into the product.

surface classification zones

Zone 1: Product Contact Surface (PCS).

Zone 2: Nonproduct Contact Surface—Exposed (NPCS-E)—beyond the normal PCS where normal operations (i.e., draining, filling, etc.) pose a significant risk of incidental contamination.

Zone 3: Nonproduct Contact Surface—Remote (NPCS-R)—remotely beyond the normal PCS where normal operations (i.e., draining, filling, etc.) pose a minimal risk of incidental contamination.

Zone 4: Non-Exposed Surfaces (NES) with significantly reduced likelihood of resulting in product contamination.

verification test (performance). An optional sample weldment (when agreed upon between Owner and Contractor) intended to confirm the welder's or welding operator's ability to meet the requirements of 6.2, Visual Examination Acceptance Criteria.

weld finishing. A post-weld process that leaves the weld area in a noticeably different condition than as welded. Finishing processes include, but are not limited to mechanical (grinding, polishing, glass bead blasting and so forth), chemical (passivating or pickling), or electrochemical (electropolishing).

4. Qualification

4.1 Procedure Qualification

4.1.1 A written qualified Welding Procedure Specification (WPS) shall be followed for each weld in sanitary applications. The welding procedure specification may be in any convenient format provided all the welding variables of 4.1.5, Welding Variables, are recorded. A sample WPS form is shown in Annex C.

4.1.2 The welding variables required to be addressed for each procedure shall be those specified in 4.1.5.

4.1.3 The evaluation of procedure qualification test weldments shall be as listed in 4.1.3.1 through 4.1.3.4. The actual welding variables used during the qualification tests shall be recorded in addition to the results of the destructive and visual examination. The welding procedure qualification record may be in any convenient format provided all the welding variables of 4.1.5, Welding Variables, and the results of all tests are recorded.

4.1.3.1 Procedure qualification shall be by standard test weldment as required in AWS B2.1, *Specification for Welding Procedure and Performance Qualification*, except that the essential and nonessential variables of 4.1.5 apply.

4.1.3.2 Procedure qualification test weldments shall be visually examined on all surfaces.

4.1.3.3 The destructive test sample preparation shall be as required in AWS B2.1, Annex II, except that bend specimens shall not be machined flat. The maximum radius at the edge of the bend specimens is 1/16 in [2 mm].

4.1.3.4 If any test fails, the procedure fails, and a new welding procedure qualification test shall be conducted.

4.1.4 Acceptance Criteria of Procedure Qualification Test Welds

4.1.4.1 Visual examination may be conducted with or without magnification. The results of visual examination shall meet the acceptance criteria of 6.2, Visual Examination Acceptance Criteria.

4.1.4.2 After visual examination, two transverse tensile specimens, two root and two face bend or side bend specimens based on the material thickness shall be tested in accordance with AWS B2.1, *Specification for Welding Procedure and Performance Qualification*.

4.1.4.3 Each tensile specimen shall have a tensile strength not less than at least one of the following:

(1) If the specimen breaks in the base metal outside of the weld or weld interface, the test shall be accepted, provided the strength is not more than 5% below the specified minimum tensile strength of the base metal.

(2) If the specimen breaks in the weld or weld interface, the test specimen shall have tensile strength not less than the minimum specified tensile strength of the base metal, or the weaker of the two base metals if metals of different minimum tensile strengths are used.

(3) The specified minimum tensile strength of the weld metal when the referencing document provides for the use of weld metal having a lower tensile strength than the base metal.

(4) If the base metal has no specified minimum tensile strength, then failure in the base metal shall be acceptable.

4.1.4.4 Bend specimens shall be bent in one of the guided bend test fixtures shown in AWS B2.1. For transverse specimens, the weld metal and heat-affected zone (HAZ) shall be completely within the bent portion of the specimen after bending. Bend test specimens shall be examined at a minimum of 10x magnification for specimen thicknesses less than 1/32 in [1 mm] only. Bend specimens shall have no openings greater than 1/16 in [2 mm] or 1/2 T, whichever is less, where T equals the base metal thickness of the qualification specimen.

4.1.5 Welding Variables. Table 1 lists the matrix of welding variables required to be addressed on both the welding procedure qualification record and welding procedure specification. The types of welding variables found in this matrix are essential (E) and nonessential (N) variables, as defined in Section 3.

A change in an essential variable beyond that allowed in Table 1 requires requalification of the WPS. A change

in a nonessential variable may be made without requalification, but a revised WPS or new WPS shall be prepared.

4.2 Performance Qualification

4.2.1 Performance qualification shall be by standard test in accordance with AWS B2.1. The welder/welding operator performance qualification shall be documented and may be in any convenient format provided all the welding variables of 4.2.8, Performance Qualification Variables, and the results of all tests are recorded. A sample Performance Qualification Record (PQTR) form is shown in Annex C.

4.2.2 Visual examination of standard test weldments shall meet the acceptance criteria of 6.2.

4.2.3 Bend specimens shall be bent in one of the guided bend test fixtures shown in AWS B2.1. For transverse specimens, the weld metal and heat-affected zone shall be completely within the bent portion of the specimen after bending. Bend test specimens shall be examined visually. Bend specimens shall have no openings greater than 1/16 in [2 mm] or 1/2 T, whichever is less, where T equals the base metal thickness qualified.

4.2.4 As an alternate to 4.2.3, radiography may be performed for evaluation of performance qualification test welds. The radiographic procedure shall be as listed in AWS B2.1, Annex E. For acceptance, the weld shall have no discontinuities exceeding 1/16 in [2 mm] or 1/2 T, whichever is less. Oxide islands shall not be considered relevant indications for this test.

4.2.5 The performance qualification of a welder or welding operator shall be affected when one of the following conditions occur:

(1) When he has not welded with a process during a period of 6 months or more, his qualifications for that process shall expire.

(2) Requalification as a result of (1) is permitted by having the welder or welding operator make one test weldment using the same process. If the test weldment meets the requirements of this specification, then all of the welder's or welding operator's previous qualifications for that process, for materials, thicknesses, product forms, and other variables are reinstated.

(3) When there is a specific reason to question his ability to make welds that meet the specification, the qualifications which support the welding he is doing shall be revoked. All other qualifications not questioned remain in effect.

(4) Requalification as a result of (3) is permitted by having the welder or welding operator successfully complete performance qualification test(s) that support the qualification(s) questioned.

Table 1
Essential and Nonessential Variables for Procedure Qualification

WELDING VARIABLES

This matrix lists the welding variables required to be addressed on both the Welding Procedure Qualification Record and Welding Procedure Specification. The types of variables found in this matrix are essential (E) and nonessential (N) variables as defined in Section 3. If no type of variable is listed, the variable is not applicable for the process and does not need to be addressed.

SectionParagraph		WELDING PROCESSES ⁽¹⁾								
		EBW	FCAW	GMAW	GTAW	LBW	PAW	SAW	SMAW	SW
Joint Design										
4.1.5.1	(1) Any change in groove type (V-groove, U-groove, single bevel, etc.)	E	N	N	N	E	N	N	N	
	(2) Any change in joint details (e.g., angle, groove radius, root face, etc.)	N	N	N	N	N	N	N	N	
	(3) Any change in treatment of backside, method of gouging/preparation	N	N	N	N	N	N	N	N	
	(4) A change from a fillet to a groove weld	E	E	E	E	E	E	E	E	
	(5) An increase in the root opening beyond that used in the qualification test	E	N	N	N	N	E	N	N	
	(6) A change in size, shape, ferrule/flux type									N
	(7) A change in the M-Number of backing	E	E	E	E	E	E	E	E	
Base Metal										
4.1.5.2	(1) For base metals thinner than 1/8 in, a change in the base metal thickness greater than 1/2 T to 2T where T = the thickness qualified. For base metals 1/8 and greater, the thickness provision of B2.1 apply.	E	E	E	E	E	E	E	E	N
	(2) A change from one M-Number to another M-Number or to an unlisted base metal, except as permitted in AWS B2.1	E	E	E	E	E	E	E	E	E
	(3) A change from one M-Number group to any other M-Number group	E	N	N	N	E	N	N	N	N
	(4) Any change in diameter (tubular only)	N	N	N	N	N	N	N	N	N
Filler Metal										
4.1.5.3	(1) The addition or deletion of filler metal	E			E	E	E			
	(2) For ferrous materials, a change in the filler metal A-Number	E	E	E	E	E	E	E	E	
	(3) A change in the filler metal diameter		N	N	N		N	N	N	
	(4) A change from one F-Number to any other F-Number or to any filler metal not listed in AWS B2.1	E	E	E	E	E	E	E	E	

(Continued)

Table 1 (Continued)
Essential and Nonessential Variables for Procedure Qualification

SectionParagraph		WELDING PROCESSES ⁽¹⁾								
		EBW	FCAW	GMAW	GTAW	LBW	PAW	SAW	SMAW	SW
4.1.5.3 (Cont'd)	(5) If the weld metal alloy content is largely dependent upon the composition of the flux, any change in the welding procedure which would result in the important weld metal alloying elements being outside the specified chemical composition range of the WPS							E		
	(6) A change in the cross-sectional area of filler metal added (excluding Buttering) of ±10%	E				E				
	(7) A change in filler metal classification	E	N	N	N	E	N	N	N	
	(8) A change from one of the following filler metal product forms to another: (a) flux cored (b) bare (solid) or metal cored (c) flux covered (d) any filler metal not covered	E	E	E	E	E	E	E	E	
	(9) A change in the number of electrodes	E	E	E	E	E	E	E		
	(10) A change in flux type or a change from AWS electrode-flux classification listed to another classification, or to an unlisted electrode-flux classification							E		
Shielding										
4.1.5.4	(1) A change in the specified nominal head or torch gas composition		E	E	E	E	E			E
	(2) A change in the specified nominal backing (purge) gas composition		E	E	E	E	E			E
	(3) An omission or deletion of torch shielding gas		E	E	E	E	E			E
	(4) The addition or deletion of a trailing gas			N	N	N	N			
	(5) A change in shielding as a result of an addition or deletion of flux or a change in the flux type		E	E	E		E		E	
	(6) A change in the shielding gas flow rate greater than ±25% from that qualified		E	E	E	E	E			E
	(7) A change in the backing (purge) gas flow rate greater than ±10% from that qualified		N	N	N	N	N		N	
	(8) Deletion of a backing (purge) gas		E	E	E	E	E		E	
	(9) A change of shielding environment from vacuum to inert gas	E				E				
	(10) An increase or decrease in vacuum pressure	E								
	(11) A change in shielding as a result of a change in ferrule or flux type									E

(Continued)

Table 1 (Continued)
Essential and Nonessential Variables for Procedure Qualification

SectionParagraph		WELDING PROCESSES ⁽¹⁾								
		EBW	FCAW	GMAW	GTAW	LBW	PAW	SAW	SMAW	SW
4.1.5.4 (12) (Cont'd)	The addition, deletion, a flow rate change greater than 5% for any gas used in the process, or a change in the orientation of the plasma-removing gas jet relative to the work piece (e.g., coaxial transverse to beam)					E				

Electrical Characteristics

4.1.5.5 (1)	The addition or deletion of pulsing current	E	E	N	N		E			
(2)	Any change in pulsing parameters from that qualified	N	N	N	N		N			
(3)	A change in current type or polarity		E	E	E		E	E	E	E
(4)	A change in the current range greater than $\pm 10\%$ from that qualified				N	N	N		N	
(5)	A change in the current (or wire feed) range greater than $\pm 10\%$ from that qualified		N	N				N		
(6)	A change in tungsten type				N		N			
(7)	A change in tungsten size				N		N			
(8)	A change exceeding $\pm 2\%$ in the voltage from that qualified	E								
(9)	A change exceeding $\pm 7\%$ in the voltage from that qualified		N	N				N		
(10)	A change exceeding $\pm 5\%$ in the beam or beam focus current from that qualified	E								
(11)	A change in laser power exceeding $\pm 5\%$ from that qualified					E				
(12)	A change in the mode of metal transfer from short-circuiting to globular, spray, or pulsed and vice versa		E	E						
(13)	A change in filament type, size, or shape	E								
(14)	A change in the type of power source, or a change in the arc timing exceeding 1/10 second, or a change in amperage exceeding $\pm 10\%$ from that qualified									E

Other Variables

4.1.5.6 (1)	A change in the welding process	E	E	E	E	E	E	E	E	E
(2)	A change in the cup or nozzle size		N	N	N		N			
(3)	A change from a collet body to a gas lens or vice versa				N					

(Continued)

Table 1 (Continued)
Essential and Nonessential Variables for Procedure Qualification

Section	Paragraph	WELDING PROCESSES ⁽¹⁾								
		EBW	FCAW	GMAW	GTAW	LBW	PAW	SAW	SMAW	SW
4.1.5.6	(4) A change in the cleaning method (Cont'd)	N	N	N	N	N	N	N	N	N
	(5) A change in the type of welding (manual, semiautomatic, mechanized, or automatic)		N	N	N		N	N	N	N
	(6) A change exceeding $\pm 10\%$ in travel speed for mechanized or automatic welding		N	N	N		N	N	N	
	(7) A change in the nominal size or shape of the stud at the section to be welded									E
	(8) A change exceeding $\pm 2\%$ in travel speed	N				N				
	(9) A change in the stud gun model, or a change exceeding 1/32 in [1 mm] in the nominal lift									E
	(10) A change exceeding $\pm 5\%$ in focus or gun-to-workpiece distance, or axis of beam angle relative to the workpiece	N								
	(11) A change in position		N	N	N		N	N	N	N
	(12) A change in vertical progression		E	E	N		N		E	
	(13) A change in electrode stick out		N	N				N		

Other Welding Variables

4.1.5.7 Other welding processes not covered by this matrix may be used provided the WPSs are qualified by applicable tests as prescribed in Section 4.1 (procedure qualification) and approved by the Owner. In conjunction with the tests, the WPSs and limitation of essential variables applicable to the specific welding process shall be established by the Contractor developing the WPS and approved by the Owner. The range of essential variables shall be based on documented evidence of experience with the process, or a series of tests shall be conducted to establish the limit of essential variables. Any change in essential variables outside the range so established shall require requalification.

Note:

(1) Process Abbreviations:

EBW = Electron Beam Welding
 FCAW = Flux Cored Arc Welding
 GMAW = Gas Metal Arc Welding
 GTAW = Gas Tungsten Arc Welding
 LBW = Laser Beam Welding
 PAW = Plasma Arc Welding
 SAW = Submerged Arc Welding
 SMAW = Shielded Metal Arc Welding
 SW = Stud Arc Welding

4.2.6 Documentation should be maintained that shows the qualified welder or welding operator has welded in the six (6) month period listed in 4.2.5.

4.2.7 Verification performance test welds may be required by the Owner or Owner's Authorized Representative at any time during the duration of the contract (see Section 3, Definitions).

A welder or welding operator who fails the verification performance test may be retested using (1) or (2) below.

(1) If a verification performance retest is permitted without further training or practice, it shall consist of two consecutive verification performance test weldments for each position failed. Both verification performance test weldments shall be acceptable for the welder or welding operator to qualify. If either verification performance test weldment does not meet the requirements of 4.2.2, the welder or welding operator shall requalify by standard test as directed by 4.2.1.

(2) Provided that the welder or welding operator has had further training or practice, one verification performance test weld for each position failed is permitted. If the verification performance test weldment does not meet the requirements of 4.2.2, the welder or welding operator shall be retested in accordance with 4.2.1.

4.2.8 Performance Qualification Variables. Qualification with one WPS will also qualify for welding with any other WPS within the limits given in the following performance qualification variables shown in Table 2.

4.2.8.1 The performance qualification variables for welders are listed in 4.2.8.1 of Table 2.

4.2.8.2 The performance qualification variables for welding operators are listed in 4.2.8.2 of Table 2.

5. Fabrication Practices

A detailed discussion of basic fabrication requirements is beyond the scope of this document. The rules and guidelines provided below are included to prevent or minimize contamination of the stainless steel and nickel alloys.

5.1 Mandatory Standard Practices. The following items shall be a part of the fabricators standard practices.

5.1.1 Stainless steel and nickel alloy fabrication shall be segregated from that of carbon and low alloy steels to minimize iron contamination.

5.1.2 If fabrication equipment (i.e., brakes, rolls, presses, etc.) is used for both carbon steel and stainless or nickel alloy material, prudent measures shall be taken to prevent iron contamination. These measures may

include, but are not limited to, cleaning or flexible isolation barriers (such as carpet, cardboard, paper, plastic, etc.).

5.1.3 Tools or abrasive materials that have been previously used on carbon or low alloy steels shall not be used on stainless steel or nickel alloys.

5.1.4 To minimize iron contamination, stainless steel and nickel alloy material shall not be stored, nor handled, in contact with carbon steel.

5.2 Nonmandatory Standard Practices. The following items should be a part of the fabricator's standard practices.

5.2.1 Material storage facilities should be designed and operated to minimize damage, contamination, and loss of material identity.

5.2.2 Forming equipment that makes contact with the workpiece surface, such as bending dies and rolls should be free of dirt, burrs, and other foreign materials that might become embedded in the workpiece surface.

5.2.3 Prior to welding, each side the weld joint should be cleaned and free of dirt, oxides, oil, and grease.

5.2.4 Members to be welded should be brought into correct alignment and held by suitable mechanical devices or tack welds.

5.2.4.1 Tack welds shall be free of cracks, porosity, and heat discoloration.

5.2.4.2 Tack welds shall be fully consumed by subsequent welding operations.

5.2.4.3 Tack welds not incorporated into final welds shall be removed unless otherwise permitted by specification.

6. Visual Examination Requirements

6.1 Extent of Examination. Two separate inspections may be required for equipment approval.

6.1.1 Welders and welding operators shall examine each weld they make and verify that the weld meets the criteria in 6.2 prior to post weld finishing. Supervisors shall examine a representative portion of each welder's and welding operator's production to verify that the work is satisfactory.

6.1.2 Welds that require special finishing by the contract specification shall also be examined in the finished condition in accordance with 6.3 and 6.4.

Table 2
Essential and Nonessential Variables for Performance Qualification

PERFORMANCE QUALIFICATION VARIABLES

A change in any variable listed below from that which was used in the welder's qualification test will require requalification of the welder:

Section	Paragraph	FCAW	GMAW	GTAW	PAW	SAW	SMAW	SW
Welders								
4.2.8.1	(1) A change in the welding process	E	E	E	E	E	E	E
	(2) The deletion of backing	E	E	E	E	E	E	
	(3) A change in the filler metal F-Number except as permitted in AWS B2.1	E	E	E	E	E	E	
	(4) A change in base metal except as permitted in AWS B2.1	E	E	E	E	E	E	E
	(5) A change from alternating to direct current or vice versa, or a change in polarity			E				
	(6) A change in position from that qualified except as permitted in AWS B2.1	E	E	E	E	E	E	E
	(7) A change in vertical weld progression from uphill to downhill, or vice versa for any pass except root passes that are completely removed by back gouging or final passes used to dress the final weld surface	E	E	E	E		E	
	(8) A change from spray transfer, globular transfer, or pulsed spray transfer to short-circuiting transfer, or vice versa	E	E					
	(9) The omission or addition of consumable inserts, or the deletion of root shielding gas except for double welded butt joints, partial penetration groove, and fillet welds	E	E	E	E	E	E	
	(10) A change in thickness or diameter from that tested except as permitted in AWS B2.1	E	E	E	E	E	E	E

A change in any variable listed below from that which was used in the operator's qualification test will require requalification of the operator:

Section	Paragraph	EBW	FCAW	GMAW	GTAW	LBW	PAW	SAW	SW
Welding Operators									
4.2.8.2	(1) A change in the welding process	E	E	E	E	E	E	E	E
	(2) A change from direct visual to remote visual control or vice versa	E	E	E	E	E	E	E	E
	(3) A change in base metal except as permitted in AWS B2.1	E	E	E	E	E	E	E	E
	(4) A change in position from that qualified except as permitted in AWS B2.1	E	E	E	E	E	E	E	E
	(5) A change from spray transfer, globular transfer, or pulsed spray transfer to short-circuiting transfer, or vice versa			E					
	(6) The deletion of consumable inserts		E	E	E		E	E	

6.2 Visual Examination Acceptance Criteria

6.2.1 Weld Acceptance Criteria. The provisions of this section apply to the integrity of all welds prior to any weld finishing operation. The weld quality shall meet the requirements shown in 6.2.1.1 through 6.2.1.7. Equipment constructed to other codes or specifications shall also meet the acceptance criteria of those codes or specifications.

6.2.1.1 The weld shall have no cracks.

6.2.1.2 Complete fusion shall exist between adjacent passes of weld metal and between weld metal and base metal.

6.2.1.3 All craters shall be filled to the full cross section of the weld.

6.2.1.4 Weld profiles shall be in accordance with Figure 1(A), (B), or (D), and shall meet the limits stated below. Typical unacceptable weld profiles are shown in Figure 1(C) and (E).

(1) For fillet welds in surface classification Zones 1 and 2, convexity or concavity in final fabricated form shall be minimized to the extent that no product or cleaning solution shall be trapped after cleaning or that the effectiveness of cleaning is compromised. Fillet weld profiles may be slightly convex, flat, or slightly concave in surface classification Zones 3 and 4.

(2) Groove welds shall be made with minimum weld reinforcement unless otherwise stated. Reinforcement of welds with WF-1 through WF-5 Finish shall not exceed the limits shown in Table 3.

Individual passes on multiple pass welds shall be transitioned into previous passes in such a way as to avoid coarse ripples, and abrupt ridges and valleys.

6.2.1.5 Welds shall be free of overlap. Undercut shall not exceed the following dimensions:

(1) 1/64 in [0.4 mm] for material less than 3/16 in [5 mm] in thickness

(2) 1/32 in [1 mm] for material equal to or greater than 3/16 in [5 mm] and less than 1 in (25 mm) in thickness

(3) 1/16 in [2 mm] is permitted for an accumulated length of 2 in [50 mm] in any 12 in (300 mm) in material thicker than 1/2 in [13 mm]

(4) 1/16 in [2 mm] for material equal to or thicker than 1 in [25 mm]

6.2.1.6 Neither the weld face nor root of the weld shall have an underfill condition (concave profile) exceeding 10% of the wall thickness of the thinner member. No level of underfill (concave profile) is acceptable when it does not allow the processing or cleaning products to drain completely or compromises the effectiveness of cleaning.

6.2.1.7 For welds in Zones 1, 2, and 3 of Figure 2, no visible porosity is permitted.

6.2.1.8 For welds in Zone 4 of Figure 2, the sum of diameters of visible porosity 1/32 in [1 mm] or greater shall not exceed 3/8 in [10 mm] in any linear inch of weld, and shall not exceed 3/4 in [19 mm] in any 12 in [300 mm] length of weld.

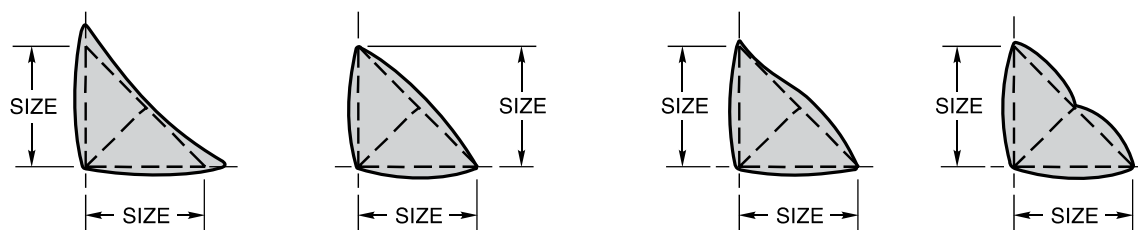
6.3 Finished Weld Acceptance Criteria. The provisions of this section apply to welds in Zones 1, 2, and 3, unless otherwise specified. These welds shall meet the weld finish specified by the Owner per 1.2. Such welds shall be reexamined after surface finishing to verify that the surfaces meet the Owner's specification and the quality requirements of 6.3.

6.3.1 Welds shall not contain any discontinuity open to the surface such as cracks, undercut, crevices, porosity, pits, or embedded nor protruding materials.

6.3.2 Intermittent fillet welds are prohibited on Zones 1, 2, and 3 to eliminate crevices that could contribute to bacteria growth and contamination of the product.

Table 3
Weld Reinforcement—Groove Welds

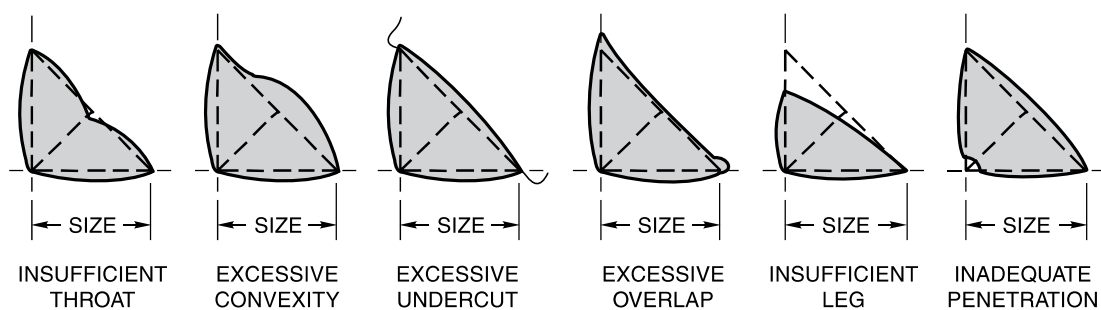
Material Thickness		Max Reinforcement	
< 1/16 in	< 2 mm	0.030 in	1 mm
1/16–1/8 in	2 mm–4 mm	0.060 in	2 mm
> 1/8–5/8 in	> 4 mm–17 mm	3/32 in	3 mm
> 5/8 in	> 17 mm	1/8 in	4 mm



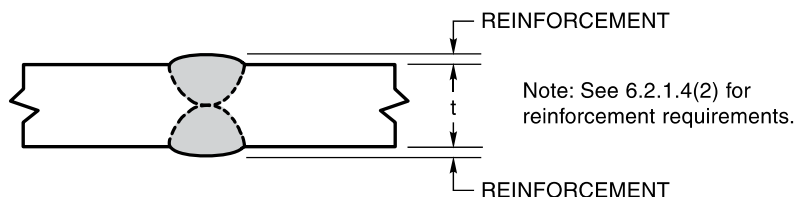
Note: See 6.2.1.4(1) for fillet weld profile requirements.

(A) DESIRABLE FILLET WELD PROFILES

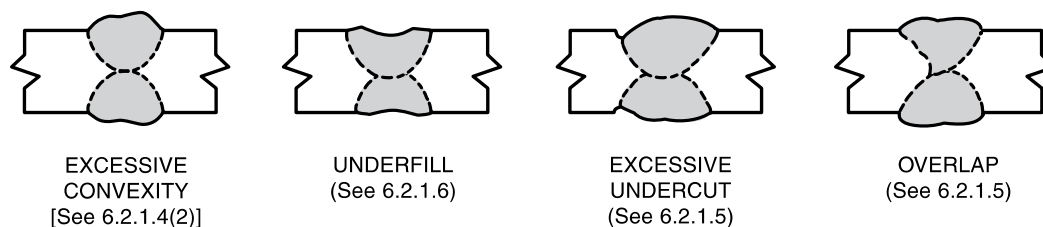
(B) ACCEPTABLE FILLET WELD PROFILES



(C) UNACCEPTABLE FILLET WELD PROFILES

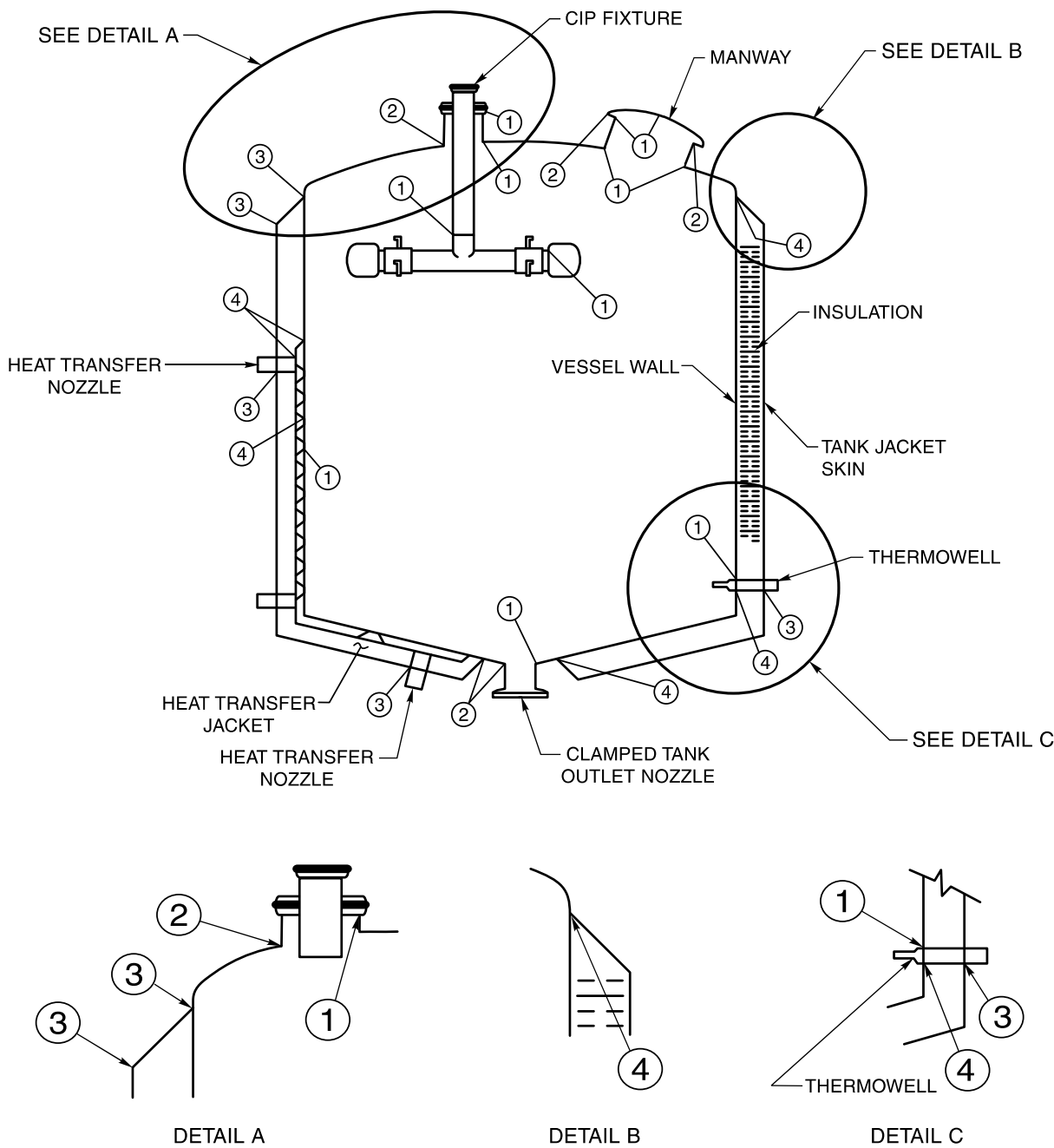


(D) ACCEPTABLE GROOVE WELD PROFILE



(E) UNACCEPTABLE GROOVE WELD PROFILES

Figure 1—Acceptable and Unacceptable Weld Profiles



Surface Classification Zones
Zone 1—Product Contact Surface (PCS)
Zone 2—Nonproduct Contact Surface—Exposed (NPCS-E)
Zone 3—Nonproduct Contact Surface—Remote (NPCS-R)
Zone 4—Nonexposed Surfaces (NES)

Figure 2—Schematic Example of Surface Classification Zones

6.3.3 All Zone 1 and 2 weld surfaces shall be finished so that:

- (1) No product or cleaning solution is trapped after cleaning, and
- (2) The effectiveness of cleaning is not compromised.

6.3.4 All internal angles of less than 135° on product contact surfaces shall have radii of not less than $1/4$ in [6 mm], except that when the thickness one or of both parts being joined is less than $3/16$ in [5 mm] the minimum radii for fillet welds on product contact surfaces shall be not less than $1/8$ in [3 mm].

6.3.5 When finishing welds, particularly fillet welds, the final dimensions of the weld throat and the adjacent base metal shall not be less than the minimum specified.

7. Documentation

7.1 The manufacturer or Contractor shall maintain copies of Procedure Qualification Records, and Welding Procedure Specifications for each type of joint welded on the project. These records shall be made available per specification or contract.

7.2 The manufacturer or Contractor shall maintain copies of Performance Qualification Test Records.

7.3 The manufacturer or Contractor should prepare, certify, and deliver a document to the Owner that states that all welds meet all of the requirements of this specification.

This page is intentionally blank.

Nonmandatory Annexes

Annex A

Guidelines for Preparation of Technical Inquiries for AWS Technical Committees

(This Annex is not a part of AWS D18.3/D18.3M:2005, *Specification for Welding of Tanks, Vessels, and Other Equipment in Sanitary (Hygienic) Applications*, but is included for informational purposes only.)

A1. Introduction

The AWS Board of Directors has adopted a policy whereby all official interpretations of AWS standards will be handled in a formal manner. Under that policy, all interpretations are made by the committee that is responsible for the standard. Official communication concerning an interpretation is through the AWS staff member who works with that committee. The policy requires that all requests for an interpretation be submitted in writing. Such requests will be handled as expeditiously as possible but due to the complexity of the work and the procedures that must be followed, some interpretations may require considerable time.

A2. Procedure

All inquiries must be directed to:

Managing Director, Technical Services
American Welding Society
550 N.W. LeJeune Road
Miami, FL 33126

All inquiries must contain the name, address, and affiliation of the inquirer, and they must provide enough information for the committee to fully understand the point of concern in the inquiry. Where that point is not clearly defined, the inquiry will be returned for clarification. For efficient handling, all inquiries should be type-written and should also be in the format used here.

A2.1 Scope. Each inquiry must address one single provision of the standard, unless the point of the inquiry involves two or more interrelated provisions. That provision must be identified in the scope of the inquiry, along

with the edition of the standard that contains the provisions or that the inquirer is addressing.

A2.2 Purpose of the Inquiry. The purpose of the inquiry must be stated in this portion of the inquiry. The purpose can be either to obtain an interpretation of a standard's requirement, or to request the revision of a particular provision in the standard.

A2.3 Content of the Inquiry. The inquiry should be concise, yet complete, to enable the committee to quickly and fully understand the point of the inquiry. Sketches should be used when appropriate and all paragraphs, figures, and tables (or the Annex), which bear on the inquiry must be cited. If the point of the inquiry is to obtain a revision of the standard, the inquiry must provide technical justification for that revision.

A2.4 Proposed Reply. The inquirer should, as a proposed reply, state an interpretation of the provision that is the point of the inquiry, or the wording for a proposed revision, if that is what the inquirer seeks.

A3. Interpretation of Provisions of the Standard

Interpretations of provisions of the standard are made by the relevant AWS Technical Committee. The secretary of the committee refers all inquiries to the chairman of the particular subcommittee that has jurisdiction over the portion of the standard addressed by the inquiry. The subcommittee reviews the inquiry and the proposed reply to determine what the response to the inquiry should be. Following the subcommittee's development of the response, the inquiry and the response are presented to the entire committee for review and approval. Upon

approval by the committee, the interpretation will be an official interpretation of the Society, and the secretary will transmit the response to the inquirer and to the *Welding Journal* for publication.

A4. Publication of Interpretations

All official interpretations will appear in the *Welding Journal* and will be posted on the AWS web site.

A5. Telephone Inquiries

Telephone inquiries to AWS Headquarters concerning AWS standards should be limited to questions of a general nature or to matters directly related to the use of the standard. The Board of Directors' policy requires that all AWS staff members respond to a telephone request for an official interpretation of any AWS standard with the information that such an interpretation can be

obtained only through a written request. The Headquarters staff cannot provide consulting services. The staff can, however, refer a caller to any of those consultants whose names are on file at AWS Headquarters.

A6. The AWS Technical Committee

The activities of AWS Technical Committees regarding interpretations, are limited strictly to the interpretation of provisions of standards prepared by the committee or to consideration of revisions to existing provisions on the basis of new data or technology. Neither the committee nor the staff is in a position to offer interpretive or consulting services on: (1) specific engineering problems; or (2) requirements of standards applied to fabrications outside the scope of the document or points not specifically covered by the standard. In such cases, the inquirer should seek assistance from a competent engineer experienced in the particular field of interest.

Annex B

Weld and Adjacent Zone Finishes

(This Annex is not a part of AWS D18.3/D18.3M:2005, *Specification for Welding of Tanks, Vessels, and Other Equipment in Sanitary (Hygienic) Applications*, but is included for informational purposes only.)

The fabricator may use workmanship examples, electronic images, or photographs of the weld finishes noted below to further define acceptance criteria. Such examples shall be available for review by the Owner if requested.

- | | |
|---|--|
| <p>WF-1 As welded. No further work required.</p> <p>WF-2 All weld slag shall be removed. The removal of other nonmetallic adhesions on the weld surface is not required. Loose weld spatter shall be removed, but firmly adhering spatter may be left in place.</p> <p>WF-3 All slag and other adhesions (metallic and non-metallic), including weld spatter, shall be removed.</p> <p>WF-4 WF-3, plus heat discoloration shall be removed using either mechanical (grinding, polishing, bead blasting, and so forth), chemical (passivating or pickling), or electrochemical means (electropolishing) methods. Adhesive tape may be applied on both sides of the weld to produce a uniformly striped appearance.</p> <p>WF-5 WF-3 or WF-4 as specified in the contract documents, plus the weld surface shall have a uniform appearance. Small ripples and minor irregularities are acceptable. If grinding is required for coarse ripples or irregularities, the abrasive shall be no rougher than 60 grit unless otherwise specified by the Owner. No roughness levels (R_a) shall be specified for WF-5.</p> | <p>WF-6 WF-3 or WF-4 as specified in contract documents, plus the weld surfaces shall be ground smooth and uniform. Groove welds may have a significant amount of material removed but are not required to be flush with the base metal. The weld toes may still be visible. Pits and crevices shall be removed by weld filling (as needed) and grinding. The final grinding abrasive shall be no rougher than 80 grit unless otherwise specified by the Owner. When a requirement exists for fillet welds, the weld profile shall be flat or concave. Convex fillet welds are not acceptable. No (R_a) shall be specified for WF-6.</p> <p>WF-7 WF-3 or WF-4, plus the surfaces of groove welds shall be ground smooth and flush with the base metal. Pits and crevices shall be removed by grinding or by weld filling and grinding, as needed. Such finishing shall not reduce the base metal thickness below the minimum design thickness. Grinding marks are not required to blend with the base metal, but the average roughness value shall be comparable to the base metal. The final surface roughness (R_a) shall be specified by the Owner. Adhesive tape may be applied on both sides of the weld to produce a uniformly striped appearance. Fillet welds shall be ground to a concave profile, and the toes shall blend smoothly into the base metal. Surfaces shall meet the same roughness criteria.</p> <p>WF-8 WF-7, plus the weld shall be electropolished to the (R_a) specified by the Owner.</p> |
|---|--|

This page is intentionally blank.

Annex C

Sample Forms

(This Annex is not a part of AWS D18.3/D18.3M:2005, *Specification for Welding of Tanks, Vessels, and Other Equipment in Sanitary (Hygienic) Applications*, but is included for informational purposes only.)

This Annex contains three sample forms.

C1. Sample of Welding Procedure Specification (WPS)

COMPANY NAME _____ BY _____

WPS No. _____ DATE _____

WPS REV. No. _____ REV. DATE _____

SUPPORTING PQR Nos. _____

WELDING PROCESS(ES) _____ TYPE _____

Manual, Semiautomatic, Automatic, Robotic

JOINTS

JOINT TYPE _____

BACKING _____

BACKING MATERIAL (TYPE) _____

GROOVE ANGLE _____

ROOT OPENING RADIUS ☐ U or ☐ J

ROOT FACE _____

BACKGOUGING ☐ YES or ☐ NO

BACKGOUGING METHOD _____

Joint Details

Sketches, production drawings, welding symbols, or written description should show the general arrangement of the parts to be welded. Where applicable, the root spacing details of the weld groove may be specified.

BASE METAL(S)

M-No. _____ GROUP No. _____ OR TO M-No. _____ GROUP No. _____

SPECIFICATION TYPE AND GRADE _____

TO SPECIFICATION TYPE AND GRADE _____

THICKNESS RANGE _____

OF BASE METAL GROOVE _____ FILLET _____

DEPOSITED METAL GROOVE _____ FILLET _____

PIPE DIAMETER RANGE GROOVE _____ FILLET _____

OTHER _____

FILLER METALS

FILLER METAL F-No. _____ OTHER _____

AWS CLASSIFICATION _____

AWS SPECIFICATION _____

WELD METAL ANALYSIS A-No. _____ OTHER _____

FILLER METAL SIZE _____

ELECTRODE-FLUX (CLASS) _____

FLUX TRADE NAME _____

CONSUMABLE INSERT _____

OTHER _____

C1. Sample WPS Form (Continued)

WPS NUMBER (PAGE 2) _____

POSITIONS

POSITION(S) OF GROOVE _____

WELD PROGRESSION _____

POSITION(S) OF FILLET _____

PREHEAT

PREHEAT TEMP. (MINIMUM) _____

INTERPASS TEMP. (MAXIMUM) _____

PREHEAT MAINTENANCE _____

CONTINUOUS OR SPECIAL HEATING OR MAINTENANCE _____

POSTWELD HEAT TREATMENT

TEMPERATURE _____

TIME _____

SHIELDING

	SHIELDING	BACKING	TRAILING
GAS(ES)			
COMPOSITION			
FLOW RATE			

FLUX ☐ YES or ☐ NO

FLUX TYPE/TRADE NAME _____

ELECTRICAL CHARACTERISTICS

CURRENT TYPE AND POLARITY _____

PULSING ☐ YES or ☐ NO

CURRENT (RANGE) _____

VOLTAGE (RANGE) _____

WIRE FEED SPEED (RANGE) _____

TUNGSTEN ELECTRODE SIZE AND TYPE _____

PULSING PARAMETERS _____

OTHER _____

OTHER VARIABLES

CUP OR NOZZLE SIZE _____

COLLET BODY ☐ OR GAS LENS ☐

CLEANING METHOD _____

NUMBER OF ELECTRODES _____

OTHER _____

WELDING PARAMETERS

LAYERS	PROCESS	FILLER METAL		ELECTRICAL			TRAVEL SPEED RANGE
		Class	Diameter	Type and Polarity	Current Range	Voltage Range	

C2. Sample of Procedure Qualification Record (PQR)

COMPANY NAME _____ BY _____
 PQR No. _____ DATE _____
 PQR REV. No. _____ REV. DATE _____
 SUPPORTING WPS Nos. _____
 WELDING PROCESS(ES) _____ TYPE _____
 Manual, Semiautomatic, Automatic, Robotic

JOINTS

JOINT TYPE _____
 BACKING _____
 BACKING MATERIAL (TYPE) _____
 GROOVE ANGLE _____
 ROOT OPENING RADIUS ☐ U or ☐ J
 ROOT FACE _____
 BACKGOUGING ☐ YES or ☐ NO
 BACKGOUGING METHOD _____

Joint Details

Sketches, production drawings, welding symbols, or written description should show the general arrangement of the parts to be welded. Where applicable, the root spacing details of the weld groove may be specified.

BASE METAL(S)

M-No. _____ GROUP No. _____ OR TO M-No. _____ GROUP No. _____
 SPECIFICATION TYPE AND GRADE _____
 TO SPECIFICATION TYPE AND GRADE _____
 THICKNESS RANGE _____
 OF BASE METAL GROOVE _____ FILLET _____
 PIPE DIAMETER RANGE GROOVE _____ FILLET _____
 OTHER _____

FILLER METALS

FILLER METAL F-No. _____ OTHER _____
 AWS CLASSIFICATION _____ AWS SPECIFICATION _____
 WELD METAL ANALYSIS A-No. _____ OTHER _____
 FILLER METAL SIZE _____
 ELECTRODE-FLUX (CLASS) _____
 FLUX TRADE NAME _____
 CONSUMABLE INSERT _____
 OTHER _____

C2. Sample PQR Form (Continued)

PQR NUMBER (Page 2) _____

POSITIONS

POSITION(S) OF GROOVE _____ WELD PROGRESSION _____

POSITION(S) OF FILLET _____

PREHEAT

PREHEAT TEMPERATURE _____ INTERPASS TEMPERATURE _____

POSTWELD HEAT TREATMENT

TEMPERATURE _____ TIME _____

SHIELDING

	SHIELDING	BACKING	TRAILING
GAS(ES)			
COMPOSITION			
FLOW RATE			

FLUX ☐ YES or ☐ NO FLUX TYPE/TRADE NAME _____**ELECTRICAL CHARACTERISTICS AND WELDING PARAMETERS**CURRENT TYPE AND POLARITY _____ PULSING ☐ YES or ☐ NO

CURRENT (RANGE) _____ VOLTAGE (RANGE) _____

WIRE FEED SPEED (RANGE) _____ TRAVEL SPEED (RANGE) _____

TUNGSTEN ELECTRODE SIZE AND TYPE _____

PULSING PARAMETERS _____

OTHER _____

OTHER VARIABLESCUP OR NOZZLE SIZE _____ ☐ COLLET BODY or ☐ GAS LENSCLEANING METHOD _____ TECHNIQUE: ☐ STRINGER or ☐ WEAVE

NUMBER OF ELECTRODES _____ NUMBER OF PASSES PER SIDE _____

OTHER _____

WELDING PARAMETERS

LAYERS	PROCESS	FILLER METAL		ELECTRICAL			TRAVEL SPEED RANGE
		Class	Diameter	Type and Polarity	Current Range	Voltage Range	

C2. Sample PQR Form (Continued)

PQR NUMBER (Page 3) _____

TENSILE TESTS

Specimen No.	Width	Thickness	Area	Results				Failure Type and Location
				Yield Load	Yield Strength	Tensile Load	Tensile Strength	

GUIDED BEND TESTS

Type and Figure Number	Results

WELDER'S NAME _____

ID or SS No. _____

TESTS CONDUCTED BY _____

LAB TEST No. _____

We, the undersigned, certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of AWS D18.3.

MANUFACTURER OR CONTRACTOR _____

DATE _____ BY _____

Please Print

Signature

C3. Sample of Welder Qualification Test Record

Welder or Welding Operator Qualification Test Record

☐ Welder Qualification ☐ Verification Test

Welder's Name _____ Identification No. _____

WPS Followed _____ Revision _____

Base Metal Specification _____ ☐ PLATE or ☐ PIPE

Welder Qualification Variables	Actual Values	Range Qualified
Welding process(es)		
Type used	☐ Manual, ☐ Semiautomatic, or ☐ NA	☐ Manual, ☐ Semiautomatic, or ☐ NA
Mode of Transfer (GMAW)	☐ Short circuiting, ☐ Globular, ☐ Spray, ☐ Pulses spray, or ☐ NA	☐ Short circuiting, ☐ Globular, ☐ Spray, ☐ Pulses spray, or ☐ NA
Base metal M-No. (see AWS B2.1)		
Thickness		
Diameter (if pipe or tube)		
Backing	☐ With or ☐ Without	☐ With or ☐ Without
Consumable inserts	☐ With or ☐ Without	☐ With or ☐ Without
Current type and polarity	☐ DCEN, ☐ DCEP, ☐ Alternating, ☐ Pulsing, or ☐ NA	☐ DCEN, ☐ DCEP, ☐ Alternating, ☐ Pulsing, or ☐ NA
Filler metal specification and class		
Filler metal F-No. (see AWS B2.1)		
Welding position	☐ 1G, ☐ 2G, ☐ 3G, ☐ 4G, ☐ 5G, ☐ 6G ☐ 1F, ☐ 2F, ☐ 3F, ☐ 4F, ☐ 5F ☐ OTHER	☐ 1G, ☐ 2G, ☐ 3G, ☐ 4G, ☐ 5G, ☐ 6G ☐ 1F, ☐ 2F, ☐ 3F, ☐ 4F, ☐ 5F ☐ OTHER
Vertical progression	☐ Uphill, ☐ Downhill, or ☐ NA	☐ Uphill, ☐ Downhill, or ☐ NA
Welding Operator Qualification Variables	Actual Values	Range Qualified
Welding process(es)		
Type used	☐ Machine, ☐ Mechanized, ☐ Automatic, or ☐ NA	☐ Machine, ☐ Mechanized, ☐ Automatic, or ☐ NA
Control	☐ Direct visual, ☐ Remote visual, or ☐ NA	☐ Direct visual, ☐ Remote visual, or ☐ NA
Mode of transfer (GMAW)	☐ Short circuiting, ☐ Globular, ☐ Spray, ☐ Pulsed spray, or ☐ NA	☐ Short circuiting, ☐ Globular, ☐ Spray, ☐ Pulsed spray, or ☐ NA
Base metal M-No. (see AWS B2.1)		
Consumable inserts	☐ With or ☐ Without	☐ With or ☐ Without
Welding position	☐ 1G, ☐ 2G, ☐ 3G, ☐ 4G, ☐ 5G, ☐ 6G ☐ 1F, ☐ 2F, ☐ 3F, ☐ 4F, ☐ 5F ☐ OTHER	☐ 1G, ☐ 2G, ☐ 3G, ☐ 4G, ☐ 5G, ☐ 6G ☐ 1F, ☐ 2F, ☐ 3F, ☐ 4F, ☐ 5F ☐ OTHER

RESULTS

Visual Examination: Acceptable ☐ Yes or ☐ No

Guided Bend Test Results

Identification No.	Type	Result	Identification No.	Type	Result

Fillet Weld Test Results

Bend-Break Test Result _____	Fillet Size _____
Macroetch Result _____	Remarks _____

Inspected by _____ Test Number _____
Organization _____ Date _____

Radiographic Examination

Identification No.	Result	Remarks	Identification No.	Result	Remarks

Interpreted by _____ Certification Level _____
Organization _____ Test Number _____ Date _____

We the undersigned certify that the statements in this record are correct and that the test welds were prepared, welded, and tested in accordance with the requirements of AWS D18.3.

Date _____ Manufacturer or Contractor _____
Authorized By _____

This page is intentionally blank.

List of AWS Documents on Welding in Sanitary Applications

Designation	Title
D18.1	<i>Specification for Welding of Stainless Steel Tube and Pipe Systems in Sanitary (Hygienic) Applications</i>
D18.2	<i>Guide to Weld Discoloration Levels on Inside of Austenitic Stainless Steel Tube</i>

This page is intentionally blank.

Copyright American Welding Society
Provided by IHS under license with AWS
No reproduction or networking permitted without license from IHS

