

AWS D1.2/D1.2M:2003
An American National Standard



Structural Welding Code— Aluminum



American Welding Society



Key Words—Aluminum plate, castings, cyclically loaded structures, inspection, qualification, structural details, statically loaded structures, structural shapes, stud welding, tubular structures

AWS D1.2/D1.2M:2003
An American National Standard

Approved by
American National Standards Institute
February 6, 2003

Structural Welding Code— **Aluminum**

Fourth Edition

Supersedes ANSI/AWS D1.2-97

Prepared by
AWS D1 Committee on Structural Welding

Under the Direction of
AWS Technical Activities Committee

Approved by
AWS Board of Directors

Abstract

This code covers the welding requirements for any type structure made from aluminum structural alloys, except for aluminum pressure vessels and fluid-carrying pipe lines. Sections 1 through 7 constitute a body of rules for the regulation of welding in aluminum construction. This edition has been reorganized extensively from the 1997 edition. A Commentary on the code is also included with the document.



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: 0-87171-704-2

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

© 2003 by American Welding Society. All rights reserved

Printed in the United States of America

Reprinted: September 2004

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. AWS disclaims liability for the infringement of any patent resulting from the use or reliance on 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 D1 Committee on Structural Welding. 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 D1 Committee on Structural Welding 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 D1 Committee on Structural Welding 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>.

Personnel

AWS D1 Committee on Structural Welding

<i>D. D. Rager, Chair</i>	Rager Consulting
<i>D. K. Miller, Vice Chair</i>	The Lincoln Electric Company
<i>A. W. Sindel, Vice Chair</i>	Sindel and Associates
<i>B. M. Butler, Vice Chair</i>	Walt Disney World Company
<i>J. L. Gayler, Secretary</i>	American Welding Society
* <i>W. G. Alexander</i>	WGAPE
<i>N. J. Altebrando</i>	Hardesty & Hanover, LLP
<i>F. G. Armao</i>	The Lincoln Electric Company
<i>E. M. Beck</i>	Law Engineering and Environmental Services
* <i>F. R. Beckmann</i>	Consultant
<i>E. L. Bickford</i>	J. Ray McDermott, Incorporated
<i>R. D. Block</i>	Diamond Power International, Incorporated
* <i>O. W. Blodgett</i>	The Lincoln Electric Company
<i>R. Bonneau</i>	Canadian Welding Bureau
<i>F. C. Breismeister</i>	Strocal, Incorporated
<i>H. H. Campbell</i>	Bay Limited
<i>L. E. Collins</i>	Team Industries, Incorporated
<i>R. B. Corbit</i>	Amer Gen
<i>M. V. Davis</i>	Consultant
<i>R. A. Dennis</i>	Consultant
* <i>J. D. Duncan</i>	Bechtel
* <i>G. L. Fox</i>	Consultant
* <i>A. R. Fronduti</i>	Rex Fronduti & Associates
<i>M. A. Grieco</i>	Massachusetts Highway Department
<i>C. R. Hess</i>	High Steel Structures, Incorporated
* <i>G. J. Hill</i>	G. J. Hill and Associates, Incorporated
<i>M. L. Hoitomt</i>	Consultant
<i>C. W. Holmes</i>	Modjeski and Masters
* <i>A. J. Julicher</i>	A. J. Julicher and Associates
<i>J. H. Kiefer</i>	ConocoPhillips
<i>S. L. Luckowski</i>	U.S. Army ARDEC
<i>P. W. Marshall</i>	MHP Systems Engineering
<i>M. J. Mayes</i>	Mayes Testing Engineers, Incorporated
<i>D. L. McQuaid</i>	D. L. McQuaid and Associates
<i>R. D. Medlock</i>	Texas Department of Transportation
<i>J. L. Munnerylyn</i>	Consultant
<i>J. E. Myers</i>	SMI Owen Steel Company, Incorporated
<i>J. W. Post</i>	J. W. Post and Associates, Incorporated
<i>J. E. Roth</i>	James E. Roth, Incorporated
<i>T. Schlafly</i>	American Institute of Steel Construction
<i>R. E. Shaw, Jr.</i>	Steel Structures Technology Center, Incorporated
* <i>D. L. Sprow</i>	Consultant
<i>R. W. Stieve</i>	Greenman-Pederson, Incorporated
<i>P. J. Sullivan</i>	Massachusetts Highway Department (Retired)
<i>M. M. Tayarani</i>	Massachusetts Turnpike Authority
<i>K. K. Verma</i>	Federal Highway Administration
<i>B. D. Wright</i>	Advantage Aviations Technology

*Advisor

AWS D1G—Subcommittee 7 on Aluminum Structures

<i>F. G. Armao, Chair</i>	The Lincoln Electric Company
<i>T. Anderson, Vice Chair</i>	AlcoTec Wire Corporation
<i>R. C. Briden, Vice Chair</i>	Consultant
<i>M. V. Davis</i>	Consultant
<i>*P. B. Dickerson</i>	Consultant
<i>C. W. Hayes</i>	The Lincoln Electric Company
<i>J. R. Kissell</i>	The TGB Partnership
<i>R. C. Minor</i>	Hapco Aluminum Poles
<i>C. K. Nicholson</i>	Law Engineering and Environmental Services
<i>D. D. Rager</i>	Rager Consulting
<i>*W. W. Sanders, Jr.</i>	Iowa State University
<i>P. J. Sullivan</i>	Massachusetts Highway Department (Retired)
<i>J. L. Uebele</i>	Waukesha County Technical College

*Advisor

Foreword

(This Foreword is not a part of AWS D1.2/D1.2M:2003, *Structural Welding Code—Aluminum*, but is included for informational purposes only.)

In 1928, the first edition of the code for *Fusion Welding and Gas Cutting in Building Construction* was published by the American Welding Society. In 1936, the first edition of a similar code for highway and railroad bridges was published. For a number of years, separate codes were continued for each type of steel structure.

The separate committees preparing the two codes were consolidated in 1963 into a single committee, the Structural Welding Committee. In 1972, the Committee consolidated the two codes into a single version applicable to structural welding in general, along with specific requirements for buildings, bridges, and tubular structures. A series of consolidated codes have been published since that initial one, representing the latest state of the art for welding of structural steel.

In the early 1970s, interest was expressed in developing a similar consolidated code for the structural welding of aluminum. Because of the interest of both The Aluminum Association and the American Welding Society, it was decided to begin in the mid-70s the task of developing a structural welding code for aluminum. Initially, the effort was undertaken by a task force of The Aluminum Association. In 1979, this task force became a subcommittee of the AWS Structural Welding Committee and the *Structural Welding Code—Aluminum* resulted from the continued activity of that subcommittee.

Many of the users of this code will also be users of the *Structural Welding Code—Steel*. As a result, it was felt that as much similarity as possible between the codes for steel and aluminum should be achieved. Thus, the same general format was used in the development of the 1983 and 1990 editions of the aluminum code as in the steel code. The D1.2-97 code was reorganized so that the 1990 Sections 4 and 5 (Technique and Qualification) were merged into one new Section 4. Furthermore, Appendix H of D1.2-90 was moved to after the Preface.

Sections 1 through 7 constitute a body of rules for the regulation of welding on aluminum structures. This edition represents a major reorganization of the D1.2-97 format (see Annex L). For example, Sections 7, 8, and 9 of D1.2-97 have been eliminated, and their provisions distributed throughout the code.

Users should note that, beginning in this edition, the tables and figures for each section will be located at the end of each section.

Recommended joint details have been prepared for numerous complete joint penetration groove welded joints. Herein lies one of the major differences between the *Structural Welding Code—Steel* and this code. While the steel code allows for prequalified welding procedures, this code does not. This is mainly because of the many and varied possible welding conditions that can be obtained with semi-automatic welding variables most often used with aluminum and the wide range of both heat treatable and nonheat treatable alloys that may be welded under this code. Therefore, all of the joint details and the welding procedures used with this code shall be individually qualified and included in the Welding Procedure Specification (WPS).

Procedures and standards are outlined for several methods of nondestructive testing. Methods included are visual, radiographic and dye-penetrant. Ultrasonic testing is allowed, but the procedure and acceptance criteria shall be specified in the contract documents (see Annex H).

This code does not concern itself with such design considerations as the arrangements of parts, loading, and the computation of stresses for proportioning the load-carrying members of a structure and their connection. Such considerations, it is assumed, are covered elsewhere in a general code or specification, such as the *Specification for Aluminum Structures* (The Aluminum Association).

The first edition of the *Structural Welding Code—Aluminum* (hereafter referred to as the *code*) represented the continuing AWS policy to provide standards for structural welding. This code is provided for the fabrication, erection and manufacturing industries as a set of rules and regulations for the welding of structural aluminum. Some of the more important aspects of this edition of the code are outlined in the following paragraphs.

Changes in Code Requirements. All editorial and technical changes to the text are indicated by underlining. Changes to illustrations are indicated by a single vertical line.

Commentary. After the first edition of this code was published, the Committee prepared a *Commentary on the Structural Welding Code—Aluminum*, similar to the Commentary for the AWS D1.1, *Structural Welding Code—Steel*. The Commentary was issued separately in 1984. In this edition, the Committee has updated the Commentary in line with the revised provisions, and it has been bound into the code after the Annexes. The Commentary is not intended to supplement code requirements, but only to provide a useful document for interpretation and application of the code. None of its provisions are binding.

Welding Inspector Qualifications. All users are urged to review the provisions relating to the welding inspector qualification requirements in 5.1.3 and its subsections. The requirements in this code are identical with those requirements for welding inspector qualification given in ANSI/AWS D1.1-88, *Structural Welding Code—Steel*.

Index. As in previous codes, the entries in the Index are referred to by subsection number rather than by page number. This should enable the user of the Index to locate a particular item of interest in minimum time.

Errata. It is the Structural Welding Committee's policy that all errata should be made available to users of the code. Therefore, in the Society News Section of the *AWS Welding Journal*, any errata (major corrections) that have been noted will be published in the July and November issues of the *Welding Journal*.

Suggestions. Comments and suggestions for the improvement of this standard are welcomed. They should be sent to the Secretary, AWS D1 Committee on Structural Welding, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

Interpretations. Official interpretations of any of the technical requirements of this standard may be obtained by sending a request, in writing, 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 (see Annex K).

Errata

(The following Errata have been identified and incorporated into the current reprint of this document.)

Page iii, Personnel—Add “H. H. Campbell...Bay Limited” to list of committee members.

Page 14, Section 3.11.2—incorrect reference to 5.14.5, 5.14.6, and 5.14.7—change to 5.15.1, 5.15.2, and 5.15.3.

Table of Contents

	Page No.
<i>Personnel</i>	iii
<i>Foreword</i>	v
<i>List of Tables</i>	xii
<i>List of Figures</i>	xiii
1. <u>General Requirements</u>	1
1.1 Scope	1
1.2 Approval	1
1.3 Definitions	1
1.4 Welding Symbols	1
1.5 Safety Precautions	1
1.6 Standard Units of Measure	1
1.7 <u>Reference Documents</u>	1
2. <u>Design of Welded Connections</u>	3
2.0 <u>Scope</u>	3
2.1 <u>Structural Design</u>	3
2.2 Drawings	3
2.3 Groove Welds	4
2.4 Fillet Welds	4
2.5 Plug and Slot Welds	4
2.6 Filler Plates	5
3. <u>Qualification</u>	9
Part A—General Requirements	9
3.1 General	9
3.2 Qualification of WPSs	9
3.3 Qualification of Welders, Welding Operators, and Tack Welders	9
3.4 Position of Test Welds	9
Part B—Types of Tests, Test Methods, and Acceptance Criteria	10
3.5 Types and Purposes of Tests	10
3.6 Visual Examination	11
3.7 Tension Tests—Groove Welds	11
3.8 Bend Tests—Groove Welds—Plate and Pipe	12
3.9 Soundness Tests—Groove Welds in Castings	13
3.10 Soundness Tests—Fillet Welds	14
3.11 RT	14
Part C—WPS Qualification	14
3.12 General	14
3.13 Limits of Qualified Positions for WPSs	15
3.14 Limitation of Essential Variables—WPS Qualification	15
3.15 Tests—WPS Qualification	15
3.16 Retests	16
Part D—Performance Qualification	16
3.17 General	16
3.18 Limits of Qualified Positions for Performance	16

3.19	Preparation of Test Weldments—Performance Qualification.....	16
3.20	<u>Essential Variables</u>	17
3.21	Tests—Performance Qualification.....	17
3.22	Retests.....	18
3.23	Period of Effectiveness	18
4.	<i>Fabrication</i>	63
4.0	<u>Scope</u>	63
4.1	Processes.....	63
4.2	Base Metal	63
4.3	Filler Metal	63
4.4	Tungsten Electrodes.....	64
4.5	Shielding Gas.....	64
4.6	Welding and Cutting Equipment	64
4.7	Backing	64
4.8	Preheat and Interpass Temperatures	64
4.9	Welding Environment	64
4.10	Compliance with Design.....	64
4.11	Preparation of Base Metal	64
4.12	Assembly	66
4.13	<u>Technique</u>	66
4.14	Tack and Temporary Welds	66
4.15	Dimensional Tolerances <u>for Welded Members</u>	67
4.16	Arc Strikes	67
4.17	Weld Termination	67
4.18	Control of Distortion and Shrinkage.....	68
4.19	Weld Profiles.....	68
4.20	Repairs	69
4.21	Copper Inclusions	69
4.22	Cleaning of Completed Welds	69
4.23	Anti-Spatter Compound.....	69
4.24	<u>Postweld Heat Treatment</u>	69
5.	<i>Inspection</i>	77
	Part A—General Requirements.....	77
5.1	General.....	77
5.2	Inspection of Materials	78
5.3	Inspection of WPS Qualification and Equipment.....	78
5.4	Inspection of Welder, Welding Operator, and Tack Welder Qualifications	78
5.5	Inspection of Work and Records.....	78
5.6	Obligations of the Contractor	78
5.7	Nondestructive Testing	79
5.8	Extent of Testing.....	79
	Part B—Radiographic Testing (RT) of Groove Welds in Butt Joints.....	80
5.9	General.....	80
5.10	RT Procedures.....	80
5.11	Acceptability of Welds	82
5.12	Examination, Report, and Disposition of Radiographs	82
	Part C—Ultrasonic Testing (UT) of Groove Welds	82
5.13	General.....	82
	Part D —Acceptance Criteria.....	83
5.14	Visual Inspection	83

5.15	RT	83
5.16	UT	84
5.17	PT	84
6.	<i>Stud Welding</i>	97
	Part A—General Requirements	97
6.1	General	97
6.2	Material Requirements	97
6.3	Workmanship	97
6.4	Qualification Requirements	97
6.5	Operator and Preproduction Qualification	99
6.6	Acceptance Criteria—Production Welds	99
6.7	Mislocated Studs	99
6.8	Repair of Misapplied Studs	99
	Part B—Arc Stud Welding	99
6.9	General Requirements	99
6.10	Material Requirements	99
6.11	Workmanship	99
6.12	Technique	99
	Part C—Capacitor Discharge Stud Welding	100
6.13	General Requirements	100
6.14	Material Requirements	100
6.15	Technique	100
7.	<i>Strengthening and Repair of Existing Structures</i>	105
7.1	General	105
7.2	Base Metal	105
7.3	Design	105
7.4	Repair Procedure	105
7.5	Inspection	105
	<i>Nonmandatory Annexes</i>	107
	<i>Annex A—Reference Documents</i>	107
	<i>Annex B—Recommended Groove Welded Joints</i>	109
	<i>Annex C—Examples of Tubular Connections</i>	133
	<i>Annex D—Effective Throat</i>	137
	<i>Annex E—Sample Welding Forms</i>	139
	<i>Annex F—Sample NDT Forms</i>	147
	<i>Annex G—Solutions for Macroetching Aluminum Weldments</i>	151
	<i>Annex H—Guide for Specification Writers</i>	153
	<i>Annex I—Safe Practices</i>	155
	<i>Annex J—Tungsten Electrodes</i>	159
	<i>Annex K—Guidelines for Preparation of Technical Inquiries for AWS Technical Committees</i>	161
	<i>Annex L—Reorganization</i>	163
	<i>Commentary</i>	171
	<i>Foreword</i>	173
C1.	<i>General Requirements</i>	175
C1.1	Scope	175
C2.	<i>Design of Welded Connections</i>	177
C2.0	Scope	177
C2.1	Structural Design	177
C2.2	Drawings	177

	Page No.
C2.3 Groove Welds	178
C2.5 Plug and Slot Welds	178
<i>C3. Qualification</i>	179
Part A—General Requirements	179
C3.1 General	179
C3.3 Qualification of Welders, Welding Operators, and Tack Welders	179
Part B—Types of Tests, Test Methods, and Acceptance Criteria	179
C3.5 Types and Purposes of Tests	179
C3.8 <u>Bend Tests—Groove Welds—Plate and Pipe</u>	179
Part C—WPS Qualification	179
C3.13 Limits of Qualified Positions for WPSs	180
C3.14 Limitation of Essential Variables—WPS Qualification	180
C3.15 Tests—WPS Qualifications	180
Part D—Performance Qualification	180
C3.17 General	180
C3.20 Essential Variables	180
C3.22 Retests	180
<i>C4. Fabrication</i>	181
C4.1 Processes	181
C4.2 Base Metal	181
C4.3 Filler Metal	181
C4.8 Preheat and Interpass Temperatures	181
C4.9 Welding Environment	181
C4.11 Preparation of Base Material	181
C4.12 Assembly	182
C4.13 <u>Technique</u>	182
C4.14 Tack and Temporary Welds	182
C4.15 Dimensional Tolerances <u>for Welded Members</u>	182
C4.16 Arc Strikes	183
C4.17 Weld Termination	183
C4.18 Control of Distortion and Shrinkage	183
C4.19 Weld Profiles	183
C4.20 Repairs	183
C4.24 <u>Postweld Heat Treatment</u>	183
<i>C5. Inspection</i>	185
Part A—General Requirements	185
C5.1 General	185
C5.2 Inspection of Materials	185
C5.3 Inspection of WPS Qualification and Equipment	185
C5.4 Inspection of Welder, Welding Operator, and Tack Welder Qualifications	185
C5.5 Inspection of Work and Records	186
C5.6 Obligations of the Contractor	186
C5.7 NDT	186
C5.8 Extent of Testing	186
Part B—RT of Groove Welds in Butt Joints	187
C5.9 General	187
C5.10 RT Procedures	187
C5.12 Examination, Report, and Disposition of Radiographs	188

	Page No.
Part C—UT of Groove Welds	188
C5.13 General	188
<i>C6. Stud Welding</i>	189
Part A—General Requirements	189
C6.2 Material Requirements	189
C6.3 Workmanship.....	189
C6.4 Qualification Requirements.....	189
C6.5 Operator Preproduction Qualification	189
C6.6 Acceptance Criteria—Production Welds.....	189
C6.7 Mislocated Studs.	190
C6.8 Repair of Misapplied Studs	190
Part B—Arc Stud Welding	190
C6.12 Technique	190
<i>C7. Strengthening and Repair of Existing Structures</i>	191
C7.1 General	191
C7.2 Base Metal.....	191
C7.3 Design.....	191
<i>Index</i>	193
<i>List of AWS Documents on Structural Welding</i>	201

List of Tables

Table	Page No.
2.1 Minimum Diameter of Hole for Plug Welds or Width of Slot for Slot Welds.....	6
3.1 Limitations of Essential Variables of a WPS	19
3.2 Tensile Strength of Welded Aluminum Alloys (GTAW or GMAW with No Postweld Heat Treatment)....	21
3.3 WPS Qualification—Type of Weld and Position Limitations.....	23
3.4 Number and Type of Test Specimens and Range of Thickness Qualified—WPS Qualification— CJP Groove Welds	24
3.5 Number and Type of Test Specimens and Range of Thickness Qualified—WPS Qualification— PJP Groove Welds	27
3.6 Number and Type of Test Specimens and Range of Thickness Qualified—WPS Qualification— Fillet Welds	28
3.7 Welder Performance Qualification—Type of Weld and Position Limitations.....	29
3.8 Number and Type of Test Specimens and Range of Thickness Qualified—Welder and Welding Operator Qualification	30
3.9 Welding Personnel Performance Essential Variable Changes Requiring Requalification	34
4.1 Aluminum Alloy Products Available for Structural Applications	70
4.2 Recommended Aluminum Alloy Filler Metals for Structural Welding of Various Base Aluminum Alloys.....	71
4.3 Limit of Acceptability and Repair of Cut Edge Discontinuities in Plate.....	72
4.4 Technique	72
4.5 Maximum Heat Exposure Time at Temperature	73
5.1 Hole-Type IQI Requirements.....	85
5.2 Wire IQI Requirements.....	85
5.3 Acceptable Undercut Values (Cyclically Loaded Nontubular Structures).....	86
5.4 Maximum Acceptable Porosity in Radiographs for Any 3 in. [75 mm] Length of Weld (<u>Cyclically</u> Loaded Nontubular)	86
5.5 Acceptance Criteria—Class I Structures.....	86
5.6 Acceptance Criteria—Class II Structures	87
5.7 Maximum Acceptable Porosity in Radiographs for Any 3 in. [75 mm] Length of Weld (Tubular).....	87
6.1 Minimum Required Torque Values and Tension Loads for Welding F-22 Aluminum-Alloy Studs.....	101
6.2 <u>Stud Alloys for Arc Stud Welding of Various Base Alloys</u>	101
6.3 <u>Stud Alloys for Capacitor Discharge Stud Welding of Various Base Alloys</u>	102
J-1 Typical Current Ranges for Tungsten Electrodes.....	159
J-2 Typical Chemical Composition of Tungsten Electrodes.....	160

List of Figures

Figure	Page No.
2.1	7
2.2	8
2.3	8
3.1	35
3.2	36
3.3	37
3.4	38
3.5	39
3.6	40
3.7	41
3.8	42
3.9	42
3.10	43
3.11	44
3.12	45
3.13	46
3.14	47
3.15	49
3.16	51
3.17	52
3.18	53
3.19	54
3.20	55
3.21	56
3.22	56
3.23	57
3.24	57
3.25	58
3.26	58
3.27	59
3.28	59
3.29	60
3.30	60
3.31	60
3.32	61
3.33	61
3.34	62
4.1	74
4.2	75
5.1	88
5.2	89

5.3	Radiographic Identification and Hole-Type or Wire IQI Locations on Transition Joints 10 in. [250 mm] and Greater in Length	90
5.4	Radiographic Identification and Hole-Type or Wire IQI Locations on Transition Joints Less Than 10 in. [250 mm] in Length.....	91
5.5	Hole-Type IQI Design.....	92
5.6	Wire IQI	94
5.7	RT Edge Blocks	95
5.8	Acceptable Undercut for Nontubular Statically Loaded Structures.....	95
5.9	Acceptable Undercut for Total Length of Joint—Class I Tubular Structures	96
6.1	Stud Weld Bend Jig.....	103
6.2	Torque Testing Arrangement for Stud Welds.....	104

Annexes

B1	Recommended CJP Groove Welded Joints	110
B2	PJP Box Connections	131
B3	PJP—Circular—Tubular Joints for T-, Y-, and K-Connections Made by GTAW and GMAW	132
C1	Examples of Tubular Connections	134
D1	Effective Throats of PJP Groove Welds Reinforced with Fillet Welds.....	137

Commentary

C4.1	Examples of Unacceptable Cutting Beyond the Point of Tangency	184
C4.2	Permissible Offset in Abutting Members.....	184
C4.3	Correction of Misaligned Members	185
C4.4	Measurement of Flange Warpage and Tilt	185

Structural Welding Code—Aluminum

1. General Requirements

1.1 Scope

This code contains the requirements for fabricating and erecting welded aluminum structures. When this code is stipulated in the contract documents, conformance with all provisions of the code shall be required, except those provisions that the Engineer or contract documents specifically modifies or specifically exempts.

1.1.1 Limitations. This code is not intended for specialized fabrication such as pressure vessels or pressure piping.

1.1.2 Alternate Requirements. Alternate requirements from those in this code shall be submitted to the Engineer for approval. These requirements shall be based on experience, experimental evidence, or engineering analyses, and shall consider materials, loads, and environment.

1.2 Approval

All references to the need for approval shall be interpreted to mean approval by the Building Commissioner or the Engineer. Hereinafter, the term *Engineer* shall be used, and is to be construed to mean the Building Commissioner or the Engineer.

1.3 Definitions

Welding terms used in this code shall be interpreted in conformance with the latest edition of AWS A3.0, *Standard Welding Terms and Definitions*.

1.4 Welding Symbols

Welding symbols shall conform to the latest edition of AWS A2.4, *Symbols for Welding, Brazing, and Non-*

destructive Examination. Special conditions shall be explained in notes or details.

1.5 Safety Precautions

1.5.1 This code may involve hazardous materials, operations, and equipment. The code does not purport to address all of the safety problems associated with its use. It is the responsibility of the user to establish appropriate safety and health practices. The user should determine the applicability of any regulatory limitations prior to use.

1.5.2 Safety precautions shall conform to the latest edition of ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, published by the American Welding Society (see Annex I, Safe Practices).

1.6 Standard Units of Measure

This standard makes use of both U.S. Customary Units and the International System of Units (SI). The measurements may not be exact equivalents; therefore, each system shall be used independently of the other without combining in any way. The standard with the designation D1.2:2003 uses U.S. Customary Units. The standard with the designation D1.2M:2003 uses SI units. The latter are shown within brackets.

1.7 Reference Documents

Annex A contains a list of all documents referenced in this code.