Underwater Welding Code

American Welding Society

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Underwater Welding Code

5th Edition

Supersedes AWS D3.6M:1999

Prepared by the
American Welding Society (AWS) D3 Committee on Welding in Marine Construction
Under the Direction of the
AWS Technical Activities Committee
Approved by the
AWS Board of Directors

Abstract

This Code covers the requirements for welding structures or components under the surface of water. It includes welding in both dry and wet environments. Clauses 1 through 6 constitute the general requirements for underwater welding while clauses 7 through 9 contain the special requirements applicable to three individual classes of weld:

Class A—Comparable to above-water welding
Class B—For less critical applications
Class O—To meet the requirements of another designated code or specification
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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).

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This standard is subject to revision at any time by the AWS D3 Committee on Welding in Marine Construction. It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn.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 D3 Committee on Welding in Marine Construction 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 D3 Committee on Welding in Marine Construction 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, 8669 Doral Blvd., Doral, FL 33166.
Dedication

The D3 Committee on Welding in Marine Construction dedicates this edition of AWS D3.6M, Underwater Welding Code, to the memory of Conway E. ‘Whitey’ Grubbs.

C. E. ‘WHITEY’ GRUBBS
1918–2004

Whitey passed away in June 2004 at the age of 85 and is considered by many in the field as the father of underwater wet welding. During his more than 30 years of dedication to underwater welding, Whitey founded the AWS committee that established the standard for underwater welding, and served as its Chairman from 1974 to 1988. He authored more than 50 papers on underwater welding, received numerous awards for his contributions, and held three patents. He was the first to design and use the scallop sleeve splice for connecting tubular members by wet welding. Whitey retired from Global Industries as the Director of Underwater Welding Research. He was a friend and mentor to many in the industry today.
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Foreword

This foreword is not part of AWS D3.6M:2010, Underwater Welding Code, but is included for informational purposes only.

In 1975, the AWS Committee on Marine Construction requested the Subcommittee on Underwater Welding to establish a standard reflecting state-of-the-art technology relative to underwater welding. The first edition of the Code was published in 1983, with subsequent editions issued in 1989, 1993, and 1999.

This edition is presented with the SI units of measure being the standard. The U.S. Customary Units are approximate and for information only. Clauses 1 through 6 constitute the general requirements applicable to all classes of underwater welds. Clauses 7 through 9 contain unique requirements applicable to each class.

Initially applied as a means of temporary repair for damaged steel-hulled vessels, underwater welding has evolved into an accepted method of construction and repair of engineered structures. Recent applications include engineered repair and alteration of off-shore structures, submerged marine pipelines, underwater port facilities and nuclear power plant components.

There are five basic methods of underwater welding currently in use:

1. Welding in a pressure vessel in which the pressure is reduced to approximately one atmosphere, independent of depth (dry welding at one atmosphere).
2. Welding at ambient pressure in a large chamber from which water has been displaced in an atmosphere such that the welder/ diver does not work in diving equipment (dry welding in a habitat).
3. Welding at ambient pressure in a simple open-bottomed dry chamber that accommodates, as a minimum, the head and shoulders of the welder/ diver in full diving equipment (dry chamber welding).
4. Welding at ambient pressure in a small, transparent, gas-filled enclosure with the welder/ diver outside in the water (dry spot welding).
5. Welding at ambient pressure with the welder/ diver in the water without any mechanical barrier between the water and the welding arc (wet welding).

No sharp distinction exists between these methods; intermediate degrees of weldment and welder protection from the water are in use. Metal-transfer characteristics, solidification behavior, weld appearance, mechanical properties, and other characteristics can vary with pressure, and each method of welding may differ from its usual behavior with conventional surface welding. Special quality requirements and inspection procedures must be established for underwater welds because of the altered environment and accessibility. This document is intended to define the important variables associated with underwater welding and to describe welding and inspection procedures so that work of a known quality level can be conveniently specified.

Three weld classes (A, B, and O) are specified herein. They encompass the range of quality and properties currently produced by application of the various methods. Each weld class defines a set of criteria for weldment properties that must be established during qualification, and a set of weld soundness requirements that are to be verified during construction. Welds in each class must meet all the criteria specified for that class. This Code does not address the selection of the class that meets the service requirements of a particular application. The selection of the class of weld to be provided is to be prescribed by the customer.

Comments and suggestions for the improvement of this standard are welcome. They should be addressed to the Secretary, AWS D3B Subcommittee on Underwater Welding, American Welding Society, 8669 Doral Blvd., Doral, FL 33166.
Errata

The following Errata have been identified and are incorporated in this reprint.

Page 60—Figure 7.2, note 2b—Correct “≤” to “≥”.

Page 62—Table 7.3, replace Table 7.3 with the table shown below:

<table>
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<tr>
<th>Coupon</th>
<th>Joint Type</th>
<th>Thickness Tested mm (in)</th>
<th>Visual(^a) (see 6.9)</th>
<th>Radiographic(^d) (see 6.11)</th>
<th>Root and Side</th>
<th>Macro(^c)</th>
<th>Fillet Weld Break (See Figure 5.8)</th>
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<tbody>
<tr>
<td>Plate</td>
<td>Groove</td>
<td>T ≤ 10 (3/8)</td>
<td>Yes</td>
<td>Yes(^a)</td>
<td>2 each</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T ≥ 20 (3/4)</td>
<td>Yes</td>
<td>Yes(^a)</td>
<td>–</td>
<td>4</td>
<td>–</td>
</tr>
<tr>
<td>Plate</td>
<td>Fillet</td>
<td>All</td>
<td>Yes</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2 1</td>
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<td>Pipe</td>
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<td>Yes</td>
<td>–</td>
<td>–</td>
<td>4 4</td>
<td>4 4</td>
</tr>
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</table>

\(^a\) Ultrasonic or three Macros may be substituted. See 7.6.1
\(^b\) For plate and pipe between 10 mm (3/8 in) and 20 mm (3/4 in) thick, Customer may specify either root and face bends or side bends.
\(^c\) See 5.11.2, 7.7, and Figure 5.8. Hardness tests not required.
\(^d\) See Clause 6, Part II for visual examination, Part III for radiographic examination.

Page 63—Figure 7.3, note a—Correct “≥” to “≤”.

Page 63—Figure 7.3, note b—Correct “≤” to “≥”.

Page 72—Table 8.1, note a—Correct “First position only. Qualification for additional positions will omit groove weld tension, macroetch, and fillet weld shear strength tests.” to “First position only. Qualification for additional positions will omit groove weld tension, macroetch, Charpy tests, and fillet weld shear strength tests.”

Page 72—Table 8.1, note 1—Correct “WM=Weld Metal; HAZ = Heat-Affected Zone.” to “HAZ Charpy Impact Testing is not required for qualification of wet welding procedures. WM = Weld Metal; HAZ = Heat-affected Zone.”

Page 75—Figure 8.2, note 3b—Correct “≤” to “≥”.

Page 75—Table 8.2, footnote b—Correct “See 5.11.5 and Table 8.1, Note 5.” to “HAZ Charpy Impact Testing is not required for qualification of wet welding procedures. See 5.11.5 and Table 8.1, footnote d.”

Page 77—Figure 8.3, note b—Correct “≤” to “≥”.

Page 79—Table 8.3, Column Heading—Correct “Fillet Weld Break (See Figure 5.9)” to “Fillet Weld Break (See Figure 5.8)”.

\(^{x}\)
# Table of Contents

### Dedication

### Personnel

### Foreword

### List of Tables

### List of Figures

### List of Forms

## 1. General Provisions

1.1 Scope

1.2 Normative References

1.3 Purpose

1.4 Application

1.5 Base Metals

1.6 Welding Process

1.7 Definitions

1.8 Welding and NDE Symbols

1.9 Safety and Health

1.10 Standard Units of Measure

## 2. Classification and Design of Welded Connections

2.1 Classification of Welds

2.2 Design

## 3. Workmanship

3.1 General

3.2 Base Metal Preparation

3.3 Assembly

3.4 Confirmation Weld

3.5 Dimensional Tolerances

3.6 Weld Profiles

3.7 Tack Welds and Temporary Welds

3.8 Repair

3.9 Peening

3.10 Arc Strikes

3.11 Weld Cleaning

## 4. Technique

4.1 Filler Metal

4.2 Measurement of Variable Conditions

4.3 Weld Temperature Control

## 5. Qualification

### Part I—General Requirements

5.1 Approved Procedure

5.2 Previous Qualification

5.3 Performance Qualification

5.4 Qualification Responsibility

---

Page No.

Dedication .......................................................... v
Personnel ............................................................ vii
Foreword ............................................................ ix
List of Tables ....................................................... xiv
List of Figures ...................................................... xiv
List of Forms ........................................................ xv

1. General Provisions ........................................ 1
   1.1 Scope .................................................. 1
   1.2 Normative References ................................ 1
   1.3 Purpose ................................................ 2
   1.4 Application .......................................... 2
   1.5 Base Metals .......................................... 2
   1.6 Welding Process .................................... 2
   1.7 Definitions .......................................... 3
   1.8 Welding and NDE Symbols .......................... 3
   1.9 Safety and Health .................................. 3
   1.10 Standard Units of Measure ........................ 3

2. Classification and Design of Welded Connections .... 5
   2.1 Classification of Welds ............................. 5
   2.2 Design .............................................. 5

3. Workmanship ................................................. 6
   3.1 General .............................................. 6
   3.2 Base Metal Preparation ............................ 6
   3.3 Assembly ............................................ 6
   3.4 Confirmation Weld ................................ 6
   3.5 Dimensional Tolerances ............................ 7
   3.6 Weld Profiles ....................................... 8
   3.7 Tack Welds and Temporary Welds ............... 8
   3.8 Repair .............................................. 8
   3.9 Peening ............................................. 8
   3.10 Arc Strikes ........................................ 8
   3.11 Weld Cleaning .................................... 8

4. Technique ..................................................... 9
   4.1 Filler Metal ......................................... 9
   4.2 Measurement of Variable Conditions .......... 9
   4.3 Weld Temperature Control ....................... 9

5. Qualification ................................................ 10
   Part I—General Requirements ........................... 10
   5.1 Approved Procedure ................................ 10
   5.2 Previous Qualification ............................ 10
   5.3 Performance Qualification ......................... 10
   5.4 Qualification Responsibility ....................... 10

---

xi
AWS D3.6M:2010

Part II—Procedure Qualification
5.5 Limitation of Variables .................................................. 10
5.6 Procedure Qualification Variables ..................................... 14
5.7 Types of Tests ................................................................. 15
5.8 Position of Test Welds ...................................................... 15
5.9 Joint Configuration .......................................................... 20
5.10 Test Specimens: Number and Type .................................... 22
5.11 Preparation and Testing of Specimens ................................. 23
5.12 Test Results Required ..................................................... 29
5.13 Supplemental Requirements .............................................. 30
5.14 Records ................................................................. 30

Part III—Welder Qualification ............................................... 30
5.15 General ................................................................. 30
5.16 Limitations of Variables .................................................. 31
5.17 Qualification Tests Required ............................................. 33
5.18 Method of Testing ........................................................ 38
5.19 Tests Results Required ................................................... 38
5.20 Retests ................................................................. 38
5.21 Period of Effectiveness .................................................. 38
5.22 Records ................................................................. 42

6. Inspections .................................................................. 47

Part I—General Requirements .............................................. 47
6.1 General ................................................................. 47
6.2 Inspection of Materials ................................................... 47
6.3 Inspection of Equipment .................................................. 47
6.4 Verification of Procedure and Performance Qualification ........ 47
6.5 Inspection of Work and Records ......................................... 47
6.6 Obligations of Contractor ................................................ 48
6.7 Inspection Methods ....................................................... 48
6.8 Inspection Personnel Qualification .................................... 48

Part II—Visual Examination .................................................. 49
6.9 General ................................................................. 49
6.10 Procedure ............................................................... 49

Part III—Radiographic Examination ..................................... 49
6.11 General ................................................................. 49
6.12 Procedure ............................................................... 50

Part IV—Ultrasonic Examination .......................................... 50
6.13 General ................................................................. 50
6.14 Procedure ............................................................... 50

Part V—Magnetic Particle Examination .................................. 52
6.15 General ................................................................. 52
6.16 Procedure ............................................................... 54

Part VI—Eddy Current Examination ...................................... 55
6.17 General ................................................................. 55
6.18 Procedure ............................................................... 55

7. Class A Welds ............................................................... 56
7.1 Application ............................................................... 56

Part I—Procedure Qualification .............................................. 56
7.2 Testing Requirement ...................................................... 56
7.3 Groove Welds .............................................................. 56
7.4 Fillet Welds ............................................................... 60
# AWS D3.6M:2010

## Part II—Welder Qualification

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.5</td>
<td>61</td>
</tr>
<tr>
<td>7.6</td>
<td>61</td>
</tr>
<tr>
<td>7.7</td>
<td>62</td>
</tr>
</tbody>
</table>

## Part II—Welder Qualification

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.</td>
<td>71</td>
</tr>
</tbody>
</table>

## Part I—Procedure Qualification

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>71</td>
</tr>
</tbody>
</table>

## Part III—Examination

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2</td>
<td>71</td>
</tr>
<tr>
<td>8.3</td>
<td>71</td>
</tr>
<tr>
<td>8.4</td>
<td>75</td>
</tr>
</tbody>
</table>

## Part II—Welder Qualification

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5</td>
<td>76</td>
</tr>
<tr>
<td>8.6</td>
<td>76</td>
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<tr>
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<td>76</td>
</tr>
</tbody>
</table>

## Part III—Examination

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.8</td>
<td>76</td>
</tr>
<tr>
<td>8.9</td>
<td>76</td>
</tr>
<tr>
<td>8.10</td>
<td>79</td>
</tr>
<tr>
<td>8.11</td>
<td>81</td>
</tr>
</tbody>
</table>

## Part I—Procedure Qualification

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1</td>
<td>82</td>
</tr>
</tbody>
</table>

## Part II—Welder Qualification

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5</td>
<td>84</td>
</tr>
</tbody>
</table>

## Part III—Examination

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.6</td>
<td>84</td>
</tr>
<tr>
<td>9.7</td>
<td>84</td>
</tr>
</tbody>
</table>

## Annex A (Informative)—Sample Welding Forms

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
</tr>
</tbody>
</table>

## Annex B (Informative)—Terms and Definitions

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>99</td>
</tr>
</tbody>
</table>

## Annex C (Informative)—Commentary on AWS D3.6M:2010, Underwater Welding Code

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
</tr>
</tbody>
</table>

## Annex D (Informative)—Recommended Guidelines for Safety in Underwater Welding

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
</tr>
</tbody>
</table>

## Annex E (Informative)—References

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>113</td>
</tr>
</tbody>
</table>

## Annex F (Informative)—Guidelines for the Preparation of Technical Inquiries for Structural Welding Committee

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>119</td>
</tr>
</tbody>
</table>

## Index

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
</tr>
</tbody>
</table>

## List of AWS Documents on Marine Welding

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
</tr>
</tbody>
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List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Page No.</th>
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</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Welding Variables—Dry Welding by Shielded Metal Arc, Gas Metal Arc, Flux Cored Arc, Gas Tungsten Arc, and Plasma Arc Welding Process</td>
</tr>
<tr>
<td>5.2</td>
<td>Welding Variables—Wet Welding by Shielded Metal Arc or Flux Cored Arc Welding</td>
</tr>
<tr>
<td>5.3</td>
<td>Depth Limitation for Qualification Welding</td>
</tr>
<tr>
<td>5.4</td>
<td>Procedure Qualification—Type and Position Limitations</td>
</tr>
<tr>
<td>5.5</td>
<td>Positions for Welder Qualification</td>
</tr>
<tr>
<td>5.6</td>
<td>Pipe Diameter Groups for Welder Qualification</td>
</tr>
<tr>
<td>7.1</td>
<td>Weld Procedure Qualification—Number and Type of Test Specimens for Class A Welds</td>
</tr>
<tr>
<td>7.2</td>
<td>Weld Procedure Qualification—Mechanical Test Acceptance Criteria for Class A Welds</td>
</tr>
<tr>
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<td>Welder Performance Qualification—Number and Type of Test Specimens for Class A Welds</td>
</tr>
<tr>
<td>8.1</td>
<td>Weld Procedure Qualification—Number and Type of Test Specimens for Class B Welds</td>
</tr>
<tr>
<td>8.2</td>
<td>Weld Procedure Qualification—Mechanical Test Acceptance Criteria for Class B Welds</td>
</tr>
<tr>
<td>8.3</td>
<td>Welder Performance Qualification—Number and Type of Test Specimens for Class B Welds</td>
</tr>
<tr>
<td>9.1</td>
<td>Weld Procedure Qualification—Number and Type of Test Specimens for Class O Welds</td>
</tr>
</tbody>
</table>

List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Tolerances in Assembly of Groove Weld Butt Joints—Dry Welding</td>
</tr>
<tr>
<td>5.1</td>
<td>Positions of Groove Welds</td>
</tr>
<tr>
<td>5.2</td>
<td>Positions of Fillet Welds</td>
</tr>
<tr>
<td>5.3</td>
<td>Positions of Test Plates for Groove Welds</td>
</tr>
<tr>
<td>5.4</td>
<td>Positions of Test Pipe or Tubing for Groove Welds</td>
</tr>
<tr>
<td>5.5</td>
<td>Positions of Test Plates for Fillet Welds</td>
</tr>
<tr>
<td>5.6</td>
<td>Positions of Test Pipes for Fillet Welds</td>
</tr>
<tr>
<td>5.7</td>
<td>Reduced-Section Tension Specimens</td>
</tr>
<tr>
<td>5.7A</td>
<td>Reduced-Section Tension Specimens (U.S. Customary Units)</td>
</tr>
<tr>
<td>5.8</td>
<td>Fillet Weld Break and Macroetch Test Specimens</td>
</tr>
<tr>
<td>5.8A</td>
<td>Fillet Weld Break and Macroetch Test Specimens (U.S. Customary Units)</td>
</tr>
<tr>
<td>5.9</td>
<td>Lap Joint Fillet Macroetch Test Assembly and Specimen Location</td>
</tr>
<tr>
<td>5.10</td>
<td>Face- and Root-Bend Specimens</td>
</tr>
<tr>
<td>5.10A</td>
<td>Face- and Root-Bend Specimens (U.S. Customary Units)</td>
</tr>
<tr>
<td>5.11</td>
<td>Side-Bend Specimens</td>
</tr>
<tr>
<td>5.11A</td>
<td>Side-Bend Specimens (U.S. Customary Units)</td>
</tr>
<tr>
<td>5.12</td>
<td>Bend Test Jigs</td>
</tr>
<tr>
<td>5.12A</td>
<td>Bend Test Jigs (U.S. Customary Units)</td>
</tr>
<tr>
<td>5.13</td>
<td>All-Weld-Metal Tension and Impact Specimen Test Plate Design and Specimen Locations</td>
</tr>
<tr>
<td>5.13A</td>
<td>All-Weld-Metal Tension and Impact Specimen Test Plate Design and Specimen Locations (U.S. Customary Units)</td>
</tr>
<tr>
<td>5.14</td>
<td>All-Weld-Metal Tension Test Specimen Design</td>
</tr>
<tr>
<td>5.14A</td>
<td>All-Weld-Metal Tension Test Specimen Design (U.S. Customary Units)</td>
</tr>
<tr>
<td>5.15</td>
<td>Location of Charpy V-Notch Impact Test Specimen in Test Weld</td>
</tr>
<tr>
<td>5.16</td>
<td>Fillet Weld Shear Strength Specimens—Longitudinal from Plate</td>
</tr>
<tr>
<td>5.16A</td>
<td>Fillet Weld Shear Strength Specimens—Longitudinal from Plate (U.S. Customary Units)</td>
</tr>
</tbody>
</table>
List of Forms

<table>
<thead>
<tr>
<th>Form</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A–1</td>
<td>86</td>
</tr>
<tr>
<td>A–2</td>
<td>90</td>
</tr>
<tr>
<td>A–3</td>
<td>92</td>
</tr>
<tr>
<td>A–4</td>
<td>93</td>
</tr>
<tr>
<td>A–5</td>
<td>95</td>
</tr>
<tr>
<td>A–6</td>
<td>96</td>
</tr>
<tr>
<td>A–6A</td>
<td>97</td>
</tr>
</tbody>
</table>
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Underwater Welding Code


1.1 Scope. This Code covers underwater welding in both dry and wet environments. All provisions of this document apply equally to new construction and to modification and repair of existing structures underwater.

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

AWS Documents:
AWS A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Testing
AWS A3.0, Standard Method for Standard Welding Terms and Definitions
AWS B4.0, Mechanical Testing of Welds
AWS D1.1, Structural Welding Code—Steel

Other Documents:
ANSI Z49.1, Safety in Welding, Cutting and Allied Processes
API RP2X, Recommended Practice for Ultrasonic and Magnetic Examination of Offshore Structural Fabrication and Guidelines for Qualification of Technicians
ASME BPV Code, Section IX, QW-470, Etching Processes and Reagents
ASNT SNT-TC-1A, Recommended Practice
ASTM A 370, Standard Methods and Definitions for Mechanical Testing of Steel Products
ASTM E 92, Test Method for Vickers Hardness of Metallic Materials
ASTM E 164, Standard Practice for Ultrasonic Contact Examination of Weldments
ASTM E 165, Standard Test Method for Liquid Penetrant Examination
ASTM E 309, Standard Practice for Eddy-Current Examination of Steel Tubular Products using Magnetic Saturation
ASTM E 426, Standard Practice for Electromagnetic (Eddy-Current) Examination of Seamless and Welded Tubular Products Austenitic Stainless Steel and Similar Alloys
ASTM E 709, Guide for Magnetic Particle Examination
ASTM E 1219, Standard Test Method for Fluorescent Liquid Penetrant Examination Using the Solvent-Removable Process
ASTM E 1416, Standard Test Method for Radioscopic Examination of Weldments

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1 AWS standards are published by the American Welding Society, 8669 Doral Blvd., Doral, FL 33166.
2 This ANSI standard is published by the American Welding Society, 8669 Doral Blvd., Doral, FL 33166.
3 API standards are published by the American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070.
4 ASME Codes are published by the American Society for Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.
5 ASNT standards are published by the American Society for Nondestructive Testing, PO Box 28518 1711 Arlingate Lane, Columbus, OH 43228-0518.
6 ASTM standards are published by the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.