




Underwater Welding Code



American Welding Society®



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Underwater Welding Code

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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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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:

Coupon	Joint Type	Thickness Tested mm (in)	Visual ^d (see 6.9)	Radiographic ^d (see 6.11)	Bends ^b (see 5.11.3)			Fillet Weld Break (See Figure 5.8)
					Root and face	Side	Macro ^c	
Plate	Groove	T ≤ 10 (3/8)	Yes	Yes ^a	2 each	—	—	—
		10 (3/8) < T < 20 (3/4)	Yes	Yes ^a	2 each	or 4	—	—
		T ≥ 20 (3/4)	Yes	Yes ^a	—	4	—	—
Pipe	Groove	T ≤ 10 (3/8)	Yes	Yes ^a	2 each	—	—	—
		10 (3/8) < T < 20 (3/4)	Yes	Yes ^a	2 each	or 4	—	—
		T ≥ 20 (3/4)	Yes	Yes ^a	—	4	—	—
Plate	Fillet	All	Yes	—	—	—	2	1
Pipe	Fillet	All	Yes	—	—	—	4	4

^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)”.

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Underwater Welding Code

1. General Provisions

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 Documents¹:

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*²

API RP2X, *Recommended Practice for Ultrasonic and Magnetic Examination of Offshore Structural Fabrication and Guidelines for Qualification of Technicians*³

ASME BPV Code, Section IX, QW-470, *Etching Processes and Reagents*⁴

ASNT SNT-TC-1A, *Recommended Practice*⁵

ASTM A 370, *Standard Methods and Definitions for Mechanical Testing of Steel Products*⁶

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 340, *Standard Test Method for Macroetching Metals and Alloys*

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 1220, *Standard Test Method for Visible Liquid Penetrant Examination Using the Solvent-Removable Process*

ASTM E 1416, *Standard Test Method for Radioscopic Examination of Weldments*

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.