Abstract
This code covers the requirements for design and welding of any type of titanium structure. Titanium pressure vessels and fluid-carrying pipe lines are specifically excluded. Clauses 1 through 5 and Annex A constitute a body of rules for the regulation of welding in titanium construction. A commentary on the code is also included with the document.
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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 It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn.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.
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Foreword

This foreword is not part of AWS D1.9/D1.9M:2007-ADD1, Structural Welding Code—Titanium, but is included for informational purposes only.

This first edition of the AWS D1.9/D1.9M, Structural Welding Code—Titanium (hereafter referred to as the code), represents 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 titanium. This code does not concern itself with such design considerations as the arrangements of parts 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 specification.

Users of the AWS D1.1/D1.1M, Structural Welding Code—Steel, will note similarities in the general format of this code and D1.1. This was done in order to benefit from the long established history of D1.1, adjusted for the specific requirements for titanium. In the early 2000s, interest was expressed in developing a similar consolidated code for the structural welding of titanium. Because of the interest of both the U.S. Department of Defense and the American Welding Society, it was decided to commence the task of developing a structural welding code for titanium.

A major difference between the AWS D1.1 and this code is that the former allows for prequalified welding procedures, this code does not. This is mainly because of the need to have a method of demonstrating evidence of a fabricator’s competency to fabricate in one or more of the structural titanium alloys that may be welded under this code. Therefore, all the WPSs used for fabrication of work governed by this code are required to be qualified by test.

Clauses 1 through 5 constitute a body of rules for the regulation of welding on titanium structures. Procedures and standards are outlined for several methods of nondestructive testing. Methods included are visual, radiographic, ultrasonic, and dye penetrant.

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

Addenda

The following Addenda has been made and incorporated into the current edition of this document.

Page 81—Add a row above “Fine Scattered Porosity” to Table 5.2 for crack discontinuity types as follows:
### Table 5.2
Radiographic Allowance for CJP and PJP Welds (see 3.8.2, 5.22, and A4.3.2)

<table>
<thead>
<tr>
<th>Discontinuity Types</th>
<th>Base Material Thickness Range, in [mm]</th>
<th>Radiograph Category, in [mm]</th>
<th>Acceptance Level (Reference ASTM E 390 Radiographs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cracks</td>
<td>All</td>
<td>N/A</td>
<td>None allowed</td>
</tr>
<tr>
<td>Fine Scattered Porosity</td>
<td>≥1/8 [3] and ≤1/2 [12]</td>
<td>Up to 3/8 [10], incl.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;1/2 [12] and ≤1-1/2 [38]</td>
<td>Up to 3/4 [19], incl.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;1-1/2 [38] and ≤3 [76]</td>
<td>Up to 2 [50], incl.</td>
<td>2</td>
</tr>
<tr>
<td>Coarse Scattered Porosity</td>
<td>≥1/8 [3] and ≤1/2 [12]</td>
<td>Up to 3/8 [10], incl.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;1/2 [12] and ≤1-1/2 [38]</td>
<td>Up to 3/4 [19], incl.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;1-1/2 [38] and ≤3 [76]</td>
<td>Up to 2 [50], incl.</td>
<td>2</td>
</tr>
<tr>
<td>Linear Porosity or Rounded Indications</td>
<td>≥1/8 [3] and ≤1/2 [12]</td>
<td>Up to 3/8 [10], incl.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;1/2 [12] and ≤1-1/2 [38]</td>
<td>Up to 3/4 [19], incl.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;1-1/2 [38] and ≤3 [76]</td>
<td>Up to 2 [50], incl.</td>
<td>2</td>
</tr>
<tr>
<td>Nonmetallic Inclusions</td>
<td>≥1/8 [3] and ≤1/2 [12]</td>
<td>Up to 3/8 [10], incl.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;1/2 [12] and ≤1-1/2 [38]</td>
<td>Up to 3/4 [19], incl.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;1-1/2 [38] and ≤3 [76]</td>
<td>Up to 2 [50], incl.</td>
<td>3</td>
</tr>
<tr>
<td>Tungsten Inclusions</td>
<td>≥1/8 [3] and ≤1/2 [12]</td>
<td>Up to 3/8 [10], incl.</td>
<td>2</td>
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<tr>
<td></td>
<td>&gt;1/2 [12] and ≤1-1/2 [38]</td>
<td>Up to 3/4 [19], incl.</td>
<td>2</td>
</tr>
<tr>
<td>Incomplete Joint Penetration CJP only</td>
<td>≥1/8 [3] and ≤1/2 [12]</td>
<td>Up to 3/8 [10], incl.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;1/2 [12] and ≤1-1/2 [38]</td>
<td>Up to 3/4 [19], incl.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;1-1/2 [38] and ≤3 [76]</td>
<td>Up to 2 [50], incl.</td>
<td>3</td>
</tr>
<tr>
<td>Incomplete Fusion CJP only</td>
<td>≥1/8 [3] and ≤1/2 [12]</td>
<td>Up to 3/8 [10], incl.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;1/2 [12] and ≤1-1/2 [38]</td>
<td>Up to 3/4 [19], incl.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;1-1/2 [38] and ≤3 [76]</td>
<td>Up to 2 [50], incl.</td>
<td>3</td>
</tr>
<tr>
<td>Incomplete Joint Penetration—Partial joint penetration welds only</td>
<td>All</td>
<td>N/A</td>
<td>1/32 [0.8] width full weld length 1/16 [1.5] width 4T in 8T weld length</td>
</tr>
<tr>
<td>Incomplete Fusion—Partial joint penetration welds only</td>
<td>All</td>
<td>N/A</td>
<td>1/32 [0.8] width full weld length 1/16 [1.5] width 4T in 8T weld length</td>
</tr>
</tbody>
</table>

Notes:
1. Porosity or inclusions allowed by this table shall be cause for rejection when closer than twice their maximum dimension to an edge or extremity of a weldment in a highly stressed or critical area, as determined by design engineering personnel.
2. Linear is described as having a length greater than three times the width. Rounded is defined by the converse.
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1. General Requirements

1.1 Scope

The code contains the requirements for fabricating titanium structures. When the code is stipulated in contract documents, conformance with all provisions of the code shall be required, except for those provisions that the Engineer (see 1.4.1) or contract documents specifically modify or exempt.

Annex A of the code contains requirements for the ballistic testing of structural titanium welds.

The following is a summary of the code clauses:

1. General Requirements. This clause contains basic information on the scope and limitations of the code.

2. Design of Welded Connections. This clause contains requirements for the design of welded connections.

3. Qualification. This clause contains the qualification requirements for WPSs and welding personnel (welders, welding operators, and tack welders) necessary to perform code work.

4. Fabrication. This clause contains the requirements for the preparation, assembly, and workmanship of welded titanium structures.

5. Inspection. This clause contains criteria for the qualifications and responsibilities of inspectors, acceptance criteria for production welds, and procedures for performing visual inspection and NDE (nondestructive testing).

1.2 Limitations

The code is not intended to be used for the following:

1. Pressure vessels or pressure piping.

2. Base metals other than titanium.

3. Aerospace structures.

4. Titanium material less than 1/8 in [3 mm]. When base materials thinner than 1/8 in [3 mm] are to be welded the requirements of AWS B2.1, Specification for Welding Procedure and Performance Qualification, apply for qualification in conjunction with applicable provisions of this code.

1.3 Terms and Definitions

The welding terms used in the code shall be interpreted in conformance with the definitions given in AWS A3.0, Standard Welding Terms and Definitions, and the following definitions:

1.3.1 Owner. The “Owner” is the individual, company, or government agency that has legal title or right to the product produced under the code.

1.3.2 Engineer. “Engineer” shall be defined as a duly designated individual who acts for, and in behalf of, the Owner on all matters within the scope of the code.

1.3.3 Contractor. “Contractor” shall be defined as any company, or that individual representing a company, responsible for the fabrication, erection, manufacturing, or welding, in conformance with the provisions of the code.

1.3.4 Subcontractor. A person or business, which has a contract (as an “independent contractor” and not an employee) with a Contractor to provide some portion of the work or services on a project, which the Contractor has agreed to perform.

1.3.5 OEM (Original Equipment Manufacturer). “OEM” shall be defined as that single Contractor that assumes some or all of the responsibilities assigned by the code to the Engineer.