Specification for Coiled Tubing

U.S. Customary and SI Units

Upstream Segment

API SPECIFICATION 5ST
FIRST EDITION, APRIL 2010

EFFECTIVE DATE: OCTOBER 1, 2010
Special Notes

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

Classified areas may vary depending on the location, conditions, equipment, and substances involved in any given situation. Users of this specification should consult with the appropriate authorities having jurisdiction.

Users of this specification should not rely exclusively on the information contained in this document. Sound business, scientific, engineering, and safety judgment should be used in employing the information contained herein.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which this publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where these publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.
Foreword

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

Shall: As used in a standard, “shall” denotes a minimum requirement in order to conform to the specification.

Should: As used in a standard, “should” denotes a recommendation or that which is advised but not required in order to conform to the specification.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API standard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually by API, 1220 L Street, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.
1 Scope
2 References
3 Definitions
4 Information to be Supplied by the Purchaser
  4.1 Mandatory Purchaser Requirements
  4.2 Optional Purchaser Requirements and Requirements Subject to Agreement
5 Processes of Manufacture and Material
  5.1 General
  5.2 Types of Welds
  5.3 Welding Processes
  5.4 Heat Treatment
  5.5 Traceability
6 Material Requirements
  6.1 Chemical Requirements
  6.2 Mechanical Properties
7 Dimensions, Masses per Unit Length, Lengths, Defects, and End Finishes
  7.1 General
  7.2 Length of Strings and Sections of Strings
  7.3 Diameter
  7.4 Wall Thickness
  7.5 Mass per Unit Length
  7.6 Tube-to-tube Welds
  7.7 Workmanship and Defects
  7.8 End Finishes
8 Testing
  8.1 Test Equipment—Accuracy of Measuring Instruments
  8.2 Testing of Chemical Composition—Chemical Analysis Sampling Frequency
  8.3 Testing of Mechanical Properties
  8.4 Hydrostatic Tests
  8.5 Drift (Gauge Ball) Testing
9 Test Methods
  9.1 Chemical Analysis
  9.2 Tensile Test
  9.3 Microhardness Test
  9.4 Grain Size Determination
  9.5 Charpy V-Notch Test
10 Nondestructive Inspection
  10.1 General
  10.2 NDE Reference Standards Demonstration
  10.3 Qualification of Personnel
  10.4 Standard Practices for Inspection
  10.5 Methods of Nondestructive Inspection
  10.6 Radiographic Inspection of Skelp End Welds and Tube-to-tube Welds
  10.7 Inspection of Welds by Other Nondestructive Test Methods
**Contents**

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.8</td>
<td>Ultrasonic and Electromagnetic Inspection of the Seam Weld</td>
<td>25</td>
</tr>
<tr>
<td>10.9</td>
<td>Magnetic Particle and Liquid Penetrant Inspection</td>
<td>27</td>
</tr>
<tr>
<td>10.10</td>
<td>Disposition of Defects and Imperfections</td>
<td>27</td>
</tr>
<tr>
<td>11</td>
<td>Invalidation of Tests</td>
<td>28</td>
</tr>
<tr>
<td>12</td>
<td>Retests</td>
<td>28</td>
</tr>
<tr>
<td>12.1</td>
<td>Chemistry Recheck Analyses</td>
<td>28</td>
</tr>
<tr>
<td>12.2</td>
<td>Tensile Retest</td>
<td>28</td>
</tr>
<tr>
<td>12.3</td>
<td>Flattening Retest</td>
<td>29</td>
</tr>
<tr>
<td>12.4</td>
<td>Flaring Retest</td>
<td>29</td>
</tr>
<tr>
<td>12.5</td>
<td>Hardness Retests</td>
<td>29</td>
</tr>
<tr>
<td>12.6</td>
<td>Fracture Toughness Test Retests</td>
<td>29</td>
</tr>
<tr>
<td>13</td>
<td>Marking</td>
<td>30</td>
</tr>
<tr>
<td>13.1</td>
<td>General</td>
<td>30</td>
</tr>
<tr>
<td>13.2</td>
<td>Sequence of Markings</td>
<td>30</td>
</tr>
<tr>
<td>13.3</td>
<td>Length</td>
<td>30</td>
</tr>
<tr>
<td>14</td>
<td>Coating and Protection</td>
<td>31</td>
</tr>
<tr>
<td>14.1</td>
<td>Coatings</td>
<td>31</td>
</tr>
<tr>
<td>14.2</td>
<td>Protection from Corrosion</td>
<td>31</td>
</tr>
<tr>
<td>15</td>
<td>Document Control and Retention</td>
<td>31</td>
</tr>
<tr>
<td>15.1</td>
<td>General</td>
<td>31</td>
</tr>
<tr>
<td>15.2</td>
<td>Certification</td>
<td>32</td>
</tr>
<tr>
<td>15.3</td>
<td>Retention of Records</td>
<td>33</td>
</tr>
<tr>
<td>Annex A</td>
<td>(normative) Tables</td>
<td>33</td>
</tr>
<tr>
<td>Annex B</td>
<td>(normative) Requirements for Tube-to-tube Welding of Coiled Tubing</td>
<td>52</td>
</tr>
<tr>
<td>Annex C</td>
<td>(normative) Skelp-end and Tube-to-tube Welding Procedure Specification</td>
<td>53</td>
</tr>
<tr>
<td>Annex D</td>
<td>(normative) Supplementary Requirements</td>
<td>54</td>
</tr>
<tr>
<td>Annex E</td>
<td>(normative) Purchaser Inspection</td>
<td>59</td>
</tr>
<tr>
<td>Annex F</td>
<td>(informative) Use of the API Monogram by Licensees</td>
<td>60</td>
</tr>
<tr>
<td>Annex G</td>
<td>(informative) Coiled Tubing Shipping and Service Reels</td>
<td>63</td>
</tr>
<tr>
<td>Annex H</td>
<td>(normative) SI Conversion Procedure</td>
<td>65</td>
</tr>
<tr>
<td>Bibliography</td>
<td></td>
<td>68</td>
</tr>
</tbody>
</table>

**Figures**

1. Full Section Specimen | 17
2. Strip Specimen | 18
3. Orientation of Tensile Test Strip Specimen | 18
4. Through-wall Hardness Test Impression Locations | 22
5. NDT Reference Indicators | 26
Contents

Tables
A.1 Chemical Requirements (mass percent). ................................................................. 33
A.2 Tensile Requirements ....................................................................................... 33
A.3 Elongation Table—Normative ........................................................................... 34
A.4 Flattening Requirements .................................................................................. 37
A.5 Coiled Tubing Dimensions, Masses per Unit Length and Test Pressures (U.S. Customary Units). ......................................................................................... 38
A.6 Coiled Tubing Dimensions, Masses per Unit Length, and Hydrostatic Test Pressures (SI Units). ......................................................................................... 42
A.7 Tolerances a for Diameter at Tubing Body ...................................................... 45
A.8 Tolerances for Wall Thickness ........................................................................... 45
A.9 Maximum Depth of Trim .................................................................................. 45
A.10 Gauge Ball Drift Dimensions and Standoff. .................................................... 46
A.11 ASTM Image Quality Indicator ....................................................................... 49
A.12 ISO Wire 4 Percent Image Quality Indicators ............................................... 50
A.13 ISO Wire 2 Percent Image Quality Indicators ............................................... 50
A.14 Acceptance Limits .......................................................................................... 51
A.15 Retention of Records ....................................................................................... 51
G.1 Spooling Radius Ratio for Tubing on Various Core Diameter Reels ................ 64
1 Scope

This specification covers the manufacturing, inspection, and testing of all carbon and low alloy steel coiled tubing in Grades CT70, CT80, CT90, CT100 and CT110, in the designations and wall thicknesses given in Table A.5, that can be used as work strings, completion strings, and static installations in oil and gas wells. Coiled tubing may be ordered to this specification.

Coiled tubing is manufactured using the continuously milled process. This specification does not cover the joining of seamless or welded tubing segments in lengths less than 200 ft (61 m).

Tubing of a higher grade is not be substituted for tubing ordered as a lower grade without purchaser approval.

In the dimensional tables herein, coiled tubing is designated by outside diameter, expressed to the thousandth of an inch (0.1 mm), with OD sizes ranging from 0.750 in. (19.1 mm) through 3 1/2 in. (88.9 mm).

Both U.S. Customary units and SI units are shown in this document. Annex H covers specific information about conversion factors and rounding procedures.

The suitability of the coiled tubular products made to this specification for use in environments containing hydrogen sulfide (H₂S) is outside of the scope of this document. It is the responsibility of the purchaser (and/or the user) of coiled tubing to determine the level of resistance to sour service damage mechanisms such as sulfide stress cracking necessary for the end use of the tubing.

2 References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Requirements of other standards included by reference in this specification are essential to the safety and interchangeability of the equipment produced.

Other nationally or internationally recognized standards shall be submitted to and approved by API for inclusion in this specification prior to their use as equivalent standards.

API Technical Report 5C3, Technical Report on Equations and Calculations for Casing, Tubing, and Line Pipe used as Casing or Tubing; and Performance Properties Tables for Casing and Tubing

API Specification 5LCP, Specification for Coiled Line Pipe

API Recommended Practice 5SI, Recommended Practice for Purchaser Representative Surveillance and/or Inspection at the Supplier

API Standard 5T1, Imperfection Technology

API Standard 1104, Welding of Pipelines and Related Facilities

ASME Boiler and Pressure Vessel Code ¹, Section IX, Welding and Brazing Qualifications

ASNT SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A450, *Standard Specification for General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes*

ASTM A751, *Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products*


ASTM E8, *Standard Test Methods for Tension Testing of Metallic Materials*

ASTM E18, *Standard Test Methods for Rockwell Hardness of Metallic Materials*


ASTM E29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*

ASTM E44, *Standard Definitions of Terms Relating to Heat Treatment of Metals*

ASTM E83, *Standard Practice for Verification and Classification of Extensometer Systems*

ASTM E94, *Standard Guide for Radiographic Examination*

ASTM E112, *Standard Test Methods for Determining Average Grain Size*

ASTM E140, *Standard Hardness Conversion Table for Metals*

ASTM E164, *Standard Practice for Contact Ultrasonic Testing of Weldments*

ASTM E165, *Standard Practice for Liquid Penetrant Examination*

ASTM E213, *Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing*

ASTM E273, *Standard Practice for Ultrasonic Examination of the Weld Zone of Welded Pipe and Tubing*

ASTM E309, *Standard Practice for Eddy-Current Examination of Steel Tubular Products Using Magnetic Saturation*


ASTM E570, *Standard Practice for Flux Leakage Examination of Ferromagnetic Steel Tubular Products*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASTM E747, *Standard Practice for Design, Manufacture, and Material Grouping Classification for Wire Image Quality Indicators (IQIs) Used for Radiology*

ASTM E797, *Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact method*

ASTM E1025, *Standard Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators Used for Radiology*