



American Welding Society  
LEARNING

# Study Guide: API 1104

Twenty-First Edition

**STUDY GUIDE**  
for  
**API Standard 1104:**  
**Welding of Pipelines**  
**and Related Facilities**  
**21<sup>st</sup> Edition**

**CWI**  
**Seminar**

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# Study Guide

for

## API Standard 1104 Welding of Pipelines and Related Facilities

TWENTY-FIRST EDITION

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Abstract

This study guide contains information on the use of API Standard 1104, Twenty-First Edition, which will assist the student in learning how to use the standard as well as in preparing for code-related examinations. Material is provided for each of the 13 sections of the standard and Annexes A and B. Exercise questions and answers are provided for each section and annex, and additional practice tests are included at the end.



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# Study Guide for API Standard 1104, Twenty-First Edition

## Foreword

AWS Education Services has published this Study Guide for API 1104 to assist quality professionals—inspectors and supervisors—and quality-conscious engineers and managers in reading, understanding, and learning to apply the American Petroleum Institute’s (API) Standard 1104, Welding of Pipelines and Related Facilities, Twenty-First Edition. This Study Guide was written specifically for the 21st Edition with Errata 4 and Addendum 2. For other errata or addenda, page numbers may be different.

The API Standard 1104 applies to the welding of piping used in the compression, pumping, and transmission of petroleum products, fuel gases, carbon dioxide, and nitrogen. The standard’s purpose is to present methods for the production and inspection of high-quality welds through the use of qualified personnel using approved procedures, materials, and equipment. It applies to new construction and in-service welding and is voluntary.

This API 1104 Study Guide consists of an introduction, 15 sections, each covering the corresponding section or annex of the standard along with exercise questions for each section, and several groups of practice questions with an answer key.

Answering the practice questions serves as a valuable review of the section contents. These questions also illustrate the types of questions you’re likely to encounter on the AWS CWI exam.

In addition to explanations of each section of API 1104, in some cases, this Study Guide also provides a commentary or examples to further explain the provision.

As you read this book, open the standard to the corresponding page.

Remembering excerpts from the standard is neither necessary nor desirable. You need not memorize the standard; just learn how to use it.

The American Welding Society appreciates feedback from participants in its education programs. Please send comments or questions to:

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or contact the AWS Education Services Department by email at [aws.seminars@aws.org](mailto:aws.seminars@aws.org). Additional information on AWS products and services may be found on our website at [www.aws.org](http://www.aws.org).



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# Introduction

How to Use API 1104



## INTRODUCTION: HOW TO USE API 1104

### Definition of Documents

All codes, standards, and specifications are conceptually similar, but each has a specific application and purpose. API 1104 is a good example of the concept, so learning to use this standard will help you learn to use others as well.

A CODE is a body of laws arranged systematically for easy reference and use. Because a code has legal status, it is, by definition, mandatory, and it uses words such as shall, will, and must to express requirements and to verify that those requirements are being met. Examples of codes include the AWS D1.1 Structural Welding Code — Steel, the AASHTO/AWS D1.5 Bridge Welding Code, and the ASME B31.1 Power Piping Code.

A STANDARD is established for use as a rule or basis of comparison in measuring quality, quantity, content, relative value, etc. API Standard 1104, Welding of Pipelines and Related Facilities, is an example. So are the AWS A3.0, Standard Welding Terms and Definitions and AWS QC1 Standard for AWS Certification of Welding Inspectors.

A SPECIFICATION is a detailed description of the parts of a whole; a statement or enumeration of particulars, as to actual or required size, quality, performance, terms, etc. Thus, a specification describes all pertinent technical information for a material, product, system, or service, and indicates how to determine that the requirements have been met. Examples include the AWS Filler Metal Specifications A5.1 through A5.36.

A RECOMMENDED PRACTICE is a description of generally accepted industrial methods and techniques. One of the most common examples is ASNT's Recommended Practice No. SNT-TC-1A, ASNT's guideline to personnel qualification and certification in nondestructive examination.

### Less Than or Greater Than?

In many codes and standards, including API 1104, the rules vary depending on the size of a part, the intended service, and the manufacturing requirements. Often these rules are differentiated symbolically. Most people know that = means "equal to" but the symbols for "less than" and "greater than" can cause confusion. Here's an easy way to keep them straight:

"<" is the symbol for "less than" and it points to the left. Example:  $5 < 9$  indicates that five is less than nine.

">" is the symbol for "greater than" and it points to the right. Example:  $9 > 5$  indicates that nine is greater than five.

"≤" is the symbol for "less than or equal to."

"≥" is the symbol for "greater than or equal to."

## Other Definitions

Section 3 Terms, Definitions, Acronyms, and Abbreviations presents a list of welding terms and their definitions that adds on to and, in some cases, supersedes those listed in AWS 3.0 Standard Welding Terms and Definitions. Many of the terms defined in Section 3 are specific to API 1104.

## The Meaning of Quality

Quality is generally understood to mean measurable conformance to specifications. To establish product quality, purchasers invoke or mandate certain codes, standards, and/or specifications that state the requirements to which the product must conform. Thus, quality professionals must be able to read, understand, and apply the provisions of the governing documents cited in a contract, job specification or purchase order.

For test-taking purposes, to find requirements in a code or standard more quickly, you should attach an index tab to the first page of each section and to significant tables and figures that you will use frequently. In addition, it may be helpful to briefly describe the contents of the section on that tab. API 1104 has 13 sections and two annexes that are included in the scope of the AWS CWI exam. See Study Guide Figure A below.

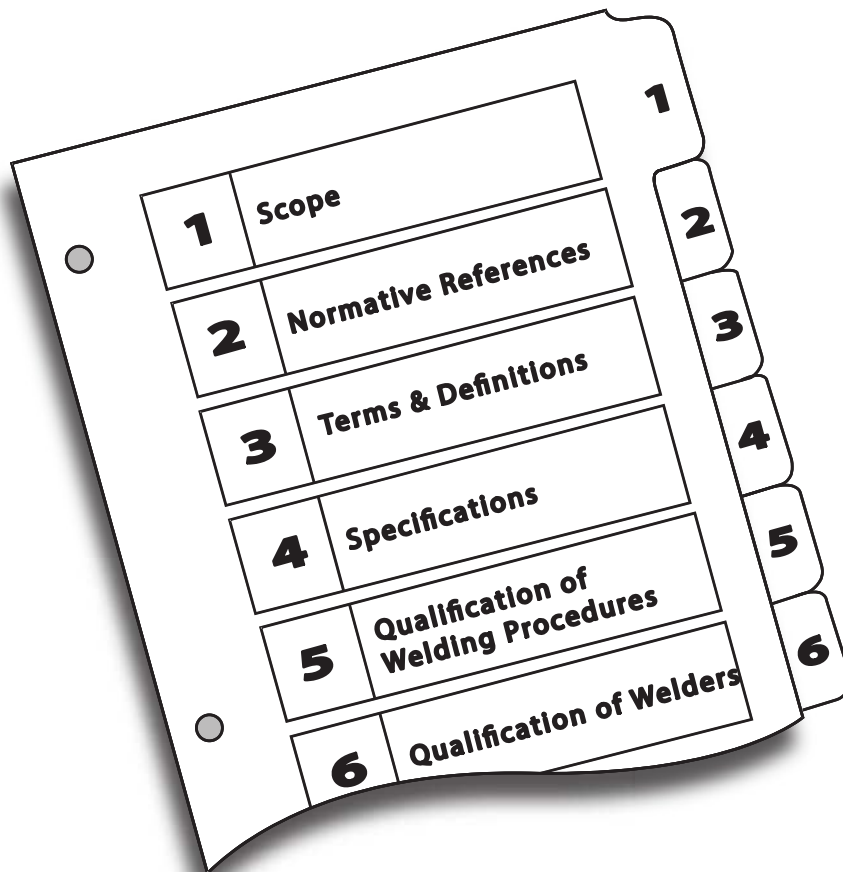


Figure A: Section ID Tabs

Many codes and standards make extensive use of notes, which may be footnotes in tables or figures or general notes incorporated into the text, to explain something or to cover special cases or particular circumstances. Every time you read the provisions of a code or standard, be thorough and pay close attention to any notes.

Carefully review the tables and figures, being attentive to superscripts and their corresponding footnotes, which can modify the application of the information in the table or figure. In many cases, the answer to a given code or standard inquiry will either be modified by the footnote or contained completely within the footnote. If the question does not invoke the conditions of the footnote, the footnote does not apply.

You will see three types of footnotes. They are:

- (a) Global or general footnotes—These appear in the title of a figure, list, or table and they influence all provisions from that figure, list, or table. Sometimes general footnotes are located in the footer of a table or figure and are labeled as “NOTE(S).”
- (b) Regional footnotes—These appear in the column header or at the end of a row title in a table or at the top of a subsection and influence only that column or row of the table or that specific subsection of text.
- (c) Local or specific footnotes—These apply only to the specific item being footnoted.

For example, turn to page 15 in API 1104. Note the small superscript letters that follow certain filler metal Group Numbers in Table 1. Each superscript refers to a local footnote, which changes some aspect of the table’s provisions for that specific filler metal in the table.

As you work with a code or standard, be aware of applicable Errata Sheets. Errata are published to correct printing errors. If any exist, mark the changes in the code or standard. Subsequent printings of that code or standard will usually incorporate those corrections.

Typically, codes and standards are revised according to a regular schedule. API generally updates its standards every five years, though up to two additional years may be added to a review cycle. See the Foreword of API 1104 for information on ascertaining the status of the Twenty-First Edition.

## Finding Provisions

Codes and standards typically use the multiple decimal numbering system. See Study Guide Figure B below. The first “1” in “1.1.1.2.2” is the chapter or section in which the provision is found. The second “1” is the subsection within Section 1. However, for simplicity, in this Study Guide, any indented reference further than the second (subsection) number will be referred to simply as a “paragraph.” For instance, Section 5 is where rules for qualifying welding procedures using manual or semiautomatic welding processes are found. Subsection 5.4 lists the essential variables but “paragraph” 5.4.2.2 addresses base materials.



1.
  - 1.1
    - 1.1.1- -----
    - 1.1.2- -----
  - 1.2
    - 1.2.1- -----
    - 1.2.2- -----
- 2.

Figure B Multiple Decimal Numbering System

A provision is the specific text contained within a numbered section, subsection, or paragraph of a code or standard.

When you use a code or standard, identify the key term or phrase that best describes the issue or requirement of interest and then locate the provision that best addresses that issue or requirement.

Although you might find a particular provision by paging through the standard, a more systematic approach is to convert the information you seek into a question, then analyze the question to identify key words or phrases. In API 1104, look for those key words or phrases in the table of contents to locate the applicable provisions by section or subsection number. Those numbers are called references. Then locate those references in the text.

## Reference Exercise

For the radiographic test method, how long after processing of the developed film shall the images still be interpretable?

- Key Words:
- a) radiographic test method
  - b) processed, handled, and stored

Check Contents:           Section 11 Procedures for NDT on page vi and  
                                   Subsection 11.1 Radiographic Test Methods

Look it up: Find reference 11.1.10.4 Image Processing on page 61.

Provision: “When requested by the company, film or other imaging media shall be processed, handled, and stored so that the images are interpretable for at least three years after they are produced.”

## API 1104 Contents

API 1104 contains 13 sections and three annexes. They are:

1. Scope

2. Normative References
  3. Terms, Definitions, Acronyms, and Abbreviations
  4. Specifications
  5. Qualification of Welding Procedures with Filler Metal Additions
  6. Qualification of Welders
  7. Design and Preparation of a Joint for Production Welding
  8. Inspection and Testing of Production Welds
  9. Acceptance Standards for NDT
  10. Repair and Removal of Weld Defects
  11. Procedures for NDT
  12. Mechanized Welding with Filler Metal Additions
  13. Automatic Welding Without Filler Metal Additions
- Annex A Alternative Acceptance Standards for Girth Welds
- Annex B In-service Welding
- Annex C Requests for Interpretation and Request for Revision to the Document

This Study Guide follows the structure of API 1104, except that Annex C will not be discussed. Otherwise, the sections and subsections in this Study Guide correspond to those in API 1104.

The table of contents in API 1104 is titled “Contents” and it begins on page v. It contains:

- (a) A list of provisions by section and subsection number and title, e.g., “3.1 Terms and Definitions.” The page on which a given section or subsection begins is to the right of that section or subsection’s title. For the annexes, only the number of the title page is listed.
- (b) A list of figures. A figure is a pictorial or schematic illustration. Figures are listed by number, title, and the page on which they appear in the text. The list of figures begins on page vii.
- (c) A list of tables. A table is a systematic arrangement of data, typically in rows and columns. Tables are listed by number, title, and the page on which they appear in the text. The list of tables begins on page viii.

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# Section 1

Scope



## Section 1: Scope

API 1104 provides a list of eight permitted welding processes. They are listed below:

- (a) Shielded metal arc welding (SMAW).
- (b) Submerged arc welding (SAW).
- (c) Gas tungsten arc welding (GTAW).
- (d) Gas metal arc welding (GMAW).
- (e) Flux-cored arc welding (FCAW).
- (f) Plasma arc welding (PAW).
- (g) Oxyacetylene welding (OAW).
- (h) Flash butt welding (FW).

API 1104 also states that these processes may be applied using manual, semiautomatic, mechanized, or automatic welding techniques or a combination of these techniques. All of these techniques, except manual welding, are defined in Section 3. Study Guide Table 1.1 indicates which techniques are applicable to the permitted welding processes.

API 1104 covers procedures for various NDT methods and the acceptance standards to be applied to production welds. The NDT methods are listed below, along with their AWS abbreviations:

- (a) Radiographic testing (RT).
- (b) Magnetic particle testing (MT).
- (c) Liquid penetrant testing (PT).
- (d) Ultrasonic testing (UT).
- (e) Visual testing (VT).

The numerical values stated in API 1104 are given in either U.S. Customary units or metric (SI) units. The U.S. Customary values typically appear first, followed by the SI units in parentheses, but the SI units are approximations of the corresponding U.S. customary units. API 1104 emphasizes that you must use one system or the other and not combine them.

<i>Process</i>	<i>Manual</i>	<i>Semi-automatic</i>	<i>Mechanized</i>	<i>Automatic</i>
<b><i>Shielded metal arc welding (SMAW)</i></b>	<b>X</b>			
<b><i>Submerged arc welding (SAW)</i></b>		<b>X</b>	<b>X</b>	
<b><i>Gas tungsten arc welding (GTAW)</i></b>	<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>
<b><i>Gas metal arc welding (GMAW)</i></b>		<b>X</b>	<b>X</b>	<b>X</b>
<b><i>Flux-cored arc welding (FCAW)</i></b>		<b>X</b>	<b>X</b>	<b>X</b>
<b><i>Plasma arc welding (PAW)</i></b>	<b>X</b>		<b>X</b>	<b>X</b>
<b><i>Oxyacetylene welding (OAW)</i></b>	<b>X</b>			
<b><i>Flash butt welding (FW)</i></b>				<b>X</b>

Table 1.1

Processes and Techniques

## Exercise Questions

### Section 1 Scope

#### 1.1 What topic(s) does API 1104 cover?

- A. Gas welding of butt welds
- B. Arc welding of fillet and socket welds
- C. Welding of carbon and low-alloy steel piping
- D. Welding of petroleum pipelines
- E. All of the above

#### 1.2 Which testing method(s) is(are) specified in API 1104?

- A. Nick break tests
- B. Only bend tests for butt welds
- C. Radiographic testing only
- D. Ultrasonic testing only
- E. Both radiographic and ultrasonic testing

#### 1.3 Which welding process(es) is(are) addressed in API 1104?

- A. Flash butt
- B. Submerged arc
- C. Oxyacetylene
- D. Gas metal arc
- E. All of the above

#### 1.4 API 1104 permits the use of both US customary units and metric (SI) units.

- A. True, as long as each system is used independent of the other
- B. False
- C. True, as long as the inspector places the US customary value in parentheses
- D. True, as long as the metric values are used in conjunction with the US Customary values
- E. The inspector should use codes published in either SI or US Customary units.

#### 1.5 Welds may be produced by:

- A. Fixed welding only
- B. Position or roll welding only
- C. Position welding, roll welding, or a combination of both
- D. Only position welding
- E. Only roll welding

#### 1.6 API 1104 covers:

- A. New construction
- B. In-service welding
- C. Structural tubular applications
- D. Cyclical applications
- E. Both A & B



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# Section 2

## Normative References





## Section 2: Normative References

This section lists the standards, codes, and specifications incorporated by reference throughout the standard. The footnotes provide contact information for the organizations that publish these documents. The address for the American Welding Society, however, is incorrect. The correct address is:

8669 NW 36th Street #130  
Miami, Florida 33166-6672

## Exercise Questions

### Section 2 Normative References

**2.1 Which of the referenced documents is used by Annex A for evaluating fracture toughness?**

- A. ASTM E164
- B. API Specification 5L
- C. AWS A5.28
- D. BS EN ISO 15653
- E. None of the above

**2.2 Which organization writes most of the NDT specifications cited in API 1104?**

- A. API
- B. ASNT
- C. ASTM
- D. AWS
- E. NACE

**2.3 Which organization writes the filler metal specifications referenced in API 1104?**

- A. AWS
- B. ASNT
- C. ASTM
- D. BSI
- E. NACE

**2.4 Which organization writes a document on personnel certification in NDT methods that is cited by API 1104?**

- A. API
- B. ASNT
- C. AWS
- D. BSI
- E. NACE

**2.5 Which of the following is a specification that lists carbon steel rods for use with the GTAW process?**

- A. AWS A5.1
- B. ASTM E747
- C. AWS A5.18
- D. ER70S-2
- E. AWS A5.29

**2.6 Which of the following describes procedures for UT of weldments?**

- A. AWS A5.28
- B. ASTM E164
- C. ASNT SNT-TC-1A
- D. AWS A5.1
- E. BS EN ISO 15653

**2.7 Which of the following is a document that provides guidance for selection of metallic materials for oil field equipment when sulfide stress cracking is a concern?**

- A. NACE MR0175
- B. E71T-1
- C. E6010
- D. ASTM E747
- E. AWS A5.18

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