

Study Guide

for

API Standard 1104 Welding of Pipelines and Related Facilities

TWENTIETH EDITION

**Published by
American Welding Society
Education Services**

Abstract

This study guide contains information on the use of API Standard 1104, Twentieth Edition, which will assist the student in preparing for using the standard as well as preparing for code-related examinations. Material is provided for each of the 13 sections of the standard and both appendices. Exercise questions and answers are provided for each topic.



American Welding Society

550 N.W. LeJeune Road, Miami, FL 33126

International Standard Book Number: 978-0-87171-160-1
American Welding Society
550 N.W. LeJeune Road, Miami, FL 33126
© 2008 by American Welding Society
All rights reserved
Printed in the United States of America

Disclaimer. The American Welding Society, Inc., assumes no responsibility for the information contained in this publication. An independent, substantiating investigation should be made prior to reliance on the use of such information.

Photocopy Rights. No portion of this document may be reproduced, stored in a retrieval system, or transmitted in any form, including mechanical, photocopying, recording, or otherwise, without the prior written permission of the copyright owner.

Authorization to photocopy items for internal, personal, or educational classroom use only or the internal, personal, or educational classroom use only of specific clients is granted by the American Welding Society provided that the appropriate fee is paid to the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, tel: (978) 750-8400; Internet: <www.copyright.com>.

Study Guide for API Standard 1104, Twentieth Edition

Foreword

AWS Education Services has published this AWS Study Guide 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*, Twentieth Edition.

API 1104 applies to 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 and 15 sections, each covering a specific code section or appendix.

For each section exercise questions and answers are provided at the end of this document. Answering them provides a valuable review of the section contents. These questions also illustrate the types of questions you’re likely to encounter in practice.

The authors of this book want you to write in this book and in *API Standard 1104* to clarify your understanding of the figures, tables, and text in both volumes.

The book provides a commentary on the code; it does not repeat the contents of the code.

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

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

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

American Welding Society
Education Department
550 N.W. LeJeune Road
Miami, FL 33126

or contact AWS Education Services by email: education@aws.org. Additional information on AWS products and services may be found on our website: www.aws.org.

Table of Contents

Section	Page
Study Guide for API Standard 1104—Foreword	iii
List of Tables	ix
List of Figures.....	x
 Introduction:	
How to Use	
API 1104	
Definition of Documents	I-1
Less Than or Greater Than?	I-1
Other Definitions	I-2
The Meaning of Quality	I-2
Finding Code Provisions	I-3
Code Reference Examples.....	I-4
API 1104 Contents.....	I-4
 Section 1	
General	1-1
 Section 2	
Referenced Publications	2-1
 Section 3	
Definition of Terms	3-1
 Section 4	
Specifications	
4.1 Equipment.....	4-1
4.2 Materials	4-1
 Section 5	
Qualification of Welding Procedures for Welds Containing Filler-Metal Additives	
5.1 Procedure Qualification	5-1
5.2 Record.....	5-1
5.3 Procedure Specification	5-1
5.4 Essential Variables.....	5-3
5.5 Welding of Test Joints—Butt Welds	5-3
5.6 Testing of Welded Joints—Butt Welds	5-3
5.7 Welding of Test Joints—Fillet Welds	5-5
5.8 Testing of Welded Joints—Fillet Welds.....	5-5
 Section 6	
Qualification of Welders	
6.1 General.....	6-1
6.2 Single Qualification.....	6-1
6.3 Multiple Qualification.....	6-2
6.4 Visual Examination.....	6-2
6.5 Destructive Testing.....	6-2

Section	Page
6.6 Radiography Butt Welds Only	6-4
6.7 Retesting	6-4
6.8 Records	6-4
 Section 7	
Design and	
Preparation	
of a Joint for	
Production	
Welding	
7.1 General	7-1
7.2 Alignment	7-1
7.3 Use of Lineup Clamp for Butt Welds	7-1
7.4 Bevel	7-1
7.5 Weather Conditions	7-1
7.6 Clearance	7-1
7.7 Cleaning Between Beads	7-2
7.8 Position Welding	7-2
7.9 Roll Welding	7-2
7.10 Identification of Welds	7-2
7.11 Pre- and Postheat Treatment	7-2
 Section 8	
Inspection	
and Testing	
of Production	
Welds	
.....	8-1
 Section 9	
Acceptance	
Standards for	
Nondestructive	
Testing	
9.1 General	9-1
9.2 Rights of Rejection	9-2
9.3 Radiographic Testing	9-2
9.4 Magnetic Particle Testing	9-4
9.5 Liquid Penetrant Testing	9-5
9.6 Ultrasonic Testing	9-5
9.7 Visual Acceptance Standards for Undercutting	9-5
 Section 10	
Repair and	
Removal of	
Defects	
10.1 Authorization for Repair	10-1
10.2 Repair Procedure	10-1
 Section 11	
Procedures for	
Nondestructive	
Testing	
11.1 Radiographic Test Methods	11-1
11.2 Magnetic Particle Test Method	11-3
11.3 Liquid Penetrant Test Method	11-3
11.4 Ultrasonic Test Methods	11-3

**Section 12—
Mechanized
Welding with
Filler Metal
Additions**

12.1 Acceptable Processes 12-1
 12.2 Procedure Qualification..... 12-1
 12.3 Record 12-1
 12.4 Procedure Specification..... 12-1
 12.5 Essential Variables 12-2
 12.6 Qualification of Welding Equipment and Operators..... 12-2
 12.7 Records of Qualified Operators..... 12-3
 12.8 Inspection and Testing of Production Welds 12-3
 12.9 Acceptance Standards for Nondestructive Testing 12-3
 12.10 Repair and Removal of Defects 12-3
 12.11 Radiographic Testing 12-3

**Section 13—
Automatic
Welding without
Filler-Metal
Additions**

13.1 Acceptable Processes 13-1
 13.2 Procedure Qualification..... 13-1
 13.3 Record 13-1
 13.4 Procedure Specification..... 13-1
 13.5 Essential Variables 13-1
 13.6 Qualification of Welding Equipment and Operators..... 13-1
 13.7 Records of Qualified Operators..... 13-1
 13.8 Quality Assurance of Production Welds 13-2
 13.9 Acceptance Standards for Nondestructive Testing 13-2
 13.10 Repair and Removal of Defects 13-2
 13.11 Radiographic Procedure 13-2

**Appendix A
Alternative
Acceptance
Standards for
Girth Welds**

A.1 General A-1
 A.2 Stress Analysis A-1
 A.3 Welding Procedure..... A-1
 A.4 Qualification of Welders A-2
 A.5 Inspection and Acceptable Limits A-2
 A.6 Record A-2
 A.7 Repairs..... A-2
 A.8 Nomenclature A-2

**Appendix B
In-Service Welding**

B.1 General B-1
 B.2 Qualification of In-Service Welding Procedures B-1
 B.3 In-Service Welder Qualification B-5
 B.4 Suggested In-Service Welding Practices..... B-5
 B.5 Inspection and Testing of In-Service Welds B-6
 B.6 Standards of Acceptability: Nondestructive Testing
 (Including Visual) B-6
 B.7 Repair and Removal of Defects B-6

Exercise QuestionsEQ-1

List of Tables

Section	Table	Page
Section 1 General	1.1 Processes and Techniques	1-2
Appendix B In-Service Welding	B.1 Causes of Hydrogen Cracking.....	B-1

List of Figures

Section	Figure	Page
Introduction: How to Use API 1104	A Section ID ‘Tabs’	I-2
	B Multiple Decimal Numbering System.....	I-3
Section 3 Definition of Terms	3.1 Wire-Type IQI.....	3-2
	3.2 Socket Weld	3-3
	3.3 Trepan.....	3-4
Section 5 Qualification of Welding Procedures for Welds Containing Filler-Metal Additives	5.1 Branch-on-Pipe Connection	5-6
	5.2 Fillet Weld Qualification.....	5-6
Section 9 Acceptance Standards for Nondestructive Testing	9.1 Inadequate Cross Penetration	9-2

INTRODUCTION: HOW TO USE API 1104

Definitions of Documents

All codes, standards, specifications, and guides 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 a legal status, it is by definition mandatory, and uses words such as shall, will, and must to express certain conditions and requirements, and to verify that those requirements are being met. Examples of codes include AWS D1.1, *Structural Welding Code—Steel*, AASHTO/AWS D1.5, *Bridge Welding Code*, and 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 1104, *Welding of Pipelines and Related Facilities*, is an example. So are 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 AWS Filler Metal Specifications A5.1 through A5.34.

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

A **GUIDE** provides information on proven methods to accomplish certain tasks. It is not mandatory but should reflect best practices. An example is AWS B1.11, *Guide for the Visual Examination of Welds*.

Less Than or Greater Than?

In many codes and standards, including API 1104, the rules vary depending on the size of a part, intended service and 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:

- < The symbol for **l**ess than points to the **l**eft. Example: 5 < 9 means five is less than nine.
- > The symbol for **g**reater than points to the **r**ight. Example: 9 > 5 means nine is greater than 5.
- ≤ is the symbol for less than or equal to.
- ≥ is the symbol for greater than or equal to.