Hydrogen Piping and Pipelines

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD



ASME B31.12-2014

(Revision of ASME B31.12-2011)

Hydrogen Piping and Pipelines

ASME Code for Pressure Piping, B31

AN AMERICAN NATIONAL STANDARD



Date of Issuance: February 20, 2015

The next edition of this Code is scheduled for publication in 2017. This Code will become effective 6 months after the Date of Issuance.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Code. Interpretations, Code Cases, and errata are published on the ASME Web site under the Committee Pages at http://cstools.asme.org/ as they are issued. Interpretations and Code Cases are also included with each edition.

Errata to codes and standards may be posted on the ASME Web site under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be used on the date posted.

The Committee Pages can be found at http://cstools.asme.org/. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting "Errata" in the "Publication Information" section.

ASME is the registered trademark of The American Society of Mechanical Engineers.

This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not "approve," "rate," or "endorse" any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assumes any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which precludes the issuance of interpretations by individuals.

No part of this document may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

The American Society of Mechanical Engineers Three Park Avenue, New York, NY 10016-5990

Copyright © 2015 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved
Printed in U.S.A.

CONTENTS

Foreword		ix
Committee Ro	oster	х
	Changes	xiii
PART GR	GENERAL REQUIREMENTS	
Chapter GR-1 GR-1.1 GR-1.2 GR-1.3	Scope and Definitions Scope Responsibilities Intent of the Code	1 1 2
GR-1.4 GR-1.5 GR-1.6 GR-1.7	Packaged Equipment Requirements Terms and Definitions B31.12 Appendices Nomenclature	2 11 12
Chapter GR-2 GR-2.1 GR-2.2	Materials General Requirements Joining and Auxiliary Materials	13 27
Chapter GR-3	Welding, Brazing, Heat Treating, Forming, and Testing	•
GR-3.1 GR-3.2 GR-3.3 GR-3.4 GR-3.5 GR-3.6 GR-3.7 GR-3.8 GR-3.9 GR-3.10	General Welding and Brazing Welding and Brazing Materials Construction of Weldments Preheating for Weldments Heat Treatment Specific and Alternative Heat Treat Requirements Construction of Brazements Forming of Pipe Components Testing	28 28 31 31 44 47 47 50 50
Chapter GR-4	Inspection, Examination, and Testing	
GR-4.1 GR-4.2 GR-4.3 GR-4.4 GR-4.5 GR-4.6 GR-4.7 GR-4.8 GR-4.9 GR-4.10 GR-4.11 GR-4.12	General Inspection Examination Personnel Qualification and Certification Extent of Required Examination and Testing Acceptance Criteria Supplementary Examination Examinations to Resolve Uncertainty Defective Components and Workmanship Progressive Sampling for Examination Testing Records NDE Definitions	51 51 52 53 53 53 53 53 53 53 53 53
Chapter GR-5	Operation and Maintenance	
GR-5.1 GR-5.2 GR-5.3 GR-5.4 GR-5.5 GR-5.6	General Operation and Maintenance Plan Maintenance Requirements Leakage Surveys Repair Procedures Injurious Dents and Mechanical Damage	55 57 59 59

GR-5.7	Permanent Repair of Welds With Defects
GR-5.8	Permanent Field Repair of Leaks and Nonleaking Corroded Areas
GR-5.9	Permanent Field Repair of Hydrogen Stress Cracking in Hard Spots
GR-5.9	and Stress Corrosion Cracking
GR-5.10	Testing and Examination of Repairs
GR-5.11	Valve Maintenance
GR-5.11 GR-5.12	Transmission Pipeline Maintenance
GR-5.12 GR-5.13	Abandoning of Transmission Facilities
GR-5.14	Decommissioning of Transmission Facilities
GR-5.15	Recommissioning of Transmission Facilities
GR-5.16	Repositioning a Pipeline in Service
GR-5.17	Testing for Integrity Assessment of In-Service Pipelines
GR-5.17 GR-5.18	Distribution Pipeline Maintenance
GR-5.19	Leakage Surveys
GR-5.19 GR-5.20	Leakage Investigation and Action
GR-5.21	Repair, Testing, and Examination of Mains Operating at Hoop Stress
GR-3.21	Levels at or Above 30% of the Specified Minimum Yield Strength
GR-5.22	Requirements for Abandoning, Disconnecting, and Reinstating
GR-5.23	Distribution Facilities
Chapter GR-6	Quality System Program for Hydrogen Piping and Pipeline Systems
GR-6.1	Quality System Program
GR-6.2	Quality Manual
GR-6.2 GR-6.3	Quality System Functions
	Quality System Functions
Figures	Maria de la companya della companya della companya de la companya de la companya della companya
GR-2.1.2-1	Minimum Temperatures Without Impact Testing for Carbon Steel Materials
GR-2.1.2-2	Reduction in Minimum Design Metal Temperature Without Impact Testing
GR-3.4.3-1	Geometry of Weld Joint Detail Single Vee Groove Butt With Extended Land
GR-3.4.3-2	Geometry of Weld Joint Detail Square Butt Weld
GR-3.4.3-3	Unequal Pipe Component Thicknesses, Thicker Components Bored for
GR 5.4.5 5	Alignment
GR-3.4.3-4	Geometry of Weld Joint Detail Single Vee Groove Butt, Open Root
GR-3.4.3-5	Unequal Pipe Component Thicknesses, Thicker Components Taper-Bored
GR-3.4.3-6	to Align
GR 5.4.5 0	Backing Ring
GR-3.4.3-7	Geometry of Weld Joint Detail Single Vee Groove Butt, Continuous
CD 2 4 2 2	Tapered Backing Ring
GR-3.4.3-8	Geometry of Weld Joint Detail Single Vee Groove Butt, Consumable
CD a ta a	Insert
GR-3.4.3-9	Preparation and Alignment of Pipe Branch to Pipe Header Connection
GR-3.4.4-1	Geometry of Weld Deposit Single Vee Groove Butt, Open Root
GR-3.4.4-2	Geometry of Weld Deposit Root Single Vee Groove Butt With
	Extended Land (Without Filler Metal)
GR-3.4.4-3	Geometry of Weld Deposit Square Butt End (Without Filler Metal)
GR-3.4.5-1	Welding End Transition — Maximum Envelope
GR-3.4.6-1	Geometry of Weld Deposit Single Vee Groove Butt, Open Root With
	Concavity
GR-3.4.7-1	Fillet Weld Size
GR-3.4.7-2	Typical Details for Double-Welded Slip-On Flanges
GR-3.4.7-3	Minimum Welding Dimensions for Socket Welding Components to
	Pine Including Fit-Un Detail

GR-3.4.9-1 GR-3.4.9-2 GR-3.4.9-3 GR-3.4.9-4	Typical Welded Branch Connections	41 42 43
GR-3.8-1	Radiography	43 48
Tables GR-2.1.1-1	Material Specification Index for Piping and Pipe Components	14
GR-2.1.1-2 GR-2.1.2-1 GR-2.1.2-2	Material Specification Index for Pipelines	17 19
GR-2.1.3-1 GR-2.1.3-2	for Carbon Steel Materials Impact Testing Requirements for Metals Charmy Impact Test Temporature Reduction	21 23
GR-2.1.3-3 GR-3.4.6-1 GR-3.5-1	Charpy Impact Test Temperature Reduction Minimum Required Charpy V-Notch Impact Values Weld Reinforcement Preheat Temperatures	24 25 38 45
GR-3.6.1-1	Requirements for Postweld Heat Treatment of Weldments	45
PART IP	INDUSTRIAL PIPING	
Chapter IP-1 IP-1.1 IP-1.2 IP-1.3 IP-1.4	Scope and Responsibilities Scope Responsibilities Intent Determining Code Requirements	72 72 72 72
Chapter IP-2 IP-2.1 IP-2.2	Design Conditions and CriteriaDesign ConditionsDesign Criteria	73 74
Chapter IP-3 IP-3.1 IP-3.2 IP-3.3 IP-3.4 IP-3.5 IP-3.6	Pressure Design of Piping Components General Straight Pipe Curved and Mitered Segments of Pipe Branch Connections Closures Pressure Design of Flanges and Blanks	81 81 82 83 89
IP-3.7 IP-3.8	Reducers Pressure Design of Other Components	90 90
Chapter IP-4 IP-4.1 IP-4.2	Service Requirements for Piping ComponentsValves and Specialty Components	92 92
Chapter IP-5	Service Requirements for Piping Joints	
IP-5.1 IP-5.2 IP-5.3 IP-5.4 IP-5.5 IP-5.6	Scope Welded Joints Flanged Joints Expanded Joints Threaded Joints Caulked Joints	93 93 93 94 95
IP-5.7 IP-5.8	Brazed and Soldered Joints	95 96
Chapter IP-6 IP-6.1 IP-6.2	Flexibility and Support Flexibility of Piping	97 102

Chapter IP-7	Specific Piping Systems	
IP-7.1	Instrument Piping	105
IP-7.2	Pressure-Relieving Systems	105
Chapter IP-8	Dimensions and Ratings of Components	
IP-8.1	Dimensional Requirements	106
IP-8.2	Ratings of Components	106
IP-8.3	Reference Documents	106
Chapter IP-9	Fabrication, Erection, and Assembly	
IP-9.1	General	108
IP-9.2	Responsibility	108
IP-9.3	Content and Coverage	108
IP-9.4	Packaged Equipment Piping	108
IP-9.5	Exclusions	108
IP-9.6	Fabrication and Erection	108
IP-9.7	Construction of Weldments	108
IP-9.8	Preheating for Weldments	109
IP-9.9	Heat Treatment	109
IP-9.10	Specific and Alternative Heat Treatment Requirements	109
IP-9.11	Construction of Brazements	109
IP-9.12	Bending and Forming of Pipe and Tube	109
IP-9.13	Assembly and Erection	110
IP-9.14	Threaded Joints	110
IP-9.15	Tubing Joints	110
IP-9.16	Expanded Joints and Special Joints	110
IP-9.17		
IP-9.17 IP-9.18	Pipe Attachments and Supports	111
	Cleaning of Piping	111
Chapter IP-10	Inspection, Examination, and Testing	
IP-10.1	Scope	112
IP-10.2	Responsibility	112
IP-10.3	Inspections by Owner's Inspector	112
IP-10.4	Examination Requirements	112
IP-10.5	Testing	117
IP-10.6	Hydrostatic Leak Test	118
IP-10.7	Pneumatic Leak Test	119
IP-10.8	Hydrostatic-Pneumatic Leak Test	119
IP-10.9	Sensitive Leak Test	119
IP-10.10	Alternative Leak Test	119
IP-10.11	Mechanical and Metallurgical Testing	120
IP-10.12	Records of Testing	
Figures		
IP-3.3.1-1	Nomenclature for Pipe Bends	82
IP-3.3.3-1	Nomenclature for Miter Bends	82
IP-3.4.2-1	Branch Connection Nomenclature	85
IP-3.4.3-1	Extruded Outlet Header Nomenclature	87
IP-3.6.3-1	Blanks	91
IP-6.1.5-1	Moments in Bends	100
IP-6.1.5-2	Moments in Branch Connections	101
IP-9.14-1	Typical Threaded Joints Using Straight Threads	111
Tables		
IP-2.2.8-1	Increased Casting Quality Factors, E _c	77
IP-2.2.8-2	Acceptance Levels for Castings	77
IP-2.2.9-1	Longitudinal Weld Joint Quality Factor, E_j	78
IP-3.2-1	Values of Coefficient Y for $t < D/6$	81
IP-3.5-1	ASME BPV Code Section VIII, Division 1 References for Closures	89

IP-8.1.1-1 IP-9.6.3-1 IP-10.4.2-1 IP-10.4.3-1	Component Standards Hardness Testing Acceptance Criteria Required Nondestructive Examinations Acceptance Criteria for Weldments and Methods for Evaluating Weld	107 109 113
IP-10.4.3-2 IP-10.4.3-3	Imperfections	114 115 115
PART PL	PIPELINES	
Chapter PL-1	Scope and Exclusions	
PL-1.1	Scope	121
PL-1.2	Content and Coverage	121
PL-1.3	Exclusions	121
Chapter PL-2	Pipeline Systems Components and Fabrication Details	
PL-2.1	Purpose	122
PL-2.2	Piping System Components	122
PL-2.3	Reinforcement of Fabricated Branch Connections	124
PL-2.4	Multiple Openings and Extruded Outlets	125
PL-2.5	Expansion and Flexibility	126
PL-2.6	Design for Longitudinal Stress	127
PL-2.7	Supports and Anchorage for Exposed Piping	129
PL-2.8	Anchorage for Buried Piping	130
Chapter PL-3	Design, Installation, and Testing	
PL-3.1	Provisions for Design	131
PL-3.2	Buildings Intended for Human Occupancy	131
PL-3.3	Considerations Necessary for Concentrations of People in Location	
	Class 1 or 2	132
PL-3.4	Intent	132
PL-3.5	Risk Assessment	132
PL-3.6	Location Class and Changes in Number of Buildings Intended for	
	Human Occupancy	133
PL-3.7	Steel Pipeline	135
PL-3.8	Hot Taps	141
PL-3.9	Precautions to Prevent Combustion of Hydrogen–Air Mixtures During Construction Operations	141
PL-3.10	Testing After Construction	142
PL-3.11	Commissioning of Facilities	143
PL-3.12	Pipe-Type and Bottle-Type Holders	143
PL-3.13	Control and Limiting of Hydrogen Gas Pressure	144
PL-3.14	Uprating	146
PL-3.15	Valves	147
PL-3.16	Vault Provisions for Design, Construction, and Installation of Pipeline	17/
1 L-5.10	Components	148
PL-3.17	Location for Customers' Meter and Regulator Installations	149
PL-3.18	Hydrogen Gas Service Lines	149
PL-3.19	Inspection and Examination	150
PL-3.20	Repair or Removal of Defective Welds in Piping Intended to Operate at Hoop Stress Levels of 20% or More of the Specified Minimum Yield Strength	153
PL-3.21	Steel Pipeline Service Conversions	153
Tables		
PL-2.3.2-1	Reinforcement of Fabricated Branch Connections, Special	
	Requirements	126
PL-2.5.2-1	Thermal Expansion of Carbon and Low Alloy Steel	127
PL-2 5 5-1	Modulus of Elasticity for Carbon and Low Alloy Steel	127

PL-3.6.1-1	Location Class	133
PL-3.7.1-1	Basic Design Factor, F (Used With Option A)	135
PL-3.7.1-2	Basic Design Factor, F (Used With Option B)	135
PL-3.7.1-3	Temperature Derating Factor, <i>T</i> , for Steel Pipe	135
PL-3.7.1-4	Nominal Chemical Composition Within a Specification/Grade	137
PL-3.7.1-5	Design Factors for Steel Pipe Construction (Used With Option A)	138
PL-3.7.1-6	Design Factors for Steel Pipe Construction (Used With Option B)	138
PL-3.7.5-1	Maximum Degree of Bending	140
Mandatory A	ppendices	
I	Design of Aboveground Hydrogen Gas Pipeline Facilities	155
II	Reference Standards	159
III	Safeguarding	163
IV	Nomenclature	165
V	(In Preparation)	169
VI	Preparation of Technical Inquiries	170
VII	Gas Leakage and Control Criteria	172
VIII	(In Preparation)	178
IX	Allowable Stresses and Quality Factors for Metallic Piping, Pipeline, and	
	Bolting Materials	179
Nonmandator	y Appendices	
A	Precautionary Considerations	216
В	Alternative Rules for Evaluating Stress Range	226
C	Recommended Practices for Proof Testing of Pipelines in Place	228
D	Estimating Strain in Dents	231
E	Sample Calculations for Branch Reinforcement in Piping	232
F	Welded Branch Connections and Extruded Headers in Pipeline	
	Systems	236