

Lubrication, Shaft-sealing, and Oil-control Systems and Auxiliaries

API STANDARD 614
SIXTH EDITION, FEBRUARY 2022



American
Petroleum
Institute

This is a preview. [Click here to purchase the full publication.](#)

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. The use of API publications is voluntary. In some cases, third parties or authorities having jurisdiction may choose to incorporate API standards by reference and may mandate compliance.

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.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to ensure 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.

All rights reserved. No part of this work may be reproduced, translated, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the publisher, API Publishing Services, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001.

Copyright © 2022 American Petroleum Institute

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.

The verbal forms used to express the provisions in this document are as follows.

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

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

May: As used in a standard, “may” denotes a course of action permissible within the limits of a standard.

Can: As used in a standard, “can” denotes a statement of possibility or capability.

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, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001. 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, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001.

Suggested revisions are invited and should be submitted to the Standards Department, API, 200 Massachusetts Avenue, NW, Suite 1100, Washington, DC 20001, standards@api.org.

Contents

| | | |
|------|--|----|
| 1 | Scope..... | 1 |
| 2 | Normative References | 1 |
| 3 | Terms, Definitions, Acronyms, and Abbreviations | 5 |
| 3.1 | Terms and Definitions | 5 |
| 3.2 | Acronyms and Abbreviations | 11 |
| 4 | System Configuration (How to Use This Standard to Specify an Oil System) | 11 |
| 5 | General Requirements | 18 |
| 5.1 | Unit Responsibility | 18 |
| 5.2 | Dimensions and Units | 18 |
| 5.3 | Statutory Requirements | 18 |
| 5.4 | Document Hierarchy | 18 |
| 6 | Design | 19 |
| 6.1 | System Design | 19 |
| 6.2 | System Selection | 20 |
| 6.3 | Pressure Design Code | 23 |
| 6.4 | Welding | 23 |
| 6.5 | Baseplates | 24 |
| 6.6 | Oil Reservoirs | 26 |
| 6.7 | Pumps and Pump Drivers | 36 |
| 6.8 | Lube-oil Heat Exchangers | 44 |
| 6.9 | Filters | 49 |
| 6.10 | Transfer Valves | 52 |
| 6.11 | Accumulators | 52 |
| 6.12 | Overhead Tanks | 54 |
| 6.13 | Seal-oil Drain Traps | 56 |
| 6.14 | Degassing Drum | 57 |
| 7 | Piping | 59 |
| 7.1 | General | 59 |
| 7.2 | Lubricating, Control, and Seal-oil Piping | 68 |
| 7.3 | Instrument Piping and Tubing | 69 |
| 7.4 | Process Piping | 69 |
| 7.5 | Steam, Air, and Cooling Water Piping | 70 |
| 7.6 | Intercoolers and Aftercoolers | 70 |
| 8 | Instrumentation, Control, and Electrical Systems | 71 |
| 8.1 | General | 71 |
| 8.2 | Alarm, Shutdown, and Control Systems | 72 |
| 8.3 | Instrumentation | 77 |
| 8.4 | Electrical Systems | 83 |
| 8.5 | Control Panels | 85 |
| 9 | Inspection, Testing, and Preparation for Shipment | 87 |
| 9.1 | General | 87 |
| 9.2 | Inspection | 88 |
| 9.3 | Testing | 90 |
| 9.4 | Preparation for Shipment | 94 |
| 9.5 | Package Markings and Shipping Documentation | 96 |
| 10 | Vendor's Data | 97 |
| 10.1 | General | 97 |
| 10.2 | Documentation | 97 |
| 10.3 | Proposals | 98 |

| | |
|---|------------|
| 10.4 Contract Data | 100 |
| Annex A.1 (informative) Site and Utility Data Sheet | 103 |
| Annex A.2 (informative) Data Sheets | 105 |
| Annex B (informative) Symbols | 135 |
| Annex C (informative) Piping and Instrument Diagrams | 139 |
| Annex D (informative) Contract Documents and Engineering Design Data | 169 |
| Annex E (informative) Oil Filter Performance and Oil-system Cleanliness Testing | 176 |
| Annex F (informative) International Materials Specifications | 185 |
| Annex G (informative) Explanation of Reservoir Levels | 191 |
| Annex H (informative) Diagrams of Typical Lubrication, Oil-type Shaft-sealing, and Control-oil Systems | 193 |
| Annex I (informative) Oil Drain Line Sizing | 215 |
| Annex J (informative) Inspector's Checklist | 221 |
| Annex K (informative) Guidance to System Reliability | 224 |
| Annex L (informative) Varnish and Electrostatic Discharge | 229 |
| Bibliography | 234 |

Figures

| | |
|---|------------|
| 1 Oil System Selection Guide | 12 |
| 2 Overhead Seal-oil Tank Levels and Volumes | 55 |
| 3 Blowdown Connection Configuration | 56 |
| 4 Typical Degassing Drum Arrangement | 58 |
| B.1 Symbols | 135 |
| B.2 Symbols (continued) | 136 |
| B.3 Symbols (continued) | 137 |
| B.4 Instrumentation Symbol Code Table | 138 |
| C.1 Combined Seal-oil, Lube-oil, and Control-oil System | 139 |
| C.2 Seal-oil System Only, with Overhead Tank for Equipment with One Pressure Level | 140 |
| C.3 Seal-oil System Only, with Overhead Tanks for Equipment with More Than One Pressure Level | 141 |
| C.4 Seal-oil System Only, for Equipment with Liquid Film-type Seals—Overhead Tank Upstream of Seals | 142 |
| C.5 Seal-oil System Only, for Equipment with Liquid Film-type Seals—Overhead Tank Downstream of Seals | 143 |
| C.6 Seal-oil System with Oil Pressure Lower Than Cooling Water Pressure | 144 |
| C.7 Seal-oil System with Oil Pressure Higher Than Cooling Water Pressure | 145 |
| C.8 Seal-oil Circulation System for Equipment with Double Mechanical Seals or Multiple Sealing Pressure Levels | 146 |
| C.9 Seal-oil Module at Equipment | 147 |
| C.10 Lube-oil and Control-oil Systems Only | 148 |
| C.11 Equipment Lube-oil System Only | 149 |
| C.12 Basic Oil Supply Module | 150 |
| C.13 Equipment Lube-oil Supply and Drain Headers | 151 |
| C.14 Inner Seal-oil Drain Traps | 152 |
| C.15 Emergency Lube-oil Atmospheric-type Rundown Tank | 153 |
| C.16 Emergency Lube-oil Pressurized-type Rundown Tank | 154 |
| C.17 Direct-contact-type Overhead-tank Module for Seal-oil System, Including Optional Transfer Barrier (Bladder-type) Vessel | 155 |
| C.18 Accumulator—Manual Precharge, Bladder Type | 156 |
| C.19 Accumulator—Direct-contact, Manual-precharge Type | 157 |

| | | |
|-------|--|-----|
| C.20A | Twin Oil Heat Exchangers and Duplex Filters with Separate, Continuous-flow Transfer Valves with No Temperature Control Valve..... | 158 |
| C.20B | Twin Oil Heat Exchangers and Duplex Filters with Separate, Continuous-flow Transfer Valves with Three-way Self-contained Thermostatic Control Valve..... | 159 |
| C.20C | Twin Oil Heat Exchangers and Duplex Filters with Separate, Continuous-flow Transfer Valves with Two-way Temperature Control Valve | 160 |
| C.20D | Twin Oil Heat Exchangers and Duplex Filters with Separate, Continuous-flow Transfer Valves with Three-way Temperature Control Valve | 161 |
| C.21 | Primary (Centrifugal or Rotary) Pump Arrangement..... | 162 |
| C.22 | Booster (Rotary) Pump Arrangement | 163 |
| C.23 | Oil Reservoir..... | 164 |
| C.24 | Local Instrument Piping Details—Pressure Gauges, Switches, and Transmitters..... | 165 |
| C.25 | Local Instrument Piping Details—Combined Instrument System for Low-pressure Alarms, Pump-start and Low-pressure Shutdown Devices | 165 |
| C.26A | Oil Direct Diaphragm Actuators with External Sensing Lines | 165 |
| C.26B | Self-contained Regulators without External Sensing Lines..... | 166 |
| C.27 | Remote Instrument Piping Details—Panel- and Board-mounted Gauges, Switches, and Transmitters | 166 |
| C.28 | Instrument Piping Details—Externally Flange Connected Level Instruments | 167 |
| C.29 | Local Instrument Piping Details—Differential Instruments, Diaphragm Actuators, Indicators, Switches, and Transmitters | 167 |
| C.30 | Blower Extraction Type Oil Mist Eliminator | 168 |
| G.1 | Reservoir Levels and Oil Level Glass Details | 192 |
| H.1 | Configuration Code: LO-PRAA0-R1-HE-BP2-CS1-F2-A0-PV0-TV1-OT0..... | 193 |
| H.2 | Configuration Code: LO-PRAA0-R1-H0-BP1-CS1-F2-A0-PV0-TV1-OT0 | 194 |
| H.3 | Configuration Code: LO-PRAA0-R1-H0-(BP0 or BP1)-CS1-F2-A0-PV1-TV1-OT0 | 195 |
| H.4 | Configuration Code: LO-PRAA0-R1-HE-BP1-CS1-F2-A0-PV1-TV0-OT0..... | 196 |
| H.5A | Configuration Code: LO-PRAA0-R1-HE-BP2-CS2-F2-AL-PV2-TV3B-OTA | 197 |
| H.5B | Configuration Code: LCO-PRTA0-R1-HE-BP2-CS2-F2-ALC-PV2-TV3B-OTA..... | 198 |
| H.6 | Configuration Code: LO-PRAA0-R1-HE-BP2-CS2-F2-A0-PV2B-TV3B-OTA | 199 |
| H.7A | Configuration Code: LO-PRAA0-R1-HE-BP2-CS2-F2-A0-PV2B-TV1B-OTA | 200 |
| H.7B | Configuration Code: LCO-PRAA0-R1-HE-BP2-CS2-F2-AC-PV2B-TV1B-OTA..... | 201 |
| H.7C | Configuration Code: LO-PRSA0-R0-HE-BP0-CS2-F2-A0-PV2B-TV1B-OT0..... | 202 |
| H.7D | Configuration Code: LO-PRAA0-R1-HE-BP2-CS2-F2-A0-PV2B-TV1B-OTA | 203 |
| H.8A | Configuration Code: LO-PRS00-R0-HE-BP2-CS1-F2-A0-PV0-TV1-OT0..... | 204 |
| H.8B | Configuration Code: LO-PRSA0-R0-HE-BP2-CS1-F2-A0-PV2-TV1-OT0..... | 205 |
| H.9A | Configuration Code: LO-PRAA0-R1-HE-BP2-CS2-F2-A0-PV2B-TV1B-OT0..... | 206 |
| H.9B | Configuration Code: LO-PRSA0-R1-HE-BP0-CS2-F2-A0-PV1B-TV1B-OT0..... | 207 |
| H.10 | Configuration Code: LO-PCAA0-R1-HE-BP0-CS1-F2-A0-PV1B-TV3B-OT0..... | 208 |
| H.11A | Configuration Code: LO-PRSA0-R0-H0-BP0-CS1-F2-A0-PV0-TV0-OT0 | 209 |
| H.11B | Configuration Code: LO-PRSA0-R1-H0-BP0-CS1-F2-A0-PV1-TV0-OT0 | 210 |
| H.12A | Configuration Code: LO-PRAA0-R1-H0-BP1-CS1-F1-A0-PV0-TV1-OT0 | 211 |
| H.12B | Configuration Code: LO-PRSA0-R1-H0-BP1-CS1-F2-A0-PV1-TV1-OT0 | 212 |
| H.13 | Configuration Code: LO-PRS00-R0-H0-BP0-CS1-F1-A0-PV0-TV0-OT0 | 213 |
| H.14 | Configuration Code: LO-PRS00-R0-H0-BP0-CS1-F1-A0-PV0-TV0-OT0 | 214 |
| L.1 | Varnish Deposits on Lubrication System Servo Valve | 229 |
| L.2 | Varnish Material at 100x Magnification | 229 |
| L.3 | SEM Photomicrograph of the Varnish Material at 1000x Magnification..... | 230 |
| L.4 | FTIR Spectra of the Oxidation and Thermal Degradation Produced Varnish Material | 231 |

Tables

| | | |
|---|---|----|
| 1 | Oil System Standard Configuration Options..... | 13 |
| 2 | Requirements for Oil System Code by Equipment Type | 16 |
| 3 | Minimum Requirements for Piping Materials—Auxiliary Process Fluid | 61 |
| 4 | Minimum Requirements for Piping Materials—Steam and Air..... | 61 |
| 5 | Minimum Requirements for Piping Materials—Cooling Water | 62 |

| | | |
|-----|---|-----|
| 6 | Minimum Requirements for Piping Materials—Lubricating, Control, and Seal Oil..... | 62 |
| 7 | Minimum Pipe Wall Thicknesses..... | 63 |
| 8 | Minimum Tubing Wall Thicknesses | 63 |
| 9 | Recommended Alarms, Recommended Shutdowns, and Required Trips for Oil Systems . | 74 |
| 10 | NDE Testing Acceptance Criteria—ASME..... | 89 |
| 11 | NDE Testing Acceptance Criteria—EN ISO | 89 |
| D.1 | VDDR for Oil Systems (see text for details of the description) | 173 |
| E.1 | Relative Size Comparison of Particles of Some Common Materials | 178 |
| E.2 | Typical Dynamic Film Thickness for Equipment..... | 178 |
| E.3 | Allocation of Scale Numbers per ISO 4406 | 180 |
| E.4 | SAE AS4059E Cleanliness Classes for Differential Particle Counts (Particles/100 ml) | 181 |
| E.5 | SAE AS4059E Cleanliness Classes for Cumulative Particle Counts (Particles/100 ml)..... | 182 |
| E.6 | SAE AS4059E Class to ISO Cleanliness Code Conversion | 183 |
| F.1 | Materials Standards | 185 |
| F.2 | Miscellaneous Materials Specifications | 190 |
| I.1 | Example: Capacities of Atmospheric Oil Drain Lines Flowing $\frac{1}{2}$ Full with $\frac{1}{2}$ " per Foot Slope [for Light Turbine Oil (ISO VG 32) Flowing at 120 °F]..... | 220 |
| J.1 | Inspector's Checklist | 221 |
| K.1 | Failure Modes and Effects Analysis..... | 226 |

Introduction

API 614 is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from API 614 and provide details.

API 614 requires the purchaser to specify certain details and features.

A bullet (●) at the beginning of a section or subsection indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated in the data sheets; otherwise, it should be stated in the quotation request or in the purchase order.

A diamond (◆) at the beginning of a section or subsection indicates that the feature is required for unsparred equipment in critical service.

NOTE Sections and subsections preceded by a diamond (◆) are those features and requirements described as “special purpose” oil systems in previous editions of API 614.

In this International Standard, United States customary units are included in parentheses for information.

Annex A.1 contains a site and utility data sheet.

Annex A.2 contains oil system data sheets.

Annex B contains symbols used in piping and instrument diagrams and figures.

Annex C contains piping and instrument diagrams.

Annex D contains contract documents and engineering design data.

Annex E provides guidance on oil filter performance and oil-system cleanliness testing.

Annex F contains international materials specifications.

Annex G provides an explanation of reservoir levels.

Annex H contains diagrams of typical lubrication, oil-type shaft-sealing, and oil-control systems.

Annex I provides guidance on oil drain line sizing.

Annex J contains an inspector’s checklist.

Annex K contains a guide to system reliability.

Annex L provides guidance on varnish and electrostatic discharge.

Lubrication, Shaft-sealing, and Oil-control Systems and Auxiliaries

1 Scope

API 614 covers the minimum requirements for lubrication systems, oil-type shaft-sealing systems, oil-control systems, and auxiliaries, excluding dry gas seal systems and fuel systems. These systems can serve individual equipment such as compressors, gears, pumps, and drivers or complete trains. API 614 does not apply to dry gas seal systems. For dry gas seal systems, refer to API 692.

NOTE For high-pressure oil systems and fuel systems used on gas turbines, refer to API 616.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, except that new editions may be used on issue and shall become mandatory upon the effective date specified by the publisher or 6 months from the date of the revision (where no effective date is specified).

API Standard 520 (all parts), *Sizing, Selection, and Installation of Pressure-relieving Devices*

API Standard 526, *Flanged Steel Pressure-relief Valves*

API Standard 547, *General Purpose Form-wound Squirrel Cage Induction Motors—185 kW (250 hp) through 2240 kW (3000 hp)*

API Recommended Practice 551, *Process Measurement*

API Recommended Practice 578, *Guidelines for a Material Verification Program (MVP) for New and Existing Assets*

API Standard 594, *Check Valves: Flanged, Lug, Wafer, and Butt-welding*

API Standard 600, *Steel Gate Valves—Flanged and Butt-welding Ends, Bolted Bonnets*

API Standard 602, *Gate, Globe, and Check Valves for Sizes DN 100 (NPS 4) and Smaller for the Petroleum and Natural Gas Industries*

API Standard 610, *Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries*

API Standard 611, *General-purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services*

API Standard 660, *Shell-and-Tube Heat Exchangers*

API Standard 661, *Petroleum, Petrochemical, and Natural Gas Industries—Air-cooled Heat Exchangers*

API Standard 670, *Machinery Protection Systems*

API Standard 676, *Positive Displacement Pumps—Rotary*

API Recommended Practice 686, *Recommended Practice for Machinery Installation and Installation Design*

API Recommended Practice 691, *Risk-based Machinery Management*

API Standard 692, *Dry Gas Sealing Systems for Axial, Centrifugal, and Rotary Screw Compressors and Expanders*

ANSI B11.19 ¹, *Performance Requirements for Risk Reduction Measures: Safeguarding and Other Means of Reducing Risk*

ANSI/AGMA 9000-D11 ², *Flexible Couplings—Potential Unbalance Classification*

ANSI/AGMA 9002-B04 (R2011), *Bores and Keyways for Flexible Couplings (Inch Series)*

ASME B1.1 ³, *Unified Inch Screw Threads (UN, UNR, and UNJ Thread Forms)*

ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*

ASME B16.1, *Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250*

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Metric/Inch Standard*

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*

ASME B16.42, *Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300*

ASME B16.47, *Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard*

ASME B31.3, *Process Piping*

ASME B73.1, *Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process*

ASME B73.2, *Specification for Vertical In-line Centrifugal Pumps for Chemical Process*

ASME Boiler and Pressure Vessel Code, Section V: *Nondestructive Examination*

ASME Boiler and Pressure Vessel Code, Section VIII: *Rules for Construction of Pressure Vessels, Division 1*

ASME Y14.2, *Line Conventions and Lettering*

ASTM A193/A193M ⁴, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

ASTM A194/A194M, *Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A240/A240M, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications*

ASTM A388/A388M, *Standard Practice for Ultrasonic Examination of Steel Forgings*

ASTM A578/A578M, *Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications*

ASTM A609/A609M, *Standard Practice for Castings, Carbon, Low-Alloy, and Martensitic Stainless Steel, Ultrasonic Examination Thereof*

ASTM D5445-15, *Standard Practice for Pictorial Markings for Handling of Goods*

¹ American National Standards Institute, 1899 L Street, NW, Washington, District of Columbia 20036, <https://ansi.org>.

² American Gear Manufacturers Association, 1001 N. Fairfax Street, Suite 500, Alexandria, Virginia 22314, www.agma.org.

³ American Society of Mechanical Engineers, Two Park Avenue, New York, New York 10016, www.asme.org.

⁴ ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.

ASTM E94/E94M, *Standard Guide for Radiographic Examination Using Industrial Radiographic Film*

ASTM E165/E165M, *Standard Practice for Liquid Penetrant Testing for General Industry*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASTM E1003, *Standard Practice for Hydrostatic Leak Testing*

AWS D1.1/D1.1M ⁵, *Structural Welding Code—Steel*

EN 1092-1 ⁶, *Flanges and their joints—Circular flange for pipes, valves, fittings and accessories, PN designated—Part 1: Steel flanges*

EN 1092-2, *Flanges and their joints—Circular flange for pipes, valves, fittings and accessories, PN designated—Part 2: Cast iron flanges*

EN ISO 3452-1, *Non-destructive testing of welds—Penetrant testing—General principles*

EN 10675-1, *Non-destructive testing of welds—Acceptance levels for radiographic testing—Steel, nickel, titanium and their alloys*

EN ISO 11666, *Non-destructive testing of welds—Ultrasonic testing—Acceptance levels*

EN ISO 17636-1, *Non-destructive testing of welds—Radiographic testing—X- and gamma-ray techniques with film*

EN ISO 17636-2, *Non-destructive testing of welds—Radiographic testing—X- and gamma-ray techniques with digital detectors*

EN ISO 17637, *Non-destructive testing of welds—Visual testing of fusion-welded joints*

EN ISO 17638, *Non-destructive testing of welds—Magnetic particle testing*

EN ISO 17640, *Non-destructive testing of welds—Ultrasonic testing—Techniques, testing levels and assessment*

EN ISO 23277, *Non-destructive testing of welds—Penetrant testing—Acceptance levels*

EN ISO 23278, *Non-destructive testing of welds—Magnetic particle testing—Acceptance levels*

EN ISO 23279, *Non-destructive testing of welds—Ultrasonic testing—Characterization of discontinuities in welds*

IEC 60079 (all parts) ⁷, *Explosive atmospheres*

IEC 60529, *Degrees of protection provided by enclosures (IP code)*

⁵ American Welding Society, 8669 NW 36 Street, # 130, Miami, Florida 33166, www.aws.org.

⁶ European Committee for Standardization (CEN), Management Centre, Rue de la Science 23, B - 1040 Brussels, Belgium, <https://www.cen.eu>.

⁷ International Electrotechnical Commission, 3 Rue de Varembé, CH-1211, Geneva 20, Switzerland, www.iec.ch.