Welding Processes, Inspection, and Metallurgy

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1 Scope

This recommended practice (RP) provides guidance to the API authorized inspector on welding inspection as encountered with fabrication and repair of refinery and chemical plant equipment and piping, pipelines, and other related industries. This RP includes descriptions of common welding processes, welding procedures, welder qualifications, metallurgical effects from welding, and inspection techniques to aid the inspector in fulfilling their role implementing API 510, API 570, API 653, and API 582. The level of learning and training obtained from this document is not a replacement for the training and experience required to be a certified welding inspector under one of the established welding certification programs, such as the American Welding Society (AWS) Certified Welding Inspector (CWI), or Canadian and European equivalent schemes such as CWB, CSWIP, PCN, or EFW.

This RP does not require all welds to be inspected, nor does it require welds to be inspected to specific techniques and extent. Welds selected for inspection, and the appropriate inspection techniques, should be determined by the welding inspectors, engineers, or other responsible personnel using the applicable code or standard. The importance, difficulty, and problems that could be encountered during welding should be considered by all involved. A welding engineer should be consulted on any critical, specialized, or complex welding issues.

2 Normative 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.

API 510, *Pressure Vessel Inspection Code: Maintenance, Inspection, Rating, Repair, and Alteration*

API 570, *Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems*

API Recommended Practice 571, *Damage Mechanisms Affecting Fixed Equipment in the Refining Industry*

API Recommended Practice 574, *Inspection Practices for Piping System Components*

API Recommended Practice 578, *Material Verification Program for New and Existing Alloy Piping Systems*

API Recommended Practice 582, *Recommended Practice and Supplementary Welding Guidelines for the Chemical, Oil, and Gas Industries*

API Recommended Practice 2201, *Procedures for Welding or Hot Tapping on Equipment in Service*

ASME *Boiler and Pressure Vessel Code* [1]

Section VIII, *Rules for Construction of Pressure Vessels*

[1] ASME International, 3 Park Avenue, New York, New York 10016-5990, www.asme.org.

Section IX, *Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators*

Section XI, *Rules for Inservice Inspection of Nuclear Power Plant Components*

ASME B31, *Code for Pressure Piping*

B31.1, *Power Piping*

B31.3, *Process Piping*

B31.4, *Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols*

B31.8, *Gas Transmission and Distribution Piping Systems*

ASME PCC-2, *Repair of Pressure Equipment and Piping*

ASNT Central Certification Program CP-189 [2], *Standard for Qualification and Certification of Nondestructive Testing Personnel*

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

ASTM A833 [3], *Standard Test Method for Indentation Hardness of Metallic Materials by Comparison Hardness Testers*

ASTM A956, *Standard Test Method for Leeb Hardness Testing of Steel Products*

ASTM A1038, *Standard Practice for Portable Hardness Testing by the Ultrasonic Contact Impedance Method*

ASTM E94, *Standard Guide for Radiographic Examination*

ASTM E1316, *Standard Terminology for Nondestructive Examinations*

AWS A3.0M/A3.0:2010 [4], *Standard Welding Terms and Definitions*

AWS A5.XX, *Series of Filler Metal Specifications*

ISO 9712 [5], *Non-destructive testing—Qualification and certification of NDT personnel*

NACE SP0472 [6], *Methods and Controls to Prevent In-Service Environmental Cracking of Carbon Steel Weldments in Corrosive Petroleum Refining Environments*

WRC Bulletin 342 [7], *Stainless Steel Weld Metal: Prediction of Ferrite Content*

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[2] American Society for Nondestructive Testing, 1711 Arlingate Lane, P.O. Box 28518, Columbus, Ohio 43228, www.asnt.org.
[3] ASTM International, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428, www.astm.org.
[4] American Welding Society, 550 NW LeJeune Road, Miami, Florida 33126, www.aws.org.
[5] International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, www.iso.org.
[6] NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77218-8340, www.nace.org.
[7] The Welding Research Council, 3 Park Avenue, 27th Floor, New York, New York 10016-5902, www.forengineers.org.