Welding of Pipelines and Related Facilities

Pipeline Segment

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FOREWORD

07 The bar notations in the margins identify parts of this standard that have been changed from the previous API edition. While efforts have been made to ensure the accuracy of the notations, the user of this standard is responsible for recognizing any differences between this and the previous edition.

This standard was prepared by a formulating committee that included representatives of the American Petroleum Institute, the American Gas Association, the Pipe Line Contractors Association, the American Welding Society, and the American Society for Nondestructive Testing, as well as representatives of pipe manufacturers and individuals associated with related industries.

The purpose of this standard is to present methods for the production of high-quality welds through the use of qualified welders using approved welding procedures, materials and equipment. Its purpose is also to present inspection methods to ensure the proper analysis of welding quality through the use of qualified technicians and approved methods and equip-ment. It applies to both new construction and in-service welding.

The use of this standard is entirely voluntary and is intended to apply to welding of piping used in the compression, pumping, and transmission of crude petroleum, petroleum products, fuel gases, carbon dioxide, and nitrogen and, where applicable, to distribution systems.

This standard represents the combined efforts of many engineers who are responsible for the design, construction, and operation of oil and gas pipelines, and the committee appreciatively acknowledges their wholehearted and valuable assistance.

From time to time, revisions of this standard will be necessary to keep current with technological developments. The committee is always anxious to improve this standard and will give full consideration to all comments received.

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Suggested revisions are invited and should be submitted to the Standards and Publications Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

CONTENTS

07

Tables

Welding of Pipelines and Related Facilities

1 General

1.1 SCOPE

This standard covers the gas and arc welding of butt, fillet, and socket welds in carbon and low-alloy steel piping used in the compression, pumping, and transmission of crude petroleum, petroleum products, fuel gases, carbon dioxide, nitrogen and, where applicable, covers welding on distribution systems. It applies to both new construction and in-service welding. The welding may be done by a shielded metal-arc welding, submerged arc welding, gas tungsten-arc welding, gas metal-arc welding, flux-cored arc welding, plasma arc welding, oxyacetylene welding, or flash butt welding process or by a combination of these processes using a manual, semiautomatic, mechanized, or automatic welding technique or a combination of these techniques. The welds may be produced by position or roll welding or by a combination of position and roll welding.

This standard also covers the procedures for radiographic, magnetic particle, liquid penetrant, and ultrasonic testing, as well as the acceptance standards to be applied to production welds tested to destruction or inspected by radiographic, magnetic particle, liquid penetrant, ultrasonic, and visual testing methods.

The values stated in either inch-pound units or SI units are to be regarded separately as standard. Each system is to be used independently of the other, without combining values in any way.

Processes other than those described above will be considered for inclusion in this standard. Persons who wish to have other processes included shall submit, as a minimum, the following information for the committee's consideration:

a. A description of the welding process.
b. A proposal on the essential variables.
c. A welding procedure specification.
d. Weld inspection methods.
e. Types of weld imperfections and their proposed acceptance limits.
f. Repair procedures.

It is intended that all work performed in accordance with this standard shall meet or exceed the requirements of this standard.

2 Referenced Publications

The following standards, codes, and specifications are cited in this standard:

API
- Spec 5L — *Specification for Line Pipe*
- RP 2201 — *Safe Hot Tapping Practices in the Petroleum & Petrochemical Industries*

ASNT[1]
- RP SNT-TC-1A — *Personnel Qualification and Certification in Nondestructive Testing*
- ACCP — *ASNT Central Certification Program*

ASTM[2]
- E 164 — *Standard Practice for Ultrasonic Contact Examination of Weldments*
- E 165 — *Standard Test Methods for Liquid Penetrant Examination*
- E 709 — *Standard Guide for Magnetic Particle Examination*
- E 747 — *Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology*

AWS[3]
- A3.0 — *Welding, Terms and Definitions*
- A5.1 — *Covered Carbon Steel Arc Welding Electrodes*
- A5.2 — *Iron and Steel Oxyfuel Gas Welding Rods*
- A5.5 — *Low Alloy Steel Covered Arc Welding Electrodes*
- A5.17 — *Carbon Steel Electrodes and Fluxes for Submerged Arc Welding*
- A5.18 — *Carbon Steel Filler Metals for Gas Shielded Arc Welding*
- A5.20 — *Carbon Steel Electrodes for Flux Cored Arc Welding*
- A5.28 — *Low Alloy Steel Filler Metals for Gas Shielded Arc Welding*
- A5.29 — *Low Alloy Steel Electrodes for Flux Cored Arc Welding*

BSI[4]
- BS 7448: Pt. 2 — *Fracture Mechanics Toughness Tests Part 2, Method for Determination of K_{Ic} Critical*

[1]American Society for Nondestructive Testing, Inc., 1711 Arlingate Lane, P.O. Box 28518, Columbus, Ohio 43228-0518. www.asnt.org.
[2]American Society for Testing and Materials, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959. www.astm.org
[3]American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126. www.aws.org
[4]BSI, British Standards HQ, 389 Chiswick High Road, London, W4 4AL, United Kingdom. www.bsi-global.com

CTOD and Critical J Values of Welds in Metallic Materials

ISO[5]

ISO 1027 *Radiographic image quality indicators for non-destructive testing—Principles and Identification*

NACE[6]

MR0175 *Sulfide Stress Cracking Resistant Metallic Materials for Oil Field Equipment*

3 Definition of Terms

3.1 GENERAL

The welding terms used in this standard are as defined in AWS A3.0, with the additions and modifications given in 3.2.

3.2 DEFINITIONS

3.2.1 automatic welding: Arc welding with equipment that performs the entire welding operation without manual manipulation of the arc or electrode other than guiding or tracking and without a manual welding-skill requirement of the operator.

3.2.2 branch weld: The completed groove and/or fillet weld joining a set on or set in branch pipe or a set on or set in branch fitting to a run pipe. 07

3.2.3 company: The owner company or the engineering agency in charge of construction. The company may act through an inspector or another authorized representative.

3.2.4 contractor: Includes the primary contractor and any subcontractors engaged in work covered by this standard.

3.2.5 defect: An imperfection of sufficient magnitude to warrant rejection based on the stipulations in this standard.

3.2.6 imperfection: A discontinuity or irregularity that is detectable by methods outlined in this standard.

3.2.7 indication: Evidence obtained by nondestructive testing.

3.2.8 internal concavity: A bead that is properly fused to and completely penetrates the pipe wall thickness along both sides of the bevel, but whose center is somewhat below the inside surface of the pipe wall. The magnitude of concavity is the perpendicular distance between an axial extension of the pipe wall surface and the lowest point on the weld bead surface.

3.2.9 mechanized welding: A process where parameters and torch guidance are controlled mechanically or electronically but may be manually varied during welding to maintain the specified welding conditions.

3.2.10 position welding: Welding in which the pipe or assembly is not rotating while the weld is being deposited.

3.2.11 qualified welder: A welder who has demonstrated the ability to produce welds that meet the requirements of Sections 5 or 6.

3.2.12 qualified welding procedure: A tested and proven detailed method by which sound welds with suitable mechanical properties can be produced.

3.2.13 radiographer: A person who performs radiographic operations.

3.2.14 repair: Any rework on a completed weld that requires welding to correct a fault in the weld that has been discovered by visual or nondestructive testing and is beyond this standard's limits of acceptability.

3.2.15 roll welding: Welding in which the pipe or assembly is rotated while the weld metal is being deposited at or near the top center.

3.2.16 root bead: The first or stringer bead that initially joins two sections of pipe, a section of pipe to a fitting, or two fittings.

3.2.17 semiautomatic welding: Arc welding with equipment that controls only the filler-metal feed. The advance of the welding is manually controlled.

3.2.18 shall: Term that indicates a mandatory requirement. The term should indicates a recommended practice.

3.2.19 weld: The completed weld joining two sections of pipe, a section of pipe to a fitting, or two fittings.

3.2.20 welder: A person who makes a weld.

4 Specifications

4.1 EQUIPMENT

Welding equipment, both gas and arc, shall be of a size and type suitable for the work and shall be maintained in a condition that ensures acceptable welds, continuity of operation, and safety of personnel. Arc-welding equipment shall be operated within the amperage and voltage ranges given in the qualified welding procedure. Gas-welding equipment shall be operated with the flame characteristics and tip sizes given in the qualified welding procedure. Equipment that does not meet these requirements shall be repaired or replaced.

[5]International Organization for Standardization (ISO), 1, rue de Varembé, Case postale 56, CH-1211 Geneva 20, Switzerland. www.iso.org

[6]NACE International, 1440 South Creek Drive, Houston, Texas 77084–4906. www.nace.org