



Standard Test Method for Determination of Crack-Tip-Opening Angle of Pipe Steels Using DWTT Specimens¹

This standard is issued under the fixed designation E3039; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of fracture propagation toughness in terms of the steady-state crack-tip-opening angle (CTOA) using the drop-weight tear test (DWTT) specimen. The method is applicable to pipe steels that exhibit predominantly ductile fracture with at least 85% shear area measured according to Test Method E436 - Standard Test Method for Drop-Weight Tear Tests of Ferritic Steels. This test method applies to steel pipes with wall thicknesses between 6 mm and 20 mm.

1.2 In terms of apparatus, specimen design, and test methodology, this test method draws from Test Method E436 and API 5L3 - Recommended Practice for Conducting Drop-Weight Tear Tests on Line Pipe.

1.3 The development of this test method has been driven by the need to design for fast ductile fracture arrest of axial running cracks in steel high-pressure gas pipelines (1).² The purpose has been to develop a test to characterize fracture propagation resistance in a form suitable for use as a pipe mill test (2). The traditional Charpy test has been shown to be inadequate for modern high toughness pipe steels (1). This test method measures fracture propagation resistance in terms of crack-tip opening angle, and is used to characterize pipe steels.

1.4 The values stated in SI units are to be regarded as the standard values; those given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This test method is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.07 on Fracture Mechanics.

Current edition approved May 1, 2016. Published June 2016. DOI: 10.1520/E3039-16

² The boldface numbers in parentheses refer to a list of references at the end of this standard.

2. Referenced Documents

2.1 ASTM Standards:³

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E436 Test Method for Drop-Weight Tear Tests of Ferritic Steels

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

E1823 Terminology Relating to Fatigue and Fracture Testing

E1942 Guide for Evaluating Data Acquisition Systems Used in Cyclic Fatigue and Fracture Mechanics Testing

E2298 Test Method for Instrumented Impact Testing of Metallic Materials

E2472 Test Method for Determination of Resistance to Stable Crack Extension under Low-Constraint Conditions

2.2 ISO Standards:⁴

ISO 22889 Metallic materials — Method of Test for the Determination of Resistance to Stable Crack Extension Using Specimens of Low Constraint

ISO 14456 Steel — Charpy V-notch Pendulum Impact Test — Instrumented Test Method

2.3 API Recommended Practice:⁵

API Recommended Practice 5L3 Drop-Weight Tear Tests on Line Pipe

3. Terminology

3.1 Symbols:

a	= crack size, mm
a_n	= initial notch depth, mm
b	= specimen ligament size ($b=W-a$), mm
b_0	= initial ligament size ($b_0=W-a_n$), mm
C_v	= full-size Charpy V-notch absorbed energy, J
B	= specimen thickness, mm

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <http://www.iso.org>.

⁵ Available from American Petroleum Institute (API), 1220 L. St., NW, Washington, DC 20005-4070, <http://www.api.org>.