



Designation: E 1921 – 02

Standard Test Method for Determination of Reference Temperature, T_o , for Ferritic Steels in the Transition Range¹

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1. Scope

1.1 This test method covers the determination of a reference temperature, T_o , which characterizes the fracture toughness of ferritic steels that experience onset of cleavage cracking at elastic, or elastic-plastic K_{Jc} instabilities, or both. The specific types of ferritic steels (3.2.1) covered are those with yield strengths ranging from 275 to 825 MPa (40 to 120 ksi) and weld metals, after stress-relief annealing, that have 10 % or less strength mismatch relative to that of the base metal.

1.2 The specimens covered are fatigue precracked single-edge notched bend bars, SE(B), and standard or disk-shaped compact tension specimens, C(T) or DC(T). A range of specimen sizes with proportional dimensions is recommended. The dimension on which the proportionality is based is specimen thickness.

1.3 Requirements are set on specimen size and the number of replicate tests that are needed to establish acceptable characterization of K_{Jc} data populations.

1.4 The statistical effects of specimen size on K_{Jc} in the transition range are treated using weakest-link theory (1)² applied to a three-parameter Weibull distribution of fracture toughness values. A limit on K_{Jc} values, relative to the specimen size, is specified to ensure high constraint conditions along the crack front at fracture. For some materials, particularly those with low strain hardening, this limit may not be sufficient to ensure that a single-parameter (K_{Jc}) adequately describes the crack-front deformation state (2).

1.5 Statistical methods are employed to predict the transition toughness curve and specified tolerance bounds for 1T specimens of the material tested. The standard deviation of the data distribution is a function of Weibull slope and median K_{Jc} . The procedure for applying this information to the establishment of transition temperature shift determinations and the establishment of tolerance limits is prescribed.

1.6 The fracture toughness evaluation of nonuniform material is not amenable to the statistical analysis methods em-

ployed in this standard. Materials must have macroscopically uniform tensile and toughness properties. For example, multipass weldments can create heat-affected and brittle zones with localized properties that are quite different from either the bulk material or weld. Thick section steel also often exhibits some variation in properties near the surfaces. Metallography and initial screening may be necessary to verify the applicability of these and similarly graded materials. Particular notice should be given to the 2% and 98% tolerance bounds on K_{Jc} presented in 9.3. Data falling outside these bounds may indicate nonuniform material properties.

1.7 *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.*

2. Referenced Documents

2.1 ASTM Standards:

- E 4 Practices for Force Verification of Testing Machines³
- E 8M Test Methods for Tension Testing of Metallic Materials (Metric)³
- E 23 Test Methods for Notched Bar Impact Testing of Metallic Materials³
- E 74 Practice for Calibration of Force Measuring Instruments for Verifying the Force Indication of Testing Machines³
- E 208 Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels³
- E 399 Test Method for Plane-Strain Fracture Toughness of Metallic Materials³
- E 436 Test Method for Drop-Weight Tear Tests of Ferritic Steels³
- E 561 Practice for R-Curve Determination³
- E 812 Test Method for Crack Strength of Slow-Bend, Precracked Charpy Specimens of High-Strength Metallic Materials³
- E 1820 Test Method for Measurement of Fracture Toughness³

¹ This test method is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of E08.08 on Elastic-Plastic Fracture Mechanics Technology.

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

³ Annual Book of ASTM Standards, Vol 03.01.