



Standard Practice for Strain Controlled Thermomechanical Fatigue Testing¹

This standard is issued under the fixed designation E2368; 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 practice covers the determination of thermomechanical fatigue (TMF) properties of materials under uniaxially loaded strain-controlled conditions. A “thermomechanical” fatigue cycle is here defined as a condition where uniform temperature and strain fields over the specimen gage section are *simultaneously varied and independently controlled*. This practice is intended to address TMF testing performed in support of such activities as materials research and development, mechanical design, process and quality control, product performance, and failure analysis. While this practice is specific to strain-controlled testing, many sections will provide useful information for force-controlled or stress-controlled TMF testing.

1.2 This practice allows for any maximum and minimum values of temperature and mechanical strain, and temperature-mechanical strain phasing, with the restriction being that such parameters remain cyclically constant throughout the duration of the test. No restrictions are placed on environmental factors such as pressure, humidity, environmental medium, and others, provided that they are controlled throughout the test, do not cause loss of or change in specimen dimensions in time, and are detailed in the data report.

1.3 The use of this practice is limited to specimens and does not cover testing of full-scale components, structures, or consumer products.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

2. Referenced Documents

2.1 *ASTM Standards*:²

E3 Guide for Preparation of Metallographic Specimens

¹ This practice is under the jurisdiction of ASTM Committee E08 on Fatigue and Fracture and is the direct responsibility of Subcommittee E08.05 on Cyclic Deformation and Fatigue Crack Formation.

Current edition approved May 1, 2010. Published June 2010. Originally approved in 2004. Last previous edition approved in 2004 as E2368–04^{ε1}. DOI: 10.1520/E2368-10.

² 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.

E4 Practices for Force Verification of Testing Machines
E83 Practice for Verification and Classification of Extensometer Systems
E111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus
E112 Test Methods for Determining Average Grain Size
E220 Test Method for Calibration of Thermocouples By Comparison Techniques
E337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)
E467 Practice for Verification of Constant Amplitude Dynamic Forces in an Axial Fatigue Testing System
E606 Test Method for Strain-Controlled Fatigue Testing
E1012 Practice for Verification of Testing Frame and Specimen Alignment Under Tensile and Compressive Axial Force Application
E1823 Terminology Relating to Fatigue and Fracture Testing

3. Terminology

3.1 The definitions in this practice are in accordance with definitions given in Terminology E1823 unless otherwise stated.

3.2 Definitions:

3.2.1 Additional definitions are as follows:

3.2.2 *stress*, σ —stress is defined herein to be the engineering stress, which is the ratio of force, P , to specimen original cross sectional area, A :

$$\sigma = P/A \quad (1)$$

The area, A , is that measured in an unloaded condition at room temperature. See 7.2 for temperature state implications.

3.2.3 *coefficient of thermal expansion*, α —the fractional change in free expansion strain for a unit change in temperature, as measured on the test specimen.

3.2.4 *total strain*, ϵ_t —the strain component measured on the test specimen, and is the sum of the thermal strain and the mechanical strain.

3.2.5 *thermal strain*, ϵ_{th} —the strain component resulting from a change in temperature under free expansion conditions (as measured on the test specimen).

$$\epsilon_{th} = \alpha \cdot \Delta T \quad (2)$$