



Standard Test Method for Residual Stress Measurement by X-Ray Diffraction for Bearing Steels¹

This standard is issued under the fixed designation E2860; 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.

INTRODUCTION

The measurement of residual stress using X-ray diffraction (XRD) techniques has gained much popularity in the materials testing field over the past half century and has become a mandatory test for many production and prototype bearing components. However, measurement practices have evolved over this time period. With each evolutionary step, it was discovered that previous assumptions were sometimes erroneous, and as such, results obtained were less reliable than those obtained using state-of-the-art XRD techniques. Equipment and procedures used today often reflect different periods in this evolution; for example, systems that still use the single- and double-exposure techniques as well as others that use more advanced multiple exposure techniques can all currently be found in widespread use. Moreover, many assumptions made, such as negligible shear components and non-oscillatory $\sin^2\psi$ distributions, cannot safely be made for bearing materials in which the demand for measurement accuracy is high. The use of the most current techniques is, therefore, mandatory to achieve not only the most reliable measurement results but also to enable identification and evaluation of potential measurement errors, thus paving the way for future developments.

1. Scope

1.1 This test method covers a procedure for experimentally determining macroscopic residual stress tensor components of quasi-isotropic bearing steel materials by X-ray diffraction (XRD).

1.2 This test method provides a guide for experimentally determining stress values, which play a significant role in bearing life.

1.3 Examples of how tensor values are used are:

1.3.1 Detection of grinding type and abusive grinding;

1.3.2 Determination of tool wear in turning operations;

1.3.3 Monitoring of carburizing and nitriding residual stress effects;

1.3.4 Monitoring effects of surface treatments such as sand blasting, shot peening, and honing;

1.3.5 Tracking of component life and rolling contact fatigue effects;

1.3.6 Failure analysis;

1.3.7 Relaxation of residual stress; and

1.3.8 Other residual-stress-related issues that potentially affect bearings.

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

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.*

2. Referenced Documents

2.1 *ASTM Standards*:²

[E6 Terminology Relating to Methods of Mechanical Testing](#)

[E7 Terminology Relating to Metallography](#)

[E915 Test Method for Verifying the Alignment of X-Ray Diffraction Instrumentation for Residual Stress Measurement](#)

[E1426 Test Method for Determining the Effective Elastic Parameter for X-Ray Diffraction Measurements of Residual Stress](#)

¹ This test method is under the jurisdiction of ASTM Committee [E28](#) on Mechanical Testing and is the direct responsibility of Subcommittee [E28.13](#) on Residual Stress Measurement.

Current edition approved April 1, 2012. Published May 2012. DOI: 10.1520/E2860-12.

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.