



Standard Practice for Assessing the Tendency of Industrial Boiler Waters to Cause Embrittlement (USBM¹ Embrittlement Detector Method)²

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1. Scope

1.1 This practice,³ known as the embrittlement-detector method, covers the apparatus and procedure for determining the embrittling or nonembrittling characteristics of the water in an operating boiler. The interpretation of the results shall be restricted to the limits set forth in Section 12.

NOTE 1—The embrittlement detector was designed to reproduce closely the conditions existing in an actual boiler seam. It is considered probable that the individual conditions of leakage, concentration, and stress in the boiler seam can equal those in the detector. The essential difference between the detector and the boiler is that the former is so constructed and operated that these three major factors act simultaneously, continuously, and under the most favorable circumstances to produce cracking; whereas, in the boiler the three factors are brought together only under unique circumstances. Furthermore, in the detector any cracking is produced in a small test surface that can be inspected thoroughly, while the susceptible areas in a boiler are large and can be inspected only with difficulty. In these respects the embrittlement detector provides an accelerated test of the fourth condition necessary for embrittlement, the embrittling nature of the boiler water.

NOTE 2—Cracks in a specimen after being subjected to this test indicate that the boiler water can cause embrittlement cracking, but not that the boiler in question necessarily has cracked or will crack.

¹ United States Bureau of Mines.

² This test method is under the jurisdiction of ASTM Committee D-19 on Water and is the direct responsibility of Subcommittee D19.03 on Sampling of Water and Water-Formed Deposits, Surveillance of Water and Flow Measurement of Water.

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³ This test method was developed during an investigation conducted under a cooperative agreement between the Joint Research Committee on Boiler Feedwater Studies and the United States Bureau of Mines.

For information on the development of this test method reference may be made to the following:

Schroeder, W. C. and Berk, A. A. "Intercrystalline Cracking of Boiler Steel and Its Prevention," *Bulletin 443*, U.S. Bureau of Mines, 1941.

Schroeder, W. C., Berk, A. A. and Stoddard, C. K. "Embrittlement Detector Testing on Boilers," *Power Plant Engineering*, Vol 45, August, 1941, pp. 69–76.

"Embrittlement Symposium," *Transactions of the Am. Soc. Mech. Engrs.*, Vol 64, 1942, pp. 393–444.

Whirl, S. F. and Purcell, T. E. "Protection Against Caustic Embrittlement by Coordinated Phosphate-pH Control," *Proceedings, Third Annual Water Conference*, Engrs. Soc. of Western Penna., 1942, pp. 45–60.

Berk, A. A. and Schroeder, W. C. "A Practical Way to Prevent Embrittlement Cracking," *Transactions, Am. Soc. Mech. Engrs.*, Vol 65, 1943, pp. 701–711.

1.2 The effectiveness of treatment to prevent cracking, as well as an indication of whether an unsafe condition exists, are shown by this practice. Such treatments are evaluated in terms of method specimen resistance to failure.

1.3 The practice may be applied to embrittlement resistance testing of steels other than boiler plate, provided that a duplicate, unexposed specimen does not crack when bent 90° on a 2-in. (51-mm) radius.

1.4 *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:

A 108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality⁴

A 515/A 515M Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service⁵

D 1129 Terminology Relating to Water⁶

E 3 Methods of Preparation of Metallographic Specimens⁷

E 883 Guide for Reflected-Light Photomicrography⁷

E 1351 Practice for Production and Evaluation of Field Metallographic Replicas⁷

3. Terminology

3.1 Definitions:

3.1.1 The term *embrittlement cracking* in this test method is defined in accordance with Terminology D 1129 as follows:

3.1.1.1 *embrittlement cracking*—a form of metal failure that occurs in steam boilers at riveted joints and at tube ends, the cracking being predominantly intercrystalline.

NOTE 3—This form of cracking, which has been known as "caustic embrittlement," is believed to result from the action of certain constituents

⁴ *Annual Book of ASTM Standards*, Vol 01.05.

⁵ *Annual Book of ASTM Standards*, Vol 01.04.

⁶ *Annual Book of ASTM Standards*, Vol 11.01.

⁷ *Annual Book of ASTM Standards*, Vol 03.01.