



Standard Test Method for Determining Whether Gas-Leak-Detector Fluid Solutions Can Cause Stress Corrosion Cracking of Brass Alloys¹

This standard is issued under the fixed designation G186; 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 an accelerated test method for evaluating the tendency of gas leak detection fluids (LDFs) to cause stress corrosion cracking (SCC) of brass components in compressed gas service.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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 to determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[B135 Specification for Seamless Brass Tube](#)

[B135M Specification for Seamless Brass Tube \[Metric\]](#)

[D1193 Specification for Reagent Water](#)

[G1 Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens](#)

[G15 Terminology Relating to Corrosion and Corrosion Testing \(Withdrawn 2010\)](#)³

[G37 Practice for Use of Mattsson's Solution of pH 7.2 to Evaluate the Stress-Corrosion Cracking Susceptibility of Copper-Zinc Alloys](#)

[G38 Practice for Making and Using C-Ring Stress-Corrosion Test Specimens](#)

¹ This test method is under the jurisdiction of ASTM Committee G01 on Corrosion of Metals and is the direct responsibility of Subcommittee G01.06 on Environmentally Assisted Cracking.

Current edition approved May 1, 2016. Published May 2016. Originally approved in 2005. Last previous edition approved in 2011 as G186–05 (2011). DOI: 10.1520/G0186-05R16.

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.

³ The last approved version of this historical standard is referenced on www.astm.org.

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *Gas Leak Detector Solutions*—Also known as leak detection fluids, leak detector solutions, bubble solutions, and soap solutions, designated in this standard as LDFs, are fluids used to detect leaks in pressurized gas systems by the formation of bubbles at the leak site.

3.1.2 The terminology used herein, if not specifically defined otherwise, shall be in accordance with Terminology G15.

4. Summary of Test Method

4.1 This test method consists of three steps: The first step consists of running a sample of the test specimens to verify that they are susceptible to stress corrosion cracking using Mattsson's Solution (see Practice G37). The second step is to expose the specimens to a solution that does not cause SCC to verify that the test environment does not contain components that can cause SCC to brass. The third step is to test the LDF to determine if it causes SCC of the brass specimens within 15 wetting and evaporation cycles.

4.2 The specimen used in this test is a C-ring stressed to create at least 0.65 % strain in the outer fibers of the specimen.

4.3 Macroscopic examination of the specimens is carried out after every second wetting cycle and if cracking is suspected the specimen is examined at higher magnifications for confirmation. Metallographic sectioning through the stressed area is used to verify minor cracking at the end of the fifteen cycles.

4.4 LDFs that cause SCC in any specimens within 15 wetting cycles are considered to have failed this test and not suitable for use in pressurized gas systems with brass components.

5. Significance and Use

5.1 Brass components are routinely used in compressed gas service for valves, pressure regulators, connectors and many other components. Although soft brass is not susceptible to ammonia SCC, work-hardened brass is susceptible if its hardness exceeds about 54 HR 30T (55HRB) (Rockwell scale). Normal assembly of brass components should not induce sufficient work hardening to cause susceptibility to ammonia

SCC. However, it has been observed that over-tightening of the components will render them susceptible to SCC, and the problem becomes more severe in older components that have been tightened many times. In this test, the specimens are obtained in the hardened condition and are strained beyond the elastic limit to accelerate the tendency towards SCC.

5.2 It is normal practice to use LDFs to check pressurized systems to assure that leaking is not occurring. LDFs are usually aqueous solutions containing surfactants that will form bubbles at the site of a leak. If the LDF contains ammonia or other agent that can cause SCC in brass, serious damage can occur to the system that will compromise its safety and integrity.

5.3 It is important to test LDFs to assure that they do not cause SCC of brass and to assure that the use of these products does not compromise the integrity of the pressure containing system.

5.4 It has been found that corrosion of brass is necessary before SCC can occur. The reason for this is that the corrosion process results in cupric and cuprous ions accumulating in the electrolyte. Therefore, adding copper metal and cuprous oxide (Cu_2O) to the aqueous solution accelerates the SCC process if agents that cause SCC are present. However, adding these components to a solution that does not cause SCC will not make stressed brass crack.

5.5 Repeated application of the solution to the specimen followed by a drying period causes the components in the solution to concentrate thereby further increasing the rate of cracking. This also simulates service where a system may be tested many times during its life. These features of the test method accelerate the test and allow an answer to be obtained more rapidly.

5.6 This test method applies only to brasses. Successful passage of this test does not assure that the LDF will be acceptable for use on other alloy systems such as stainless steels or aluminum alloys.

6. Interferences

6.1 When conducting this test, it is very important that the air not be contaminated with ammonia vapors. Reagent bottles with ammonium hydroxide or other tests that involve ammonia or its compounds including amines must not be in the vicinity of these tests. This also includes Mattsson's test solution.

6.2 Cross contamination may result in false stress corrosion cracking results therefore concurrent exposure tests with different leak detector solutions should be conducted in such a way that any set of samples does not influence the results of any of the other samples.

6.3 In this test, the susceptibility of the C-ring specimens to crack in a particular test solution can be affected by the temper of the brass alloy; therefore, it is crucial that the C-rings be fabricated from hard drawn temper brass tubing that meets the minimum specified hardness requirements.

7. Reagents and Materials

7.1 Reagent grade cuprous oxide (Cu_2O) and USP/FCC grade glycerin ($\text{C}_3\text{H}_8\text{O}_3$) conforming to specifications of the

committee on Analytical Reagents of the American Chemical Society, where such specifications are applicable,⁴ shall be used.

7.2 Fine pure copper powder with particle size $<68\ \mu\text{m}$ shall be used.

7.3 Solutions using water shall be prepared using distilled or deionized water conforming to the purity requirements of Specification **D1193**, Type IV reagent water.

7.4 Leak detector solutions shall meet manufacturer's specifications.

7.5 Mattsson's Solution shall be freshly prepared according to Practice **G37**.

8. Hazards

8.1 Consult Material Safety Data Sheets (MSDS) for all chemicals both reagent and commercial before testing to gain a full understanding of any potential hazards.

8.2 The test solutions present no undue safety hazard. It is recommended, however, that appropriate personnel protection equipment such as resistant gloves and shatterproof eyewear with side shields be worn when the chemicals or specimens are handled.

8.3 The solutions contain copper and are thus considered poisonous so they should not be ingested.

8.4 Ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, in the Mattsson's solution has been reported to be allergenic. Repeated short-time skin contact with the solution over extended periods of time should be avoided.

8.5 The fumes given off by the Mattsson's test solution contain ammonia. The least detectable ammonia odor corresponds to a concentration of 50 ppm; 100 ppm can be tolerated for several hours without serious disturbance; 700 ppm causes immediate eye irritation; and greater than 5000 ppm can be lethal. The mixing and the actual testing with Mattsson's solution should therefore be run in a well-ventilated area.

9. Test Solutions

9.1 *Control Solution (benign water solution)*—Add 2.5 g Cu powder and 2.5 g Cu_2O to 1000 mL of H_2O . Then add 10 mL of glycerin to solution. Shake solution vigorously to thoroughly mix contents.

9.2 *Leak Detector Solutions*—Add 2.5 g Cu powder and 2.5 g Cu_2O to 1000 mL of each manufacturer's solution to be tested. Shake solutions vigorously to thoroughly mix contents.

NOTE 1—Some of the solids will settle out of the solutions in between cycles, therefore, it is very important to shake the solutions vigorously prior to their use in the wetting cycle.

⁴ *Reagent Chemicals, American Chemical Society Specifications*, American Chemical Society, Washington, DC. For Suggestions on the testing of reagents not listed by the American Chemical Society, see *Annual Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.

10. Test Specimen

10.1 *Type and Size*—An unnotched C-ring in accordance with Practice G38 shall be used (Fig. 1). C-rings shall have an outer diameter (OD) between 1.0 to 2.0 in. (25.4 to 50.8 mm) and thickness between 0.065 to 0.25 in. (1.65 to 6.4 mm). Widths shall be fixed at 0.75 in. (19.0 mm).

10.2 *Alloy Composition and Temper*—Test specimens shall be fabricated from copper alloy (UNS C27200) seamless tube with a H80 hard-drawn temper. The hard drawn temper shall have a minimum hardness of 70 on the 30T Rockwell scale which corresponds to minimum tensile strength of 66 ksi (455 MPa). Refer to Specifications B135 and B135M for tube information.

10.3 *Surface Finish*—Specimens shall have a 120-grit finish. Grind marks shall be in the circumferential direction.

10.4 *Restraining Hardware*—Nuts, bolts, and flat washers shall be made from a metal resistant to the chemicals used in this test (for example, Type 316 stainless steel, UNS S31600). Insulation washers shall be made from a hard resistant material to prevent relaxation of the stressed C-ring specimen (for example, alumina). Refer to Fig. 1.

10.5 *Pre-test Condition*—C-rings will be unstressed prior to testing.

10.6 *Stressing Method*—Constant-strain stressing method shall be used in stressing the C-rings (refer to Practice G38). Tensile stress will be introduced on the exterior of the ring by tightening a bolt centered on the diameter of the ring.

10.7 *Surface Preparation*—The specimen surface should be free of oil, grease, and dirt. This usually entails cleaning with organic solvent such as acetone followed by an alcohol rinse.

NOTE 2—Every precaution shall be taken to maintain the integrity of the surface after the final preparation. Avoid rough handling that could mar the surface and handle with gloves to prevent fingerprinting and the transfer of contaminants.

11. Test Setup and Apparatus

11.1 *C-ring Test Assembly*—Individual C-ring specimens shall be placed apex down in a glass-fiber-wick covered dish (Fig. 2).

11.2 *Exposure Dish*—The individual dishes shall be made out of a material that will not react with the chemicals being used for the exposure (for example, glass, polystyrene, polycarbonate). The required dish dimensions are 2.36- to 3.94-in. (60- to 100-mm) diameter and 0.59- to 0.79-in. (15- to 20-mm) height.

11.3 *Wick Material*—Borosilicate glass wick material with a fiber diameter of about 0.3 mil (8 μm) shall be used.

11.4 *Number of Specimens*—Five individual C-ring specimen test assemblies will be used for each leak detector or control solution to be tested.

11.5 *Test Assembly Arrangement*—Individual exposure dishes shall be laid out such that there is at least a 1.0 ft (305 mm) separation between groups of specimens (Fig. 3). The control solution specimens shall always be positioned in the center of the test group.

12. Calibration and Standardization

12.1 When a new batch of specimens is to be used, it is necessary to first test a representative number of C-rings from the batch with Mattsson's solution.

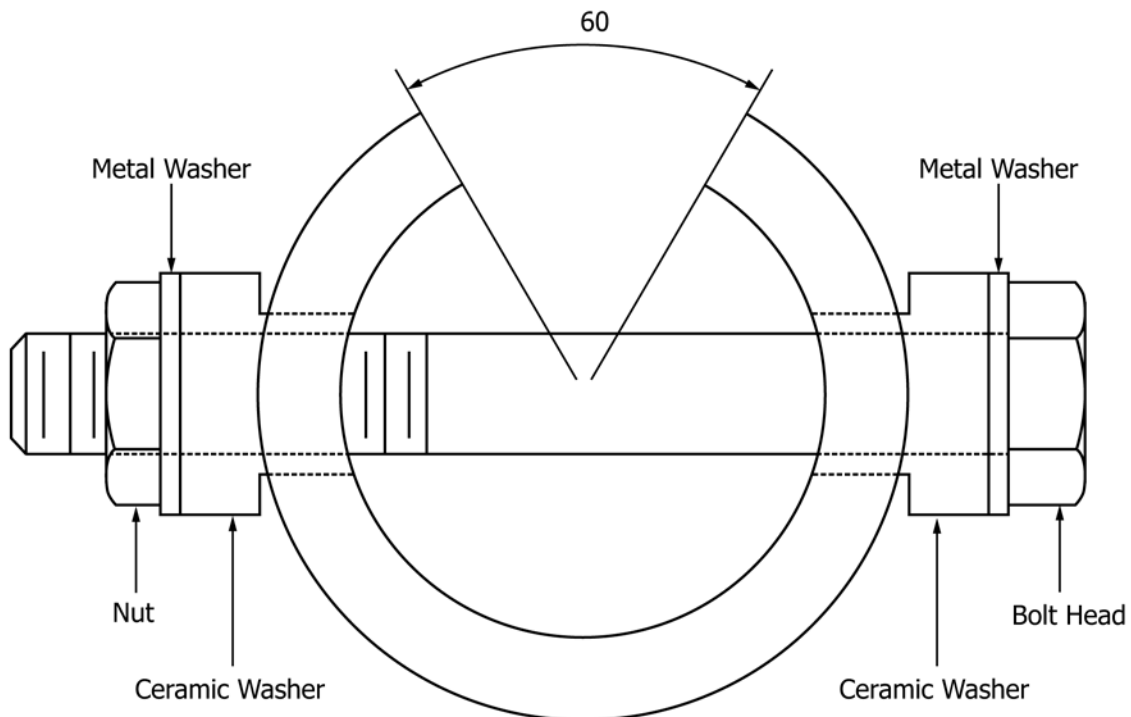


FIG. 1 C-ring Specimen