SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

SAE/USCAR-7

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DEEMBRITTLEMENT VERIFICATION TEST

1.SCOPE:

This standard outlines test methods and practices which can detect embrittlement of steel parts. It is a process control or referee verification test. The risk of embrittlement of steel is minimized by using best practices in the finishing/coating process. One such practice is described in SAE/USCAR-5, Avoidance of Hydrogen Embrittlement of Steel.

2.REFERENCES:

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE/USCAR-5, Avoidance of Hydrogen Embrittlement of Steel

3.DEEMBRITTLEMENT TEST

A torque/tension test is used for threaded parts and a tensile test is used for non-threaded parts. The test consists of three steps: 1) Determine the ultimate torque or tensile stress to failure for threaded and non-threaded parts respectively; 2) Load the parts to some percentage of the ultimate torque or tensile stress; 3) Maintain the torque or tensile stress for some determined length of time. Whenever possible, the test fixture should simulate the intended application. Section 3.5 discusses alternatives to test fixtures.

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3.1 Test Load Determination

3.1.1 Threaded Parts

a. Randomly select a minimum of 5 parts from the lot being evaluated to establish the test torque for the stress test. Note that the five part sample is only to establish the test torque used for the deembrittlement tests. The deembrittlement test sample size is discussed in section 3.2.

b. Apply torque to the test part, or the mating part of the text fixture until ultimate failure of the test part occurs. Some ideas of fixturing methods are discussed in Section 3.5. Hand or power tool tightening is acceptable, however, the selected tightening method must also be used in performing the deembrittlement test (section 3.3). Record the maximum torque for each of the five fasteners. The average maximum torque for all five test parts is the ultimate failure torque which completes step 1 referred to in section 3.

c. The test torque to be used in step 2, referred to in section 3., is 80% of the ultimate failure torque. This test torque value does not necessarily correspond to the actual application installation torque for the part.

3.1.2 Non-Threaded Parts

a. Randomly select a minimum of 5 parts from the lot being evaluated. (Note that the five part sample is only to establish the test load used for deembrittlement tests.) The deembrittlement test sample size is discussed in section 3.2.

b. Determine an acceptable tensile test method for the geometry and configuration of the part. The test fixture and test procedure must be agreed upon by the supplier and the purchaser. Some ideas on fixturing methods are discussed in section 3.5. Apply a tensile load to the part until failure of the test part occurs. Record the maximum tensile load for each of the five parts. The average maximum load for all five test parts is the ultimate load which completes step 1. The fixture and test method used for step 1 must be duplicated for steps 2 and 3. Steps 1, 2, and 3 are described in section 3.

c. The tensile load used in step 2, referred to in section 3., is to be some percentage of the ultimate load. Typical test loads are between 70 to 80 percent of the ultimate load. The supplier must determine a test load sufficient to detect embrittlement susceptibility. At a minimum, the test load should exceed the tensile load applied during assembly of the part into it's actual application.

3.2 Sample Size Determination

A lot for the purpose of the deembrittlement test is defined as follows. For a batch oven, a lot is a load of baked parts with the same part number. For a continuous baking furnace, a lot (for a particular part number) is to be defined by the supplier as is agreeable with their process; keeping in mind that if a failure should occur during the subsequent deembrittlement test, the lot shall be scrapped. The lot shall be defined such that all processing traceability is maintained for each part number/lot identification. The number of parts to be subjected to the deembrittlement test must be determined by agreement between the supplier and purchaser. The control plan will specify the test sample size.

3.3 Performing Deembrittlement Test

3.3.1 The total number of parts determined in section 3.2 are to subjected to the deembrittlement test.

3.3.2 These parts are to be loaded using the same fixture, the same loading methods and the same test load determined in paragraph 3.1.1 for threaded parts or paragraph 3.1.2 for non-threaded parts. Parts which fail while attempting to be assembled to the test load (torque) should be discarded and cannot be counted as part of the test lot.

3.3.3 These parts are to be held at load in the fixture as described below.

a. For threaded parts: Reapply test torque after the parts have been held for 24 hours. If any failures occur at this 24 hour check, the test is to be terminated and the entire lot shall be rejected as described in paragraph 3.4. If no failures occur, continue to hold the parts at load for an additional minimum of 24 hours, reapply test torque then remove from the fixture and examine per paragraph 3.4.

b. For non-threaded parts: Hold the parts at load in the fixture for a minimum period of 48 hours. Remove from the fixture and examine per paragraph 3.4.

3.4 Pass/Fail Determination

Visually inspect the parts which have undergone the 48 hour test. The parts should be free of cracks or multi-piece fractures. If cracking or fracturing has occurred on one or more of the samples, the entire lot shall be rejected and scrapped (no rework of these parts is allowed). If none of the sample parts have cracked or fractured, the process is considered to be in control for that lot and therefore can be shipped.

3.5 Fixturing Methods

The following suggestions are provided to assist in establishing the test load and method of test to induce high tensile stress for performing the deembrittlement test.