



Fastened Joint Thermal Fatigue Testing

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. Determine joint integrity when subjected to alternating loads induced by different thermal expansion rates of joint dissimilar materials.

1.2 Applicability. Unless otherwise specified, this procedure applies to the initial tightening event of joints using all new parts including threaded fasteners, bearing surfaces and clamped members.

1.3 Remarks. Evaluate joint integrity, by having test item complete 125 cycles while retaining at least 70% of target (or initial) fastener tension. An alternate criterion would require that a cycle count and retained fastener tension percentage be specified by test requestor.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- Assembly Tool Manufacturers Operating Procedure
- Data Acquisition System Manufacturers Operating Procedure

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Torque Angle Transducer.

3.2.2 Data acquisition system capable of collecting data at a sampling rate of at least 1000 Hz, plotting data at user specified scales, and identifying data at all points on curve.

3.2.3 Tightening tool.

3.2.4 Appropriate fixtures, bedplate, or slotted table.

3.2.5 Strain indicator (if applicable).

3.2.6 Strain gauged fastener or fastener prepared for ultrasonic measurement.

3.2.7 Environmental Test Chamber (with air and part temperature control). Chamber should be programmable and able to cycle part temperature from -40 °C to +155 °C. Set temperatures must be capable of being maintained within ± 3 °C. Alternate chamber capability may be specified or approved by the test requestor.

3.3 Test Vehicle/Test Piece. A complete bill of materials of required test pieces will be specified in test request documentation.

3.4 Test Time.

Calendar time: 30 d

Test time: 120 h

Coordination time: 40 h

3.5 Test Required Information. Test request documentation shall outline specific information and test parameters. Reference Appendix A, Data Sheet A1 or use similar format.

3.6 Personnel/Skills. Test Technician shall be qualified on basis of appropriate education, training, experience, and/or demonstrated skills.

4 Procedure

4.1 Preparation. Unless otherwise specified in test request, samples are to be tested in the as-received condition. This excludes any condition specifically caused by material storage or configuration (e.g., if debris falls into a threaded hole from laboratory rework, it is acceptable to blow debris out of holes).

4.1.1 Any modifications to parts, not specifically requested in the test request that may affect test results, are to be documented in the test notes. All test configurations, parts and noted deviations to be approved by the test requestor prior to executing test.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 Review part quantities and condition.

4.3.2 Secure test part to T-slot table or fixture.

4.3.3 Select proper tool, strain-gauged fastener or fastener prepared for ultrasonic measurement, and torque-angle transducer.

4.3.4 If applicable, configure ultrasonic measurement device to capture initial L-Ref (length reference) values.

4.3.5 Configure tooling to reproduce requested tightening strategy of the fastener. Refer to Assembly Tool Manufacturers Operating Procedure.

4.3.6 Align tool and torque-angle transducer to prevent side loading.

4.3.7 Tighten test item to requested tightening strategy, recording torque, tension, and angle. Refer to Data Acquisition System Manufacturers Operating Procedure. Review with requestor and receive approval prior to proceeding.

4.3.8 Continue tightening any remaining test items or joints as outlined in test request documentation.

4.3.9 Mark fastener locations with paint pen or other agreed-upon method (on head and bearing surface) for future rotation checks.

4.3.10 Place test item(s) in environmental chamber.

4.3.11 Attach chamber's part temperature control device to test piece in a location approved by test requestor.

4.3.12 Configure thermal chamber to cycle test item(s) with part temperature control as follows:

- Ramp to -40 °C ± 3 °C
- Hold for 10 minutes
- Ramp to +155 °C ± 3 °C

- Hold for 30 minutes
- Ramp to $-40\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$

Or follow a chamber program as specified by requestor. Times may vary based on size and mass of part.

4.3.13 Record fastener tension at specified intervals during testing according to following criteria:

4.3.13.1 Fastener tension is to be recorded at 0, 10, 25, 50, 75, 100, and 125 End of Test (E.O.T.) cycles or at a cycle count series as specified by requestor.

4.3.13.2 Before recording fastener tension, ramp chamber air temperature to $+21\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ (ambient) and hold for a time period sufficient to ensure stabilization of test part temperature.

4.3.13.3 Record fastener tension at ambient temperature before proceeding to next temperature cycle.

4.3.13.4 Inspect for fastener rotation at 10, 25, 50, 75, 100 and 125 E.O.T. cycles, or at a cycle count series as specified by requestor. If rotation is observed, notify and record location and amount.

4.3.13.5 Summarize all test results according to requirements of Section 5.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Not applicable.

5.3 Test Documentation.

5.3.1 Summary of Results – Required.

5.3.1.1 Provide statistical analysis of maximum installed torques and tensions. Calculate averages, minimum values, maximum values, and standard deviation.

5.3.1.2 Provide detail of failure modes consisting of, but not limited to, fastener fracture, component fracture, component distortion or internal or external thread stripping (if applicable).

5.3.1.3 Test incidents to be recorded on Fastener Test Data Summary Sheet. Reference Appendix B, Data Sheet B1 or use similar format.

5.3.1.4 Test data summarization to be on Test Data Log Sheet. Reference Appendix C, Data Sheet C1 or use similar format.

5.3.2 Summary of Results – Optional. After reviewing required data summarization, requestor may ask for additional items including, but not limited to, optional plots and tabular data tables as shown in Table 1.