GM	WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW14165

Torque, Tension, and Angle Evaluation of Fastened Joints

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 the dynamic torque, tension, and angle characteristics of the threaded fastener joint.

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

1.3 Remarks.

1.3.1 Limitations. This procedure does not apply to Pulse tools.

1.3.2 Unless otherwise specified, any requirements or direction provided in the test request documentation will supercede this test procedure.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW25

3 Resources

3.1 Facilities. GM Approved Laboratory or location for this test procedure.

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 the curve.

3.2.3 Strain gauged fastener, force washer, or fastener prepared for ultrasonic measurement.

3.2.4 Ultrasonic measurement device (if required).

3.2.5 Tightening tool.

3.2.6 Appropriate fixturing, bedplate, or slotted table.

3.2.7 Strain indicator.

3.3 Test Vehicle/Test Piece.

3.3.1 A complete bill of materials of required test pieces will be specified in the test request documentation.

3.3.2 Unless otherwise specified, a minimum of 8 samples are to be used for this procedure.

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3.4 Test Time.

Calendar time:	2 days
Test time:	12 h
Coordination time:	4 h

3.5 Test Required Information. Test request documentation should outline specific information and test parameters (Appendix A, Data Sheet A1).

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

4 Procedure

4.1 Preparation.

4.1.1 Unless otherwise specified in the 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).

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

4.2 Conditions.

4.2.1 Environmental Conditions.

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.

4.2.2.1 Unless otherwise specified, test conditions shall be as outlined on test request documentation.

4.2.2.2 Optional. Strength of fasteners with respect to minimum material specifications may be evaluated prior to this testing by one or more of the methods outlined in GMW25, Mechanical Properties and Material Requirements for Externally Threaded Fasteners.

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, force washer, or fastener prepared for ultrasonic measurement, and transducer with angle encoder.

4.3.4 Configure data acquisition system to collect torque, tension, and angle data.

4.3.5 Align tool and torque transducer to prevent side loading.

4.3.6 Unless otherwise specified, test requestor is to approve test setup.

4.3.7 Take photograph or digital image of test configuration.

4.3.8 Measure and document tool free spinning speed.

4.3.9 Joint shall be tightened to the specifications outlined in test request documentation. Test shutoff parameters may include but are not limited to:

4.3.9.1 One hundred ten percent (110%) of fastener proof load.

4.3.9.2 Maximum torque/angle specification target.

4.3.9.3 Joint failure.

4.3.9.4 Maximum fastener calibrated load.

4.3.9.5 Maximum torque capability of tightening tool.

4.3.10 Unless otherwise specified, run the first sample recording torque, tension, angle, and failure mode, if any. Review with requestor and receive approval prior to proceeding.

4.3.11 If necessary, make corrections to test configuration to comply with instructions of requestor.

4.3.12 Complete test matrix.

4.3.13 Summarize results similar to Section 5 of this procedure.

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5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Not applicable.

5.2.1 Summary of Results Required.

5.2.1.1 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).

5.2.1.2 Test incidents to be recorded on Test Data Summary Sheet (similar to Appendix B, Data Sheet B1).

5.2.1.3 Test data summarization to be on Test Data Log Sheet (similar to Appendix C, Data Sheet C1) and Torque Tension Data Sheet (similar to Appendix D, Data Sheet D1).

5.2.1.4 Required plots and tabular data tables should include items shown on the following table (see Table 1 example).

Where:

- I Individual sample plots
- M Multiple sample plot
- D Dual Y axis plots
- S Statistical plot
- T Tabular data table, followed by the incremental value

Table 1: Torque Tightening Strategy Example

	X-Axis							
Y-Axis	Torque	Tension	Angle	Compression	Load	Disp.	RPM	Time
Torque		T5	M					
Tension	M		M					
Angle								
Compression								
Load								
Displacement								
RPM								

5.2.2 Summary of Results Optional. After reviewing required data summarization, requestor may ask for additional items, including but not limited to the following.

5.2.2.1 Summary of results including, but not limited to: Upper proportional limit torques, lower proportional limit torques, maximum torques, ultimate torques, and prevailing torques (similar to Appendix E, Data Sheet E1 and/or Appendix F, Data Sheet F1).

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5.2.2.2 Optional plots and tabular data tables could include items shown on the following table (see Table 2 example).

Where:

- I Individual sample plots
- M Multiple sample plot
- D Dual Y axis plots
- S Statistical plot
- T Tabular data table, followed by the incremental value.

Table 2: Torque Angle Tightening Strategy Example

Y-Axis \ X-Axis	Torque	Tension	Angle	Compression	Load	Displacement	RPM	Time
Torque			DDIT10					IM
Tension	IS		DIT10					
Angle								
Compression								
Load								
Displacement								
RPM			DIM					

5.2.2.3 Magnified Scale Plots – Additional plots re-scaled to magnify desired detail of curves.

5.3 Test Documentation. See Section 5.2.1.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

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