



Wheel Fastener Torque Tension Test – New (Unused)

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. To determine the dynamic torque - tension characteristics of the threaded fastener joint for new (unused) wheel attachments. The test is based on: SAE J1965 (Road Vehicles - Wheels for Commercial Vehicles and Multipurpose Passenger Vehicles - Fixing Nuts - Test Methods), SAE J2315 (Wheel Nut Seat Strength), SAE J2283 (Mechanical and Material Requirements for One Piece - Wheel Nuts), and SAE J2316 (Wheel Nut Seat System Test Procedures and Performance Requirements for Passenger Cars and Light Trucks).

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

1.3 Remarks. This standard does not apply to pulse or impact tools. Unless otherwise specified, any requirements or directions provided in the test-request documentation will supersede this test procedure.

2 References

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

2.1 External Standards/Specifications.

ISO 2320	SAE J2283	SAE J2316
SAE J1965	SAE J2315	

2.2 GM Standards/Specifications.

GMW15658	GMW16590
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2.3 Additional References.

PG052770 Wheel Attachment Torque Tension Test and Criteria

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 Dynamic tightening tool.

3.2.2 Appropriate wheel test fixture, bedplate, or slotted table.

3.2.3 Torque angle transducer.

3.2.4 Data acquisition system capable of collecting data and identifying data at various points on the data curve.

3.2.5 Torque tension load cell.

3.2.6 Optional. Strain gauged fastener, or fastener prepared for ultrasonic tension measurement.

3.2.7 Optional. Strain indicator.

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3.3 Test Vehicle/Test Piece. Not applicable.

3.4 Test Time.

Calendar time: 1/2 day

Test hours: 2 hours

Coordination hours: 3/4 hour

3.5 Test Required Information. Not applicable.

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, ten (10) samples are to be tested in the as-received condition. 'Samples' in this case includes one each of new stud, nut, and wheel attachment hole.

4.1.2 Steel wheels should have nut bosses free of burrs. If burrs are found, DO NOT test; notify requestor.

4.1.3 Non-steel wheels must be verified to be free of paint and clear coat in the cone seats. If either paint or clear coat are found, DO NOT test; notify requestor.

4.1.4 Any modifications to parts not specifically requested in the test request that may affect test results are prohibited. All test configurations, parts, and deviations shall be approved prior to executing test. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2 Conditions.

4.2.1 Environmental Conditions. Test area shall be clean, dry, and between 10 °C and 37.7 °C (50 °F and 100 °F).

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 pre-test condition of all test material. Verify that the nut boss areas are free of debris and severe abrasion. The nut boss areas on non-steel wheels are to be free of clear coat and/or other paint products. Additionally, wheels must be fully cured including paint oven cure.

4.3.2 Install wheel or wheel coupon onto wheel test support fixture.

4.3.3 Select proper dynamic drive tool, torque transducer with angle encoder and torque tension load cell.

4.3.4 Measure and adjust as needed, the free spinning tool speed to be less than 200 rpm.

4.3.5 Measure and adjust as needed, the final drive tool speed to 15 rpm $\pm$ 5 rpm. Refer to drive tool operating procedure

4.3.6 Configure data acquisition system to collect torque, tension, and angle data, for example: RS Technologies Ltd., Model 9504 Lab Master Recorder and Controller. Typical run time is approximately 15 s per tightening event.

4.3.7 Load stationary fastener member(s) and hand start rotating member at least two (2) full turns. However, do not hand tighten the spinning member such that it comes in contact with the nut boss seat. This will allow the dynamic drive tool sufficient run time to obtain the free spinning tool speed prior to final tool speed being initiated.

4.3.8 Align tool and torque transducer to prevent side loading.

4.3.9 Posttest photographs of the nut bosses and cone seats are required for all wheels except for non-chromed aluminum which are optional. See Figure A5 in Appendix A for sample pictures.

4.3.10 Joint shall be tightened to the specifications shown below. Test shutoff parameters may include but are not limited to the following.

- One-hundred ten percent (110%) of fastener proof load.
- Maximum torque capability of fastener.

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- Joint or fastener fracture.
- Maximum tension load cell capability.
- Maximum torque capability of tooling.
- Maximum allowed run time.

4.3.11 Run the first sample recording torque, tension, angle, and failure mode, if anything is observed out of the ordinary, review with test engineer/requester and receive approval prior to proceeding.

4.3.12 Complete test using new components (nut, stud and wheel attachment hole) for each data point.

4.3.13 Summarize results according to requirements in Section 5 of this procedure.

Note: If testing a dealer installed nut with a non-standard coating at the interface (lock nuts, decorative nuts, etc.) it is required to initially install the O/E wheel nut to the nominal value of the dynamic torque THEN a rundown of the lock nut or accessory decorative wheel nut to the ultimate torque value.

5 Data

5.1 Calculations.

5.1.1 Input Torque at Peak Tension Data Analysis. Tabulate input torque at peak tension by test sample and calculate statistics as shown in Appendix A, Figure A3.

5.1.2 Torque Tension Summary Plot. Plot the mean input torque (nut torque in most cases) versus bolt tension and mean input torque ± 3 sigma values in increments of 10 kN of bolt tension. Also show input torque at peak tension values and the Specification Value Lines defined in 5.2.1 (reference Appendix A, Figure A2).

5.1.3 Input Torque and Friction at Tension Values Data Analysis. Calculate mean, standard deviation, and mean ± 3 sigma values of input torque (nut torque in most cases), mean effective total friction, mean thread friction and mean cone seat friction in increments of 10 kN of bolt tension, as shown in Appendix A, Figure A4.

5.1.4 Detailed Multi-Sample Data Analysis.

5.1.4.1 Input Torque and Effective Total Friction versus Tension. Tabulate input torque and effective total friction versus bolt tension increments of 10 kN for each fastener and calculate statistics, as shown in Appendix B, Figure B1.

Plot input torque (nut torque in most cases), mean torque and mean torque ± 3 sigma values versus bolt tension increments of 10 kN for each fastener. Also show input torque at peak tension values and the Specification Value Lines defined in 5.2.1, as shown in Appendix B, Figure B2.

Note: In most cases, M12 fasteners may not achieve 80 kN prior to fracture. Additionally, it is not recommended to fracture the wheel bolt during the test due to the signal spike that occurs when the fastener fractures.

5.1.4.2 Thread Torque and Thread Friction versus Tension. Tabulate thread torque and mean thread friction versus bolt tension increments of 10 kN for each fastener, and calculate statistics, as shown in Appendix B, Figure B3.

Plot thread torque, mean thread torque and mean thread torque ± 3 sigma values versus bolt tension increments of 10 kN for each fastener. Also show input torque at peak tension values (reference Appendix B, Figure B4).

5.1.4.3 Input Torque minus Thread Torque and Cone Seat Friction versus Tension. Tabulate input torque minus thread torque (seat and bolt stretch) and cone seat friction versus bolt tension increments of 10 kN for each fastener, and calculate statistics as shown in Appendix B, Figure B5.

Plot input torque minus thread torque (seat and bolt stretch), mean input torque minus thread torque and mean input torque minus thread torque ± 3 sigma values versus bolt tension increments of 10 kN for each fastener. Also show input torque at peak tension values (reference Appendix B, Figure B6).

5.2 Interpretation of Results. See sourcing documents.

5.2.1 Specification Value Lines. Reference: PG052770 Wheel Attachment Torque Tension Test and Criteria.

5.2.1.1 Maximum Mean Torque at 10 kN. Mean input torque shall be less than or equal to this value with respect to bolt size, as stated on the wheel drawing.

5.2.1.2 Maximum Mean Torque +3 Sigma at 10 kN. Mean +3 sigma input torque shall be less than or equal to this value with respect to bolt size, as stated on the wheel drawing.

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5.2.1.3 Minimum Torque at Peak Tension. All Input torque values measured at peak tension shall be greater than or equal to this value with respect to bolt size, as stated on the wheel drawing.

5.2.1.4 Minimum Mean Torque at Peak Tension. Mean input torque at peak tension shall be greater than or equal to this value with respect to bolt size, as stated on the wheel drawing.

5.3 Test Documentation. The test results documentation should include the following:

- Test Results Report (generated by Global Tire Wheel Test System (GTWTS)), if submitting Extensible Markup Language (.xml) files
- Photographs required as noted in Section 4.2.9
- Incident comments and photographs, as needed
- Data Tables and Plots
- Optional, import header and data file Appendix C, Figures C1 and C2, respectively. Figure C1 and Figure C2 shall be in Comma Separated Variable (.csv) format.
- A sample report is given in Appendix A, Figure A1 through A4.

Note: For data being loaded into the GTWTS, submit electronically the test results data files (.xml format or optional method shown above) and other supporting files listed above. GMW16590 defines the electronic file details (e.g., file types, file naming convention, and detailed file formats for .xml files) for the GTWTS.

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.

7 Notes

7.1 Glossary.

Dynamic Drive Tool: Power tool capable of tightening a threaded fastener at a controlled speed.

Failure Modes: May consist of, but are not limited to, fastener fracture, component fracture, component distortion or internal or external threaded member stripping.

Final Drive Tool Speed: The final (slower) rotational dynamic drive tool speed used to perform the final tightening sequence, measured in rpm. This value shall be set to 15 rpm $\pm$ 5 rpm.

Fracture: The partial or complete separation of one or more of the joint components.

Cone Seat Friction: μ_K , the nut cone seat coefficient of friction (Refer to Appendix D).

Effective Total Friction: μ_{ges} , the reference coefficient of friction for characterizing overall friction behavior (Refer to Appendix D).

Thread Friction: μ_G , the thread coefficient of friction (Refer to Appendix D).

Note: Friction formulas are based on documentation contained within GMW15658 Input torque, Tension, Angle, and Thread Torque valuation of Fastened Joints, and ISO 2320 Prevailing Torque Type Steel Nuts. Mechanical and Performance Properties.

Free Spinning Tool Speed: The non-loaded (free) rotational dynamic drive tool speed, measured in rpm. This value shall be less than 200 rpm for this procedure.

Peak Torque: The maximum torque value observed during testing of the joint.

Threshold Torque: A torque value at which two functions occur. First, the angle value is zeroed for the analysis process. Second, the dynamic drive tool speed changes from the free spinning to final drive tool speed. The threshold torque value shall be set to 10 Nm.

Torque Tension Load Cell: The load sensing member capable of measuring both load (fastener tension) and torque inputs, simultaneously.

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Ultimate Torque: The maximum torque the joint can tolerate prior to fracture, deformation or strip. Ultimate torque may be limited by the capability of the test equipment.

Zero Angle Reference Torque: Torque value at which the angle of all samples recorded is set to zero for analysis purposes.

7.2 Acronyms, Abbreviations, and Symbols.

GSSLT Global Subsystem Leadership Team

GTWTS Global Tire Wheel Test System

XML Extensible Markup Language

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW14994

9 Release and Revisions

This standard was originated in January 2006. It was first approved by Global Chassis Engineering Center in September 2006. It was first published in April 2007.

Issue	Publication Date	Description (Organization)
1	APR 2007	Initial publication
2	JUL 2012	Revised Paragraphs 2.3, 3.2.1, 3.2.3, 3.2.6, 3.2.7, 4.1.1, 4.1.2, 4.2.2.2, 4.2.2.3, 4.3.4, 4.3.5, 4.3.6, 4.3.7, 4.3.12, 5.1, 5.2, 5.2.1, 5.2.2, 5.2.3, 5.2.4, 5.3, 7.1, 7.2, Appendices A, B, C and D. (Tire and Wheel GSSLT)
3	APR 2017	Added photo requirements and sample photos, clarified some verbiage and corrected formula sheet in appendix D. (Chassis – Tire & Wheel Global Subsystem Leadership Team (GSSLT))

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Appendix A: Sample Report

Note: Data found in the examples in this Appendix apply to the examples only and not to the GMW document.

Figure A1: Report - Header Example

GMW14994 Torque-Tension New Report

Test Request Number: W11-00102
PQMS Activity Number: 2011-01-18-17431



Requester: James D Hosking
Requester's Phone: +61 3 9647 1881

TEST REQUEST DETAIL	
Model Year / Program: 2012 / VE/MM Test Purpose: Validation	Part Number (PIN): 92230192 Chart Number: 92230191 Broadcast Code: AADZ Steel Gauge Rim / Disc (mm): /
WHEEL PART DETAILS	
Supplier: Alcoa (ALC)-Cleveland, OH Wheel Diameter / Rim Size: 19 X 8.5 Offset: 48 Wheel Finish: Polished	
Material Rim / Disc: FORGED FLOW-FORMED ALUMINUM / FORGED ALUMINUM	
FASTENER PART DETAIL	
Attachment: 5-M14X1.5-120 Wheel Bolt Supplier:	Wheel Nut PIN: 9597846 Wheel Nut Finish: GMW3044 Zincoseal P
TEST CONDITIONS	
TR Comment: Torques and tool speeds are as per the standard spec.	
TEST RESULTS	
Wheel ID: 1.2 Machine Name / ID: Torque Tension Elec / STA 1 Technician: EEH Test Number:	Tester / Site: GMNA-TWS / GMNA-MPG Test Date: 20 APR 2011 Tool Speed (rpm): 10 TIP Approved: N/A
	Wheel Bolt Size: M14x1.5 Wheel Bolt Finish: GMW14 Geomet L 1+1 Wheel Nut Finish: GMW3044 Zincoseal P
	Tested Fastener Details Wheel Bolt PIN: 11588811 Wheel Nut PIN: 9597846

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