SURFACE VEHICLE RECOMMENDED PRACTICE

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(R) Performance Requirements and Test Procedures for Aftermarket Wheel Fastening Systems on Passenger Cars and Light Trucks

RATIONALE

Original Equipment Manufacturers (OEMs) have control of their wheels, bolts, nuts, and mounting surfaces, and the finishes thereof that are known to affect the wheel fastening system. Their fastening systems can be optimized in the presence of controlling all the components that affect the fastening system. The OEMs all have their own acceptance criteria, so those listed in this document are not applicable.

Aftermarket wheel, bolt, and nut manufacturers design their components to be used in multiple applications and they do not control of all the components. The minimum tension values, at the service torques recommended by the OEMs have been found to be serviceable for aftermarket aluminum wheel fastening system applications. See Table 1.

The name of the document is changed from “Wheel Nut Seat System” to “Wheel Fastening System” to broaden the scope of the components to include wheel nut seats, bolts, nuts, and finishes.

Multiple editorial changes are recommended to clarify the intent of the procedure. The fastener size M14x2.0 is added because it is now relevant and has been tested.

In practice, vehicle manufacturers publish recommended torque for specific vehicles so vehicle owners can retighten their lug nuts. These torques grouped reasonably well by approximate bolt size, hence binning them in Table 1.

At the high end of the torque tolerance there is a concern of stripping the nut and or stretching or fracturing the bolt. It is recommended that no stripping, of the nut and or stretching or fracturing the bolt to be observed at 120% of the service torque.

A formula has been added to determine minimum bolt tensions for specific configurations and applications. Said formula is based on a clutch theory known to be used in the industry rendering the ideal minimum tensions. The formula assumes the ideal friction necessary to disallow relative torsional motion between wheel and hub. The friction in service is not ideal. service friction is reduced by particulates of corrosion, unintended lubricants from tire and axle lube. The service friction factor is found empirically from the frequency distribution of data from measuring tension at torque on copious rundowns using QEM studs, nuts, and wheels of steel and aluminum.

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1. SCOPE

This SAE Recommended Practice provides a uniform procedure and performance requirements for evaluating fastening systems for normal highway use on aftermarket passenger cars and light trucks (except dual wheels, which are covered by SAE J1965) and multipurpose passenger vehicles. The fastening system includes the wheel, wheel bolts, and wheel nuts, as well as vehicle mating surface. The coefficients of friction for steel and aluminum mating surfaces are provided based on information available. Many factors must be considered in design and validation of wheel attachments for each specific vehicle. Where the procedure is used for original equipment applications the vehicle manufacturers specifications supersede those noted.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.2 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J328 Wheels - Passenger Car and Light Truck Performance Requirements and Test Procedures

SAE J1102 Mechanical and Material Requirements for Wheel Bolts

SAE J1965 Road Vehicles - Wheels for Commercial Vehicles and Multipurpose Passenger Vehicles - Fixing Nuts - Test Methods

SAE J2283 Mechanical and Material Requirements for One Piece Wheel Nuts

SAE J2315 Wheel Nut Seat Strength

SAE J2530 Aftermarket Wheels - Passenger Car and Light Truck Performance Requirements and Test Procedures

Parisen, J., "Automobile Wheel Attachment Design Considerations," SAE Technical Paper 820340, 1982, https://doi.org/10.4271/820340.

2.3 Other Publications

Tire Guide - Complete Tire and Wheel Information for Cars and Trucks, available at Tireguides.com and tel: 561-997-9229.

3. DEFINITIONS

3.1 WHEEL NUT SEAT AND MATING SURFACE

See Figure 1.

3.2 WHEEL BOLT AND NUT SYSTEM – STEEL WHEEL SHOWN ON LEFT

See Figure 1.

3.3 WHEEL BOLT AND TAPPED HOLE SYSTEM – ALUMINUM WHEEL SHOWN ON RIGHT

See Figure 1.

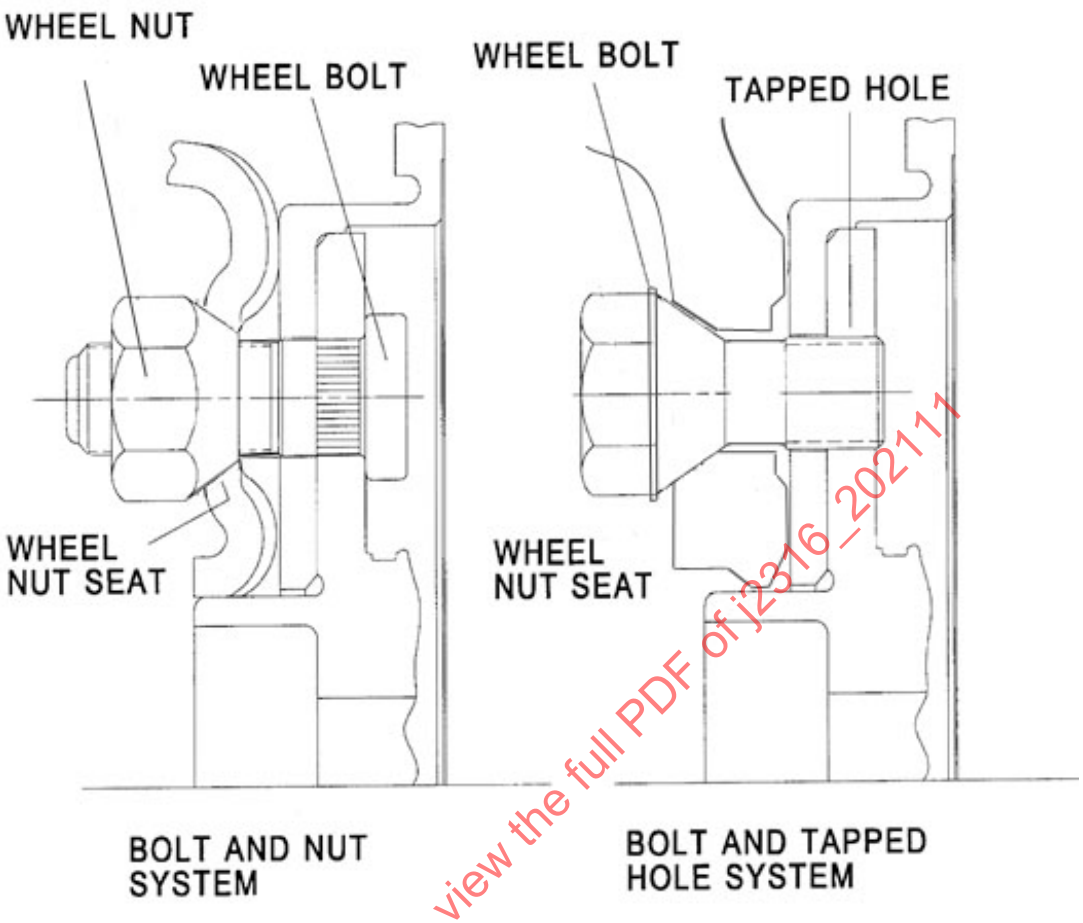


Figure 1 - Definitions

3.4 SERVICE TORQUE

The torque found in the Tire Guide for specific applications.

3.5 SERVICE FRICTION FACTOR (SFF)

The factor that is applied to the ideal minimum tension provided by the clutch theory. The factor compensates for corrosion and road debris that finds its way onto the mounting surface of the wheel or hub.

4. TEST PROCEDURES

4.1 Test Components

Fully processed (including finish) wheels or wheel discs, wheel bolts, and wheel nuts representative of production parts intended for the vehicle. For systems where wheel nuts are tightened onto serrated shank wheel bolts (bolt and nut system), hexagon head test bolts may be used in place of the wheel bolts, but they must be the same thread size and finish with similar hardness as the wheel bolts. For systems where wheel bolts are tightened directly against the wheel and into a tapped hole in the hub or axle (bolt and tapped hole system), special test blocks may be used in place of the hub or axle, but they must be the same thread size, length of thread, material, and finish as the hub or axle tapped hole. All components shall be new (unused) for each test sample.

4.2 Test Equipment

4.2.1 Tension Measuring Device

Must be capable of measuring axial tension induced in the wheel bolt as it is tightened. Accuracy shall be ±5% of tension range found in Table 1.

4.2.2 Torque Measuring Device

Must be capable of measuring torque applied to the wheel nut (or wheel bolt on a tapped hole system) as it is tightened. Accuracy shall be ±5% of torque over torque range per Table 1 from the initial torque to the service torque x 1.2.

4.2.3 Test Socket

Socket shall not contact the wheel nut seat or the threaded end of the wheel bolt at any time during the test.

4.2.4 Support Plate

A flat plate to fully support the wheel disc mounting surface for the wheel nut seat being tested. Thickness of the support plate and tension measuring device shall allow sufficient length of thread engagement between the wheel bolt and wheel nut when tightened.

4.2.5 Tightening Device

Must be capable of tightening from 50 to 120% of service torque found in the Tire Guide for the application. Recommended tightening speed shall not exceed 20 rpm at 50 Nm and above and shall be chatter free (graph of applied torque versus nut rotation recorded continuously during tightening, shall not exhibit cyclic torque fluctuation).

4.2.6 The Following Shall Be Recorded from 50 to 120% of Service Torque

a. Tightening drive torque

b. Bolt tension

4.3 Tension at Torque Test Procedure

Using all new components, insert the wheel bolt (or the tapped block if bolt and tapped hole system) into the tension measuring device and secure such that it cannot rotate during tightening. Place the wheel disc against the support plate and engage the wheel nut (or wheel bolt if bolt and tapped hole system) with the mating thread.

Tighten the wheel nut (or wheel bolt if bolt and tapped hole system) continuously until failure (bolt break or bolt tension no longer increases during tightening) or to 120% of service torque.

Loosen the fastener and repeat nine times to complete a total of ten rundowns per bolt hole.

Thread the fastener by hand to determine if the fastener has stripped or the bolt has stretched or fractured.

Install new components (wheel nut seat, wheel bolt, and wheel nut) and repeat previous procedure for a total of five samples.

5. PERFORMANCE REQUIREMENTS FOR AFTERMARKET FASTENING SYSTEMS OF STEEL AND ALUMINUM WHEELS

The steel and aluminum wheels, wheel bolts, and wheel nuts, when tested according to the procedures described in Section 4, shall meet the following minimum performance requirements:

5.1 The bolt tensions must meet or exceed the minimum tensions at service torque as found in Table 1.

5.2 When tightened to 120% of service torque the tension shall not exceed the maximum tension found in Table 1.

5.3 The bolt and nut threads shall not strip. Nut must be able to be threaded by hand.

5.4 Linearity as defined by: measured tension at 120% of service torque = 120% of tension measured at service torque ±2%

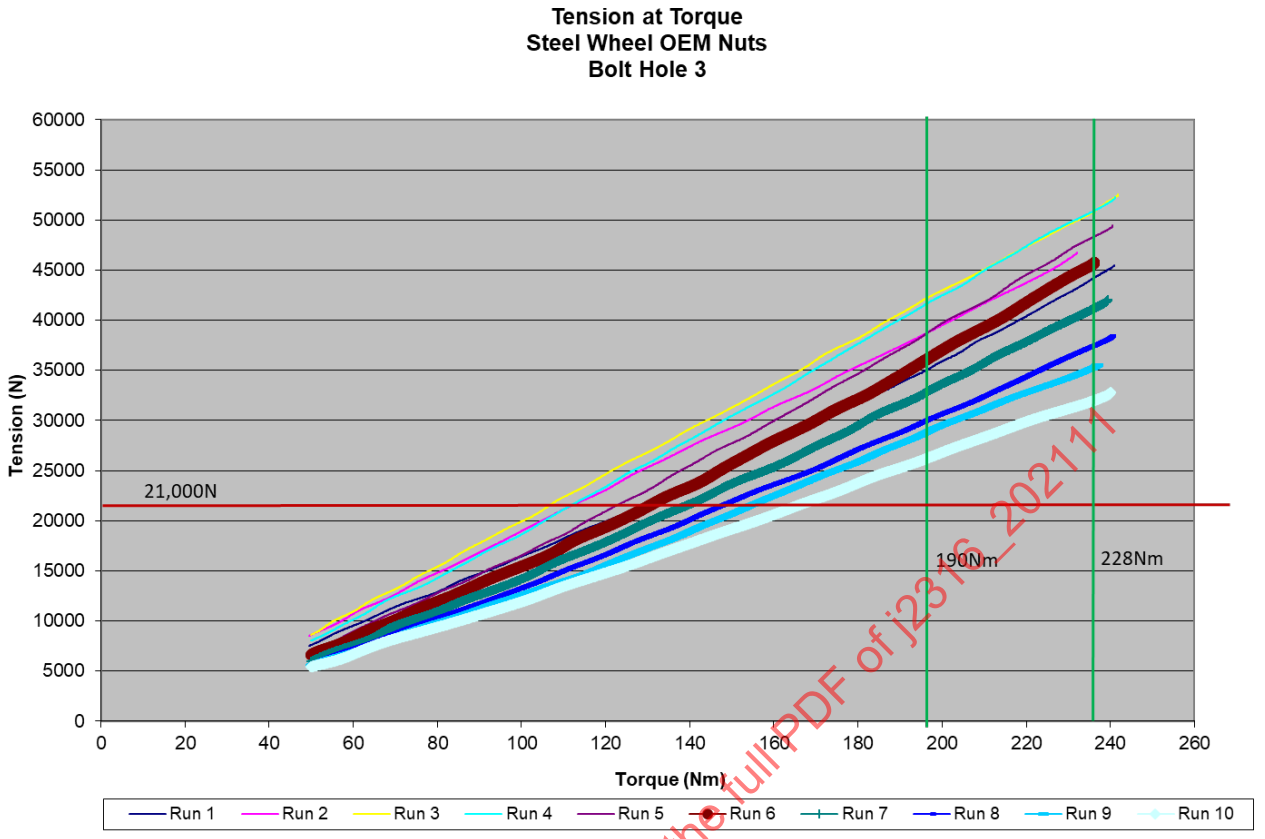
5.5 All of the performance requirements from 5.1 through 5.4 must be met.

Table 1 - Tension at torque acceptance criteria

Thread Size	Typical Service Torque Nm	Minimum Tension at Service Torque kN	Tension at 1.2 x Service Torque	Maximum Tension (Proof Load)(1) kN
M12 x 1.25	140	16	19.2	85
M12 x 1.5	140	16	19.2	85
1/2-20	140	16	19.2	85
M14 x 1.5	190	21	25.2	103
M14 x 2.0	190	21	25.2	103
9/16-18	190	21	25.2	108

(1) Proof Load for Grade 10.9 wheel bolt and nut
Reference Proof Loads SAE STD

Report to include graph of tension at torque over the ranges. Provide graph for each bolt hole.



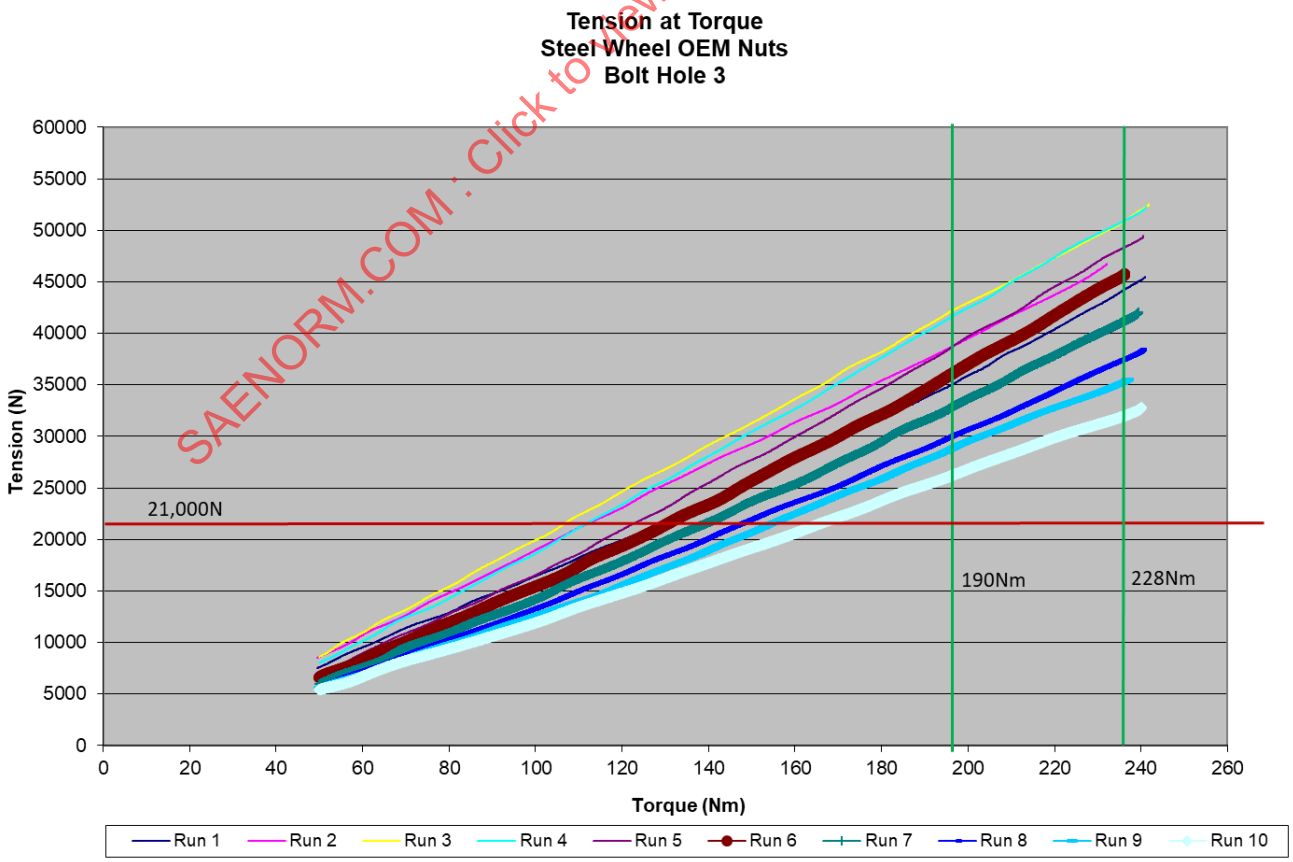


Figure 2 - Example of tension at torque bolt hole graph

Test # A-XXXX
Test Type: Tension at Torque
Test Specification: SAE J2316
Technician: Technician Name
Date: XX/XX/XXXX

Components

Wheel Part Number: Any Aluminum
Stud Part Number: OE Hardware
Nut Part Number: OE Hardware

Tension Values versus Rundowns (N)

	Tensions @ 190 Nm Expressed in N				
Rundown					
1	43520	32876	33743	32609	34041
2	46231	43938	37384	37189	42438
3	48584	48136	40639	38506	45952
4	47835	47605	40077	36134	44428
5	43946	45205	37083	33668	41320
6	39846	41220	34469	31108	38362
7	35496	38536	31545	29417	35412
8	32006	35901	28880	27555	33204
9	28803	33932	27677	26180	31658
10	26596	32629	25270	24971	29572

Statistics					
Max:	48584	48136	40639	38506	45952
Mean:	39286	39998	33677	31734	37639
Min:	26596	32629	25270	24971	29572

Tension Values versus Rundowns (N)

	Tensions @ 228 Nm Expressed in N				
Rundown					
1	53035	45320	42280	40816	44305
2	55703	55150	45521	45396	51954
3	59566	59387	49095	46529	55417
4	59966	59256	49245	44527	53846
5	55970	55719	46392	42049	50462
6	50302	51553	43802	38931	47086
7	45558	47394	39525	36697	43232
8	40285	43480	36054	34204	40315
9	35445	42054	33933	32032	38564
10	33148	40373	30917	30715	35810

Statistics					
Max:	59966	59387	49245	46529	55417
Mean:	48898	49969	41676	39190	46099
Min:	33148	40373	30917	30715	35810

	Percentage of 190 Nm Tension @ 228 Nm				
Rundown					
1	122	138	125	125	130
2	120	126	122	122	122
3	123	123	121	121	121
4	125	124	123	123	121
5	127	123	125	125	122
6	126	125	127	125	123
7	128	123	125	125	122
8	126	121	125	124	121
9	123	124	123	122	122
10	125	124	122	123	121

Performance Requirements

5.1.1 Is the minimum tension @190 Nm in excess of 21 kN?
24971 N YES

5.1.2 Is the maximum tension @228 Nm below 103 kN?
59966 N YES

5.1.3 Can all nuts be threaded by hand after testing, assuring no bolt strip or stretch?
YES

5.1.4 Is the minimum tension @228 Nm > 115% of tension @190 Nm?
120% YES

5.1.5 Are all of the performance requirements of 5.1.1 through 5.1.4 met?
If yes, then pass, if no, then fail.

YES	NO

Figure 3 - Example of datasheet for tension at torque for five bolt holes