



Standard Equipment Jack - Hardware Tests

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 test and validate the performance, strength, and durability of wheel changing equipment.

1.2 Applicability. This procedure applies to all passenger cars, light-duty/heavy-duty trucks and multipurpose passenger vehicles. Effective with new jacks or when designated for use on current jacks.

1.3 Remarks. This procedure is designed for frame/ratchet, vertical screw and scissor jacks. It also includes required operating wrenches.

1.3.1 The following platform conducted tests (p) and vendor conducted test (v) are included:

- Jack/Jack Point Durability Test (p). Subjects jack to seven (7) lifts per jacking position (reference 4.3.1).
- Bench Test/Rig Jack Durability test (v). Australian requirement (reference 4.3.2).
- Jacking Load Measurement Test (p). Obtains jack load versus lift curve versus input torque, while jacking vehicle at Gross Vehicle Mass (GVM) (reference 4.3.3).
- Proof Load Test (v). Subjects jack, in load test machine, to twice the maximum recorded jacking load for 10 minutes (reference 4.3.4).
- Jack-Vehicle and Tire-Ground Test (p). Evaluates jack head cap clearances to lowest vehicle attachment position. Also, evaluates for 50 mm tire to ground clearance and maximum tire to ground clearance (reference 4.3.5).
- Equipment Assembly Test (p). Evaluates effect of incorrectly assembled jacking equipment (reference 4.3.6).
- Wheel Nut Wrench Strength/Durability Test (v). Subjects wrench to minimum of 250% of manufacturer's maximum recommended service torque (reference 4.3.7).
- Operating Over Travel Test (v). Evaluates jack strength if attempted to operate past design limits (reference 4.3.8 and 4.3.9).
- Jack/Vehicle Stability Test, Level Surface (p). (Reference 4.3.10).
- Jack/Vehicle Slope Stability Test (p). (Reference 4.3.11).
- Head Cap Engagement Test (p). Australia requirement. Evaluates the security of engagement of a specific jack with its designated vehicle (reference 4.3.12).

1.3.2 Although 4.3.2 Bench Test/Rig Jack Durability Test and 4.3.12 Head Cap Engagement Test at Unladen Mass are noted as Australian requirements, these will apply to all platforms for the purpose that a certain platform may change export requirements at any time. Therefore, no additional testing will be required after that decision.

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.

- Vehicle Owner's Manual.
- Vehicle Technical Specifications (VTS).

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.

Note: Reference Appendix B, Data Sheet B1 as needed for instrumentation calibration details.

3.1.3 Hard-Surface Pad, 10% $\pm$ 1% Grade. See Appendix A, Figure A2.

3.2 Equipment.

3.2.1 Platform scales to measure individual wheel (vehicle corner) weights. Each scale should have a capacity of approximately 1360 kg (3000 lb) capacity for passenger cars and a 2700 kg (6000 lb) capacity for trucks.

3.2.2 Adapters (as required) to simulate actual section of jacking point for tensile test machine.

3.2.3 Wheel nut wrench test fixture (optional).

3.2.4 Compressed air supply for tire inflation.

3.2.5 Tire gauge for tire inflation.

3.2.6 Steel Scale; 610 mm (2 ft).

3.2.7 Torque application device for wrench and jack:

- Torque transducer capable of at least 500 N·m (375 lb-ft).
- Drive motor.
- Related mounting adaptors and support devices.
- Data acquisition system.

3.2.8 Stopwatch.

3.2.9 Tensile test machine.

3.2.10 Load cell fixture for measuring jacking loads. This fixture should be designed to measure vertical, fore-aft, and lateral loads at the base of the jack. The base of the jack shall be at the same level as the bottom of vehicle tires ($\pm$ 5 mm).

3.2.11 String pot or equivalent for height measurement.

3.2.12 X-Y recorder, or equivalent.

3.2.13 Force gage used to measure up to 1000 N (225 lb) of force.

3.2.14 Head Cap Engagement Fixture. (Australian requirement.) A 7 kg mass attached to the end of a pivoted 600 mm arm, which is allowed to swing through an angle of 10 degrees from vertical. The impulsive force can be applied directly to the head cap, or via a friction free steel pushrod where the jack is not readily accessible (see Appendix A, Figure A3).

3.3 Test Vehicle/Test Piece.

3.3.1 Test Vehicle.

3.3.1.1 Load Measurement and Durability Tests. The test vehicle should be selected and ballasted in such a way as to provide maximum jack load at every jack location. The following features of the vehicle should be considered: Gross Vehicle Mass Rating (GVMR), Gross Axle Mass Rating (GAMR), tire/wheel sizes, suspension drop and torsional stiffness. The vehicle (before ballasting) should be as close as possible to maximum curb mass for passenger cars, to reduce unrealistic ballasting.

3.3.1.2 Clearance Tests. Depending on suspension drop, tires, loading and vehicle stiffness, two (2) or more different vehicles may need to be tested.

3.3.1.2.1 One (1) vehicle may be needed to account for lower initial clearance.

3.3.1.2.2 One (1) vehicle may be needed to account for higher raised clearance or largest suspension drop.

3.3.1.2.3 The smallest diameter released wheel and its associated tire should be used for each model tested. This will put static clearance at the minimum.

3.3.1.3 Stability Tests. Lightest base curb mass vehicle for model line tested. Select a vehicle that results in the greatest jacked height and/or minimum load rating, taking into account suspension drops, tire diameter, etc. More than one vehicle may need to be tested. It should have maximum torsional stiffness and minimum wheelbase.

3.3.2 Test Materials and Components.

3.3.2.1 Wheel chocks if released as standard equipment for the models tested, for use in stability tests (reference 4.3.10 and 4.3.11).

3.3.2.2 Minimum diameter released wheel and its associated tire (deflated tire including options and spare). This will be used for load and clearance tests (reference 4.3.3 and 4.3.5).

3.3.2.3 Minimum diameter released wheel and its associated tire that gives lowest vehicle/ground clearance with tire deflated. This will be used for load measurement tests (reference 4.3.3).

3.3.2.4 New production-design and processed jacks and tool components shall be required in quantities as shown in Table 1.

Table 1: New Production-Design and Processed Jacks and Tool Components

Section	Test	Quantity
4.3.1	Jack/Jack Point Durability Test	3
4.3.2	Bench Test/Rig Jack Durability Test	5
4.3.3	Jacking Load Measurement Test	1
4.3.4	Proof Load Test	3
4.3.5	Jack-Vehicle and Tire-Ground Clearance	1
4.3.6	Equipment Assembly Test	1
4.3.7	Wheel Nut Wrench Strength/Durability Test	5
4.3.8	Operating Over Travel Test, Screw/Scissor Jack	1
4.3.9	Operating Over Travel Test, Frame/Ratchet Jack	1
4.3.10	Jack/Vehicle Stability Test, Level Surface	1
4.3.11	Jack/Vehicle Slope Stability Test	1
4.3.12	Head Cap Engagement Test	1

3.3.2.5 New production wheel fasteners or test fixtures. Wrenches with minimum and maximum across hex flat socket dimensions for 4.3.7, Wheel Nut Wrench Strength/Durability Test.

3.3.2.6 Verify all tire/wheel combinations across entire platform so that all requirements are met. The tire shall be at the inflated and unloaded condition.

3.4 Test Time. This is an estimate on the amount of time (work hours) needed to perform this procedure.

Calendar time: 20 days

Test time: 148 h (Technician 98 h, Engineer 50 h)

Coordination time: 2 h

Note: Consider preparation and other downtime, actual test and analysis of data in capturing a total calendar time. Platform conducted test time is estimated for two (2) technicians at 40 h each.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Test technician and engineer skilled in operating equipment in 3.2.

4 Procedure

4.1 Preparation.

4.1.1 Test Preparation. Before submitting test vehicles, complete 4.1.1.1 through 4.1.1.4.

4.1.1.1 Select vehicle for the following tests. Consult 3.3.1.1, 3.3.1.2 and 3.3.1.3 and each test for direction. Record vehicle description and mass specifications (curb and GVM) as required on Appendix B, Data Sheets B1 through B14 (as appropriate).

- 4.3.1 Jack/Jack Point Durability Test at GVM.
- 4.3.3 Jacking Load Measurement Test at GVM.
- 4.3.5 Jack-Vehicle and Tire-Ground Clearance Tested at Curb and GVM.
- 4.3.10 Jack/Vehicle Stability Test, Level Surface Tested at Curb.
- 4.3.11 Jack/Vehicle Slope Stability Test Tested at Curb.
- 4.3.12 Head Cap Engagement Test at Unladen Mass.

Note: The tests are to be witnessed and documentation signed by the supplier, and at least one (1) of the following: GM Design Release Engineer (DRE)/Design Engineer (DE), GM Validation Engineer, or GM Test Engineer (refer to Appendix B, Data Sheet B14).

Compare curb weight to specifications and adjust accordingly. Record individual wheel (vehicle corner) weights at curb as required on data sheets, as it was tested.

4.1.1.2 Verify any systems affecting vehicle heights are correct (i.e., suspension levels).

Record vehicle trim height, as it was tested (reference Appendix A, Figure A1) in Appendix B, Data Sheet B2. Check vehicle heights to specifications and adjust accordingly. Record tested height on vehicle data sheets found in Appendix B, Data Sheet B2.

4.1.1.3 Obtain vehicle manufacturer's recommended tire pressure and record on vehicle data sheets in Appendix B, Data Sheet B2.

4.1.1.4 Obtain and follow Vehicle Owner's Manual or design-intent instructions for setting transmission, park brake, tire pressures and wheel chocks.

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 Jack/Jack Point Durability Test.

4.3.1.1 Obtain vehicle selected by test engineer (reference 4.1.1.1.) Verify vehicle manufacturer's recommended tire pressure (reference 4.1.1.4). Ballast vehicle to GVM, with axle being jacked set at Gross Axle Weight Rating (GAWR). Reference Vehicle Technical Specification (VTS). Use mass determined by mass engineer in 4.1.1.1. Record tested individual wheel (vehicle corner) weights in Appendix B, Data Sheet B2, as it was tested (reference 4.1.1.1).

4.3.1.2 Park the vehicle on level concrete surface, or equivalent. Set parking brake and transmission per the vehicle manufacturer's specifications. Use wheel chocks if supplied as standard equipment for the model tested, per the Vehicle Owner's Manual instructions.

4.3.1.3 Deflate left front tire. Place one (1) of three (3) untested jacks at left front jacking position. Calculate torque for power supply due to 4.3.2.8, raise vehicle to the 50 mm clearance height (reference 4.1.1.2), measure the operating force. Lower vehicle, then remove and disassemble jack/tools. Repeat for a total of seven (7) lifts at this location. Operating force measurement required on the first lift only.

Note: Reset the parking brake and transmission after every lift (after placing vehicle in "Park", push vehicle forward and at furthest-most progress, set the parking/emergency brake). Certain vehicles may require a 3 m forward and backward movement at every two (2) lifts.

4.3.1.3.1 One (1) jack should be tested manually using released tools at all four (4) corners, power tool is allowable on subsequent jacks, maximum speed 24 rpm.

4.3.1.3.2 Cycles shall be carried out at a rate which corresponds to actual use and repeated at intervals which are sufficiently long to prevent overheating. Cooling period of 5 minutes $\pm$ 0.5 minutes per lift is permitted.

4.3.1.4 Using same jack, repeat 4.3.1.1 through 4.3.1.3 for the right front, right rear and left rear locations. This is to be repeated for all three jacks.

4.3.1.5 Subject the jack to another lift cycle while measuring the required operating force. This is the operating force after conditioning.

4.3.1.6 Repeat 4.3.1.2 through 4.3.1.5 with two (2) remaining jacks.

4.3.1.7 At completion of test, there will have been three (3) jacks cycled seven (7) times at each corner of the vehicle, for a total of twenty eight (28) cycles per jack on vehicle. Record the condition of jacks, handles, and jacking points in Appendix B, Data Sheet B3. Permanently identify or tag all hardware to prevent its reuse.

4.3.2 Bench Test/Rig Jack Durability Test. Test a fourth new jack on a progressive loading machine. Perform the test using either 4.3.2.1 or 4.3.2.2.

4.3.2.1 Perform the test on a sprung-mass progressive load rig or calculate the vertical load curve based on a sprung-mass progressive load rig for input into a computer-controlled load rig. Calculate this load curve based on a spring rate (K) defined by:

$$K \geq 1.25 \frac{\text{Nominated capacity}}{\text{Range of travel of head cap} \times 0.9}$$

Where:

The jack vertical travel under load is from 10% of normal travel range (the lowest position in the lifting cycle) to full travel.

4.3.2.2 Generate an adjusted, combined vertical load curve based on actual vehicle load measurements. This is done by multiplying the vertical axis load lift data from 4.3.2 by a factor which adjusts the peak vertical load to at least the nominated capacity of the jack. Do this for each jacking point. Combine the adjusted load curves to obtain one (1) worst case load curve (i.e., a load curve that, for each jack height position, has a vertical load of equal to or greater than each adjusted load curve). Interpolation is permitted. This is the load data to use on the test rig.

4.3.2.3 Using appropriate vehicle supplied tools, raise jack to full travel, checking that the maximum force transmitted through the jack is equal to the nominated capacity of the jack. Lower the jack. This is cycle one (1).

4.3.2.4 Subject the jack to one lifting cycle. Measure the operating force during the lift and record the maximum operating force. This is cycle two (2).

4.3.2.5 Repeat 4.3.2.3 for cycles 3 through 52, using the same jack and vehicle supplied tools. No operating force is to be measured for these cycles.

4.3.2.5.1 To test jack and tools together, do not use power tools to speed the cycling process. It is important to obtain durability information on jack handles/sockets used for jack. To test jack only, power tools are allowable. Maximum speed is 24 rpm.

4.3.2.5.2 Cycles shall be carried out at a rate which corresponds to actual use and repeated at intervals which are sufficiently long to prevent overheating. Cooling period of 5 minutes $\pm$ 0.5 minutes per lift is permitted.

4.3.2.6 Subject the jack to another lifting cycle (cycle 53) while measuring the required operating force. Record the maximum force. This is the operating force after conditioning.

4.3.2.7 At completion of rig test, there will have been one (1) jack cycled 53 times. Record the condition of jack in Appendix B, Data Sheet B3.

4.3.2.8 Raise jack to limit of its travel under no load.

4.3.2.9 Apply a force to the handle equal to 150% of operating force after conditioning. Note whether any over travel occurs.

4.3.2.10 Permanently identify or tag all hardware to prevent its reuse.

4.3.3 Jacking Load Measurement Test. Obtain vehicle selected by test engineer (reference 4.1.1.1). Verify vehicle manufacturer's recommended tire pressure (reference 4.1.1.4). Ballast vehicle to GVM, with axle being jacked set at GAWR. Reference VTS. Use mass determined by mass engineer in 4.1.1.1. Record findings in Appendix B, Data Sheet B4, as it was tested.

Note: Conduct load curve measurement on a non-frictional surface (i.e., aluminum plate).

4.3.3.1 Install minimum diameter released wheel and its associated tire (reference 3.3.2.3). Deflate tire.

Note: Engineer may elect to only conduct measurement test with wheel if sufficient information is obtained.

4.3.3.2 Park the vehicle on a level concrete surface, or equivalent. Set parking brake and transmission per the vehicle manufacturer's specification. Use wheel chocks if supplied as standard equipment for the model tested, per the Vehicle Owner's Manual instructions.

4.3.3.3 Install untested jack at an initial jacking location with load cell fixture (reference 3.2.10) under jack base. Jack base shall be at same level as bottom of tires, $\pm$ 5 mm. The vehicle may be set on pads for this. Attach string pot (or equivalent) to jacking point for height measurements. Record distance from jacking point, to bottom of jack base, in Appendix B, Data Sheet B4.

4.3.3.4 Raise vehicle with jack. Record the vertical, fore-aft and lateral (relative to jack, reference 3.2.9) load in Newton (pounds) and also record the input torque in Newton meters (pound feet) versus height, every 20 mm of jack height until the 50 mm clearance height is reached (Appendix B, Data Sheet B5). The height is measured from the jacking point to bottom of jack base.

At the 50 mm clearance height, record in Appendix B, Data Sheet B5:

- Vertical, fore-aft and lateral load.
- The height of the vehicle jack point above the bottom of jack base.
- Once 50 mm height has been met (tire to ground clearance), continue raising the jack. If jack exceeds 65 mm (tire to ground clearance), a jack limiter must be executed.

Note: Evaluate vehicle stability when performing this action. If both tires come off the ground, a Problem Resolution Tracking System (PRTS) must be issued to add a limiter.

4.3.3.5 Lower jack while recording loads, input torque and height every 20 mm of jack height, record in Appendix B, Data Sheet B5.

4.3.3.6 Operating force, must not exceed 110 N force. Torque values are calculated based on the provided wheel nut wrench (or handle) lever arm length and measured force.

4.3.4 Proof Load Test.

Note: Use suitable safety precautions during this test. Vertical loads measured in the Jacking Load Measurement Test (reference 4.3.3) are necessary to run parts of this test. For these parts, use the highest applicable vertical loads from all jacking positions. For other parts of this test the nominated capacity of the jack is used.

4.3.4.1 Place untested jack assembly and simulated section of vehicle jacking point in tensile test machine using adapters. Position the jack at height of jack that obtained 50 mm clearance height measured in Jacking Load Measurement Test (reference 4.3.3.4).

4.3.4.2 Install guards on the tensile test machine.

4.3.4.3 Apply 91 kg (200 lb) vertical load to jack. Measure height of jack and record that height in Appendix B, Data Sheet B6. Apply and hold twice the vertical load recorded at 50 mm clearance height (reference 4.3.3.5) for 10 minutes. Record load applied and height in Appendix B, Data Sheet B6.

4.3.4.4 Decrease load to 91 kg (200 lb) on jack. Measure and record height of jack in Appendix B, Data Sheet B6. Release the load and inspect the jack. Determine if jack is functional and record condition in Appendix B, Data Sheet B6.

4.3.4.5 At the completion of test, permanently identify or tag test jack to prevent its reuse.

4.3.4.6 Repeat 4.3.4.1 through 4.3.4.5 using an untested jack. The height of the jack should be at 75% maximum vertical load. Record two times the vertical load at the 50 mm clearance height (reference 4.3.3.4) (150% maximum load).

4.3.4.7 Repeat 4.3.3.1 through 4.3.3.5 using an untested jack. The height of the jack should be at 50% maximum vertical load. Record two times the vertical load at the 50 mm clearance height (reference 4.3.3.4) (100% maximum load).

4.3.4.8 Perform this test only if maximum vertical load was recorded at other than the 50 mm clearance height. (Reference 4.3.3.4 and 4.3.3.5.) Repeat 4.3.4.1 through 4.3.4.5 using an untested jack. The height of the jack should be at maximum vertical load. Obtain two times the maximum vertical load during Jacking Load Measurement, reference 4.3.3.4.

4.3.4.9 Repeat 4.3.4.1 through 4.3.4.5 using an untested jack with a height of 66% of jack range of travel for scissor/pantograph jacks (50% for all other types of vehicle jacks).

4.3.4.9.1 Apply and hold the nominated capacity of the jack for 30 minutes.

4.3.4.9.2 Measure and record the loss of height after this time.

4.3.4.9.3 Provide for comparison a reference mark on the head cap of the jack with a fixed reference mark either positioned independently of the jack or located on the non-moving part of the jack itself. Fixed reference mark shall be located to coincide with the mark on the jack when the head cap is at the midpoint of its travel.

Note: The object of the next part of the test is for the operator to initiate stopping action when the head cap reaches the midpoint, and then measure how far the head cap travels after the stopping action has been taken. This can be done using the same jack or a new jack.

4.3.4.9.4 Raise jack to the highest position with jack loaded to nominated capacity.

4.3.4.9.5 Lower the head cap with the load still applied.

4.3.4.9.6 Observe the reference marks and stop the travel of the head cap when the two (2) marks coincide.

4.3.4.9.7 Once the head cap has stopped, measure and record the distance between the marks.

4.3.4.10 Repeat 4.3.4.1 through 4.3.4.5 using an untested jack with a height of 66% of jack range of travel for scissor/pantograph jacks (50% for all other types of vehicle jacks).

4.3.4.10.1 Apply and hold twice the nominated capacity of the jack for 1 minute.

4.3.4.10.2 Remove the load and examine the jack for collapse.

4.3.4.10.3 Lower jack to its minimum height under no load.

4.3.4.10.4 Perform one (1) lifting cycle using the nominated capacity. Do not exceed the operating force specified in 4.3.3.6.

4.3.4.10.5 Report any collapse or loss of height (express loss of height as both distance and percentage). Report maximum measured operating force for the lifting cycle.

4.3.5 Jack-Vehicle and Tire-Ground Clearance.

Note: Jack-Vehicle Clearance and Tire-Ground Clearance can be combined if the test vehicle is the same.

4.3.5.1 Jack-Vehicle Clearance. Record minimum and maximum jack height.

4.3.5.1.1 Test at Curb Mass. Obtain vehicle used to represent curb mass of model line (reference 4.1.1.1). Verify vehicle manufacturer's recommended tire pressure. Reference Appendix B, Data Sheet B7.

Park the vehicle on a level concrete surface, or equivalent. Set parking brake and transmission per the vehicle manufacturer's specifications. Use wheel chocks if supplied as standard equipment for the model tested, per the Vehicle Owner's Manual instructions.

4.3.5.1.2 Raise vehicle (not with test jack) at left front position. Remove tire/wheel assembly and install minimum diameter released wheel and associated tire described in 3.3.2.2.

4.3.5.1.3 Lower vehicle, allow it to rest on wheel. Record the clearance between ground and vehicle jacking point in Appendix B, Data Sheet B7. Place test jack at left front position in full down position. Record the clearance between, jack head cap, and vehicle jacking point, in Appendix B, Data Sheet B7, replace original tire/wheel assembly not with test jack, then lower vehicle.

4.3.5.1.4 Repeat 4.3.5.1.2 and 4.3.5.1.3 for all remaining jack locations.

4.3.5.1.5 Test at GVM. Repeat 4.3.5.1.1 through 4.3.5.1.4. However, load vehicle to GVM, when testing front/rear jack locations set at GAWR, reference VTS, mass should be provided by test engineer. Record findings in Appendix B, Data Sheet B7.

4.3.5.2 Tire-Ground Clearance. Minimum-maximum jack height.

4.3.5.2.1 Test at Curb Mass. Obtain vehicle used to represent curb mass of model line (reference 4.1.1.1). Verify vehicle manufacturer's recommended tire pressure, Reference Appendix B, Data Sheet B7.

Park the vehicle on a level concrete surface, or equivalent. Set parking brake and transmission per the vehicle manufacturer's specification. Chock wheels per vehicle manufacturer's instructions if wheel chocks are provided as part of the standard jacking equipment.

4.3.5.2.2 Raise vehicle with test jack high enough to install largest diameter released wheel/tire described in 3.3.2.6, if available. Inflate tire to vehicle manufacturer's recommended pressure. Continue jacking until there is 50 mm of clearance, if possible, from bottom of tire to ground. Check clearance between, ground and vehicle jacking point, and tire to ground clearance, record findings in Appendix B, Data Sheet B7.

If wheel/tire is not available, verify 50 mm clearance from bottom of tire to ground by calculation. To do this, determine if test jack can raise vehicle so that center of wheel is at the 50 mm clearance height determined in 4.1.1.2. Record clearance height in Appendix B, Data Sheet B7.

4.3.5.2.3 Test at GVM. Repeat 4.3.5.2.1 through 4.3.5.2.2. However, load vehicle to GVM, with axle being jacked set at GAWR, reference VTS, Mass should be provided by test engineer. Record in Appendix B, Data Sheet B7.

4.3.6 Equipment Assembly Test.

4.3.6.1 Determine if it is possible to incorrectly assemble jack in a manner that would permit jacking. Repeat for related equipment such as wrenches. Record the information in Appendix B, Data Sheet B8.

Note: Do not attempt to use incorrectly assembled jack.

4.3.6.2 Inspect jack for stops to assure that jack mechanism will not separate from column/screw, etc., at maximum/minimum jack travel. Record the information in Appendix B, Data Sheet B8.

4.3.7 Wheel Nut Wrench Strength/Durability Test. Multi-use wheel fastener wrench (e.g., one that is used for jacking and lug wrench used for wheel fastener removal). Consult platform engineer for direction on accounting for additional loads (e.g., from jacking) in strength, and durability testing.

4.3.7.1 Strength Test. Install wheel mounting test fixture onto the load frame test machine base.

4.3.7.1.1 Install new production intent wheel fasteners onto the test fixture. Using a torque wrench, tighten the wheel fasteners to the service torque specification.

4.3.7.1.2 Use a new wheel nut wrench with maximum dimension socket. With the load frame test machine, apply a tightening load at the end of a new wheel lug wrench handle that will produce 250% of manufacturer's maximum recommended wheel fastener Service Torque Specification. Hold load for 30 s. Record load and moment arm length of tool in Appendix B, Data Sheet B9. If using a drive motor and torque transducer, indicate actual torque value applied.

Note: Loading may be increased to agree with wrench drawing specifications.

4.3.7.1.3 Remove wrench. Record all wrench handle and wrench socket visible issues in Appendix B, Data Sheet B9. Additionally, record any fastener rounding or fracturing.

Note: This wrench will be used in 4.3.7.1.6.

4.3.7.1.4 Using a new wheel lug wrench with maximum dimension socket, loosen wheel fastener that was tightened in 4.3.7.1.2. Record all wrench handle and wrench socket visible issues in Appendix B, Data Sheet B9. Additionally, record any fastener rounding or fracturing. This wrench will be used in 4.3.7.1.7.

4.3.7.1.5 Install new production intent wheel fasteners onto the test fixture. Using a torque wrench, tighten the wheel fasteners to the service torque specification.

4.3.7.1.6 Use the install wrench from the tightening test (reference 4.3.7.1.3) and apply a tightening load at the end of the wrench handle until ultimate strength of assembly is reached. Record ultimate load and observations in Appendix B, Data Sheet B9. If using a drive motor and torque transducer, indicate actual torque value applied.

4.3.7.1.7 Use the wrench from the loosening test (reference 4.3.7.1.4). Determine load to loosen wheel fasteners that were tightened in 4.3.7.1.1. Record all wrench handle and wrench socket visible issues in Appendix B, Data Sheet B9.

4.3.7.2 Wrench Durability.

4.3.7.2.1 Install new production intent wheel and wheel fasteners onto the test fixture.

4.3.7.2.2 Install wheel mounting test fixture onto the load frame test machine base. Using a torque wrench, tighten the wheel fasteners to the service torque specification.

4.3.7.2.3 With the load frame test machine, apply a tightening load at the end of the wheel lug wrench handle that will produce 150% of maximum recommended wheel fastener service torque specification. Hold load for 30 s. Record load and moment arm length of tool in Appendix B, Data Sheet B9. If using a drive motor and torque transducer, indicate actual torque value applied.

Note: Loading may be increased to agree with wrench drawing specifications.

4.3.7.2.4 Loosen wheel fastener with wheel lug wrench.

4.3.7.2.5 Repeat tightening and loosening, 4.3.7.2.2 through 4.3.7.2.4, for a total of 14 cycles at each wheel fastener location.

4.3.7.2.6 Record all wrench handle and wrench socket visible issues in Appendix B, Data Sheet B9. Additionally, record any fastener rounding or fracturing.

4.3.7.2.7 Repeat 4.3.7.2.2 using the same wheel lug wrench. Only install new wheel fasteners.

Note: Total test cycles count is 28 tightening cycles and 28 loosening cycles on each wheel fastener.

Note: Wheel fasteners are replaced to represent changing to a new wheel location on the vehicle.

4.3.7.2.8 Repeat 4.3.7.2.2 through 4.3.7.2.7 using the same wheel lug wrench.

4.3.7.2.8.1 For this set of cycles, implement the following changes:

4.3.7.2.8.2 Install new wheel fasteners.

4.3.7.2.8.3 Apply tightening load at the end of the wrench handle that will produce 150% of maximum recommended wheel fastener service torque specification.

4.3.7.2.8.4 Perform twelve (12) tightening/loosening cycles at each fastener position on the wheel, record in Appendix B, Data Sheet B9.

Note: Total test cycles count is 40 tightening cycles and 40 loosening cycles on each wheel fastener.

4.3.7.2.9 Repeat 4.3.7.2.8.1 through 4.3.7.2.8.4 using the same wheel lug wrench.

4.3.7.2.10 Repeat 4.3.7.2.5 through 4.3.7.2.9 with all three (3) wheel lug wrenches.

Note: At the completion of test, there will have been three (3) wheel lug wrenches with total test cycles count of 52 tightening cycles and 52 loosening cycles on each wheel fastener.

Note: Permanently identify wheel lug wrench to prevent reuse.

Note: For most passenger cars, the wrench should have been tested 260 tightening cycles and 260 loosening cycles. This is 28 high torque cycles per nut, plus 24 nominal torque cycles per nut, times five (5) nuts/wheels, equaling 260 cycles. The number may be different depending on the nuts/wheel or numbers of wheels.

4.3.8 Operating Over Travel Test, Screw/Scissor Jack.

4.3.8.1 Place an untested jack assembly in a base holding device (vice).

4.3.8.2 Record pretest condition of stops in Appendix B, Data Sheet B9.

4.3.8.3 Raise jack to full extension against stops and continue torque application to 110% of maximum torque observed during tests per 4.3.3.4. Use normal operating handle. Record information in Appendix B, Data Sheet B9.

4.3.8.4 Lower jack to full closed position and continue to 110% of maximum torque observed during tests per 4.3.3.4.

4.3.8.5 Record visual condition of jack in Appendix B, Data Sheet B9. Operate jack through travel and note irregularities in smoothness, etc.

4.3.8.6 Permanently identify jack to prevent its reuse.

4.3.9 Operating Over Travel Test, Frame/Ratchet Jack.

4.3.9.1 Place an untested jack assembly under a vehicle. Record conditions of stops and reversing mechanism in Appendix B, Data Sheet B9.

4.3.9.2 Ratchet jack to maximum height.

4.3.9.3 Apply 1100 N (250 lb) force with spring scale to jack handle at maximum distance hand could be placed. If housing advances a notch, repeat until 1100 N (250 lb) is achieved.

4.3.9.4 Lower Vehicle. Record jack observations and determine if jack is functional in Appendix B, Data Sheet B9.

4.3.9.5 To determine strength of handle stop in a downward direction, position jack under a vehicle. Raise vehicle until jack is fully loaded. Apply 1100 N (250 lb) with spring scale to jack handle (in a downward direction) at maximum distance that a hand could be placed.

4.3.9.6 Determine and record if jack is functional in Appendix B, Data Sheet B9.

4.3.9.7 Permanently identify jack to prevent reuse.

4.3.10 Jack/Vehicle Stability Test, Level Surface.

Note: One (1) new jack is used for all tests in this section.

Note: Use extreme caution during all phases of this test. If vehicle falls off jack during test, record maximum load input to vehicle, direction force was applied, and any damage.

4.3.10.1 Obtain vehicle selected by test engineer to represent curb mass, reference 4.1.1.1. Verify vehicle manufacturer's recommended trim heights and tire pressure, (reference 4.1.1.2 and 4.1.1.4). Record as tested in Appendix B, Data Sheet B10.

4.3.10.2 Conduct test at the front and rear locations with the heaviest mass, reference vehicle data sheet (Appendix B, Data Sheet B2). Record locations to be tested in Appendix B, Data Sheet B10.

4.3.10.3 Park vehicle on level concrete surface or equivalent.

4.3.10.4 Transmission Neutral/Park-Brake Off Test. Vehicle transmission to be in neutral with parking brake off.

4.3.10.5 Use wheel chocks if supplied as standard equipment for the model tested, per the Vehicle Owner's Manual instructions.

4.3.10.6 With an untested jack at front location, raise vehicle to 50 mm clearance height (reference 4.1.1.2) or maximum jack travel if less.

4.3.10.7 Gradually apply a static force specified below and hold for 30 s. Apply force 700 mm above and parallel to the ground, in any direction, to pull or push the vehicle off the jack. Record results in Appendix B, Data Sheet B10.

Note: For smaller vehicles up to wheel base 2760 mm and GVM 2300 kg: Use a force of 250 N + 25 N, -0 N (55 lb +5 lb, -0 lb).

For vehicles exceeding wheel base 2760 mm or GVM 2300 kg: Use a force of 445 N +45 N, -0 N (113 lb + 11 lb, -0 lb).

If vehicle rear projected area exceeds 4 m² (41 ft²), use a force of 890 N + 45 N, -0 N (200 lb + 10 lb, -0 lb).

4.3.10.8 Lower vehicle.

4.3.10.9 Repeat 4.3.10.6 through 4.3.10.8 with jack installed at rear location identified in 4.3.10.2, using same jack. Record results in Appendix B, Data Sheet B10.

4.3.10.10 Design-Intent Test.

4.3.10.11 Conduct test at the front and rear locations with the heaviest mass, reference Appendix B, Data Sheet B2. Record those locations to be tested in Appendix B, Data Sheet B11.

4.3.10.12 Park vehicle on level concrete surface or equivalent.

4.3.10.13 Set transmission, parking brake per Vehicle Owner's Manual instructions. Use wheel chocks, if supplied as standard equipment for the model tested, per Vehicle Owner's Manual instructions.

4.3.10.14 Install jack at front location, using same jack. Raise vehicle to 50 mm clearance height (reference 4.1.1.2) or maximum jack travel if less.

4.3.10.15 Repeat 4.3.10.7 through 4.3.10.9, with a force of, 890 + 45 N, -0 N (200 + 10 lb, -0 lb). Record the data results in Appendix B, Data Sheet B11, for the front and Data Sheet B10, for the rear jack location.

Note: For Trucks: If vehicle rear projected area exceeds 4 m² (42 ft²), use a force of 1335 N + 45 N, -0 N (300 lb + 10 lb, -0 lb).

4.3.10.16 Permanently identify jack to prevent its reuse.

4.3.11 Jack/Vehicle Slope Stability Test.

Note: One (1) new jack is used for all tests in this section.

Note: Use extreme caution during all phases of this test. If vehicle falls off jack during test, record maximum load input to vehicle, direction force was applied and any damage.

4.3.11.1 Obtain vehicle selected by test engineer to represent curb mass (reference 4.1.1.1). Verify vehicle manufacturer's recommended trim heights and tire pressure (reference 4.1.1.2 and 4.1.1.4). Record as tested in Appendix B, Data Sheet B12.

4.3.11.2 Front-Up Grade Test. Park vehicle on the 10% grade test slope at a 45 degree angle across grade. See Appendix A, Figure A2.

4.3.11.3 Set transmission and parking brake per Vehicle Owner's Manual instructions. Use wheel chocks if supplied as standard equipment for the model tested, per the Vehicle Owner's Manual instructions.

4.3.11.4 With an untested jack at right rear location, raise vehicle to a 6 mm (0.25 in) clearance height of tire to ground for the largest inflated tire and wheel.

4.3.11.5 Apply a static force of 890 N + 45 N, -0 N (200 lb + 10 lb, -0 lb) on the vehicle surface for 30 s in each of the following two directions.

- Along the vehicle fore-aft centerline (parallel to test pad) in a downhill direction at the bumper. Record results in Appendix B, Data Sheet B12, if the vehicle remained on jack.
- Along the lateral centerline (parallel to test pad) in the downhill direction at the beltline in the area of the B pillar. Record results in Appendix B, Data Sheet B12.

Note: Fore-aft and lateral directions are relative to vehicle.

4.3.11.6 Repeat 4.3.11.4 and 4.3.11.5 for the remaining three (3) jacking locations.

4.3.11.7 Front-Down Grade Test. Park vehicle on the test slope such that attitude is a 7% right road shoulder slope and a 7% downhill grade slope. See Appendix A, Figure A2.

4.3.11.8 Repeat 4.3.11.3 through 4.3.11.6 using same jack. Record results in Appendix B, Data Sheet B12.

4.3.11.9 Permanently identify jack to prevent reuse.

4.3.12 Head Cap Engagement Test (Australia Requirement).

4.3.12.1 Obtain vehicle selected by test engineer (reference 4.1.1.1). Verify vehicle manufacturer's recommended tire pressure (reference 4.1.1.4). Vehicle shall be at normal curb mass (unladen curb mass). Record as tested in Appendix B, Data Sheet B13.

4.3.12.2 Park the vehicle on a level concrete surface, or equivalent.

4.3.12.3 Vehicle transmission is to be in neutral, with parking brakes off.

Note: During this test, it is desirable to have wheel chocks placed near the wheels, but not in contact with them, or to provide some other means of preventing excessive movement of the vehicle in the event of a jack failing the test.

4.3.12.4 The jack head cap and jacking points shall be clean and dry and free from oil, grease, and other deleterious substances.

4.3.12.5 Raise vehicle to 25 mm tire to ground clearance height. Deliver an impulsive force to the jack head cap in the direction most likely to cause disengagement of the head cap from the jacking point. This can be done by

the use of the Head Cap Engagement Fixture (reference 3.2.14, Appendix A, Figure A3). Other methods of delivering an equivalent impulsive force to the head cap may be used as an alternative.

4.3.12.6 At completion of test, record results in Appendix B, Data Sheet B13.

4.3.12.7 Data Presentation. Record pertinent test results in the Appendices on the supplied Data Sheet(s).

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Not applicable.

5.3 Test Documentation. See Appendix B for all Data Sheets.

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.

Bearing Surface: The area contained within the periphery of the base of a vehicle jack.

Note: The bearing surface area of the base should be measured when the head cap is fully raised.

For jacks with a safe working load capacity of > 2000 kg, the bearing surface of the base shall not be < 130 cm².

Clearance Height 50 mm: Radial distance from the center of wheel to the tangent of the inflated tire (unloaded) plus 50 mm. Use the largest diameter wheel/tire combination (consider optional and spare wheel/tire combinations) for model line.

Functional: A jack is considered functional if it can raise and lower a vehicle one (1) time at GVM on a level surface at the heaviest jacking location. This may be determined by engineering judgment.

Jack Conditioning: The process of cycling the jack 28 times to the 50 mm clearance height (reference 4.3.1) with the vehicle loaded at GVM.

Lifting Cycle: The operation of raising the head cap of the jack with the handle provided from its fully lowered position to its fully raised position and then returning it to its fully lowered position.

Nominated Capacity: Defined as the capacity nominated by the manufacturer as the maximum load that is to be lifted by the jack.

Normal Curb/Unladen Mass: The mass of the vehicle with all standard equipment, including all lubricants and fluids necessary to operate the vehicle; option masses of specified engine, emission system and transmission, including all associated mandatory options; fuel to capacity; plus the mass of air conditioning if so equipped. This does not include the mass of occupants or their goods.

Operating Force: The force applied normal to the handle to perform a lifting cycle of the vehicle jack using the full range of travel of the operating handle while measuring the required operating force throughout the lifting cycle. This applies for all measurements of operating force. The force is measured at the center of the handgrip or, if there is no handgrip, at a point 50 mm from the operator's end of the handle.

7.2 Acronyms, Abbreviations, and Symbols.

DE	Design Engineer
DRE	Design Release Engineer
GAMR	Gross Axle Mass Rating
GAWR	Gross Axle Weight Rating
GSSLT	Global Subsystem Leadership Team