



Front Wiper System Test Procedure

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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. This standard defines the testing methodology and requirements for validating front windshield wiper systems to GM requirements. Front wiper system components include wiper motor/transmission, wiper arm, wiper blade, wiper arm beauty cap/covers; any attaching hardware.

1.1.1 Exception. This standard does not cover windshield washing systems unless the washer nozzle/hoses are attached to one of the wiping system components.

1.2 Applicability. This standard applies to all original equipment and replacement windshield wiper components for passenger cars, Multipurpose Passenger Vehicles (MPV), and trucks.

1.3 Remarks. This document is the GM Worldwide Windshield Wiper Testing Standard. Its purpose is to establish a common test methodology for windshield wiper systems to ensure that a high quality world class system is consistently developed and produced. This is a living document and any suggestions or revisions will be reviewed and/or updated annually by the Windshield Wiper Global Subsystem Leadership Team (GSSLT).

2 References

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

2.1 External Standards/Specifications.

IEC 60068-2-27 SAE J903

2.2 GM Standards/Specifications.

GMW3059	GMW14155	GMW14264
GMW3600	GMW14233	GMW17431

2.3 Additional References.

- CG180 5 Phase Template (ID)
- GM Best Practices for Wiping Patterns (The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement)
- GM Research and Development Report AS-598, "Hearing Acuity Standard for Squeak and Rattle Evaluators." (The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement)
- GM Security Guidelines - (<https://gmweb.gm.com/HR/Security/Pages/FutureGuide.aspx>)
- GM1829 Analysis Development Validation Plan and Report (ADVP&R) which is located in the SSTs
- Program specific Subsystem Technical Specification (SSTs)

(ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities. No special facilities required.

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

3.1.1.2 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.

3.1.2 Equipment. See Appendix F, Table F1 for Equipment Matrix.

3.1.2.1 Thermal Chamber large enough to minimally contain one (1) test buck the chamber should also meet the following:

- Temperature Range -40 °C to +95 °C and continuously adjustable

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- Controlled humidity
- Recirculating air temperature cabinet
- Test room, suitable for the execution of the test
- Permissible temperature accuracy: $\pm 3^{\circ}\text{C}$
- Explosion proof

3.1.2.2 Fixtures. Body test buck consisting of Body-In-White (BIW), windshield, air inlet grille cowl, A-pillar decor.

3.1.2.3 Boiler Plate. Fabricated test buck consisting of steel mounting fixture, air inlet panel and windshield.

3.1.2.4 Power Supply. Electrical power supply device that reflects vehicle electrical interface (mating connector, wire gage, control box, etc.)

3.1.2.5 Water Supply. Water spray equipment/nozzle according to SAE J903, section 5.2.2 c (820 cm³/minute minimum).

3.1.2.6 Water Quality. Water used shall comply with GMW17431 Water Quality specification.

Verify that the hardness of the water does not exceed 205 mg/L (12 grains/gal). The water hardness certification may be obtained from the local water supplier. Otherwise, contractor shall obtain an equivalent certification or conduct such test within 60 days of beginning of compliance test run. A suitable water softener shall be used if required.

3.1.2.7 Tip force, attack angle gauge.

3.1.2.8 Electric dynamic torque tool equipment.

3.1.2.9 Digital camera.

3.1.2.10 Dry erase marker.

3.1.2.11 Force gauge with hook attachment.

3.1.2.12 Electric motor dynamometer.

3.1.2.13 Output shaft holding fixture.

3.1.2.14 Wipe angle gage/reader.

3.1.2.15 Measuring scale/ruler.

3.1.2.16 Black windshield, paint or film on inside.

3.1.2.17 Cycle counter/encoder.

3.1.2.18 Oscilloscope.

3.1.2.19 Module holding fixture.

3.1.2.20 Wiper blade felt/cloth wrap.

3.1.2.21 Ice Scrapers. Ice scraper with plastic blade according to Figure 4.

- Scraper length: 250 mm to 400 mm
- Blade: 100 mm

3.1.2.22 Gram weights capable of attaching to the wiper arms and blades.

3.1.2.23 Maximum designed pressure arms (tip force/arm load).

3.1.2.24 Temperature measuring equipment.

3.1.2.25 Variable pressure arms (tip force/arm load).

3.1.2.26 Restriction Blocks.

Rubber (60 Shore A $\pm$ 10 Shore A, durometer) restriction block.

3.1.2.27 Wiper module holding fixture > 250 Hz resonance.

3.1.2.28 Accelerometer.

3.1.2.29 Vibration/Shock Machine. Electromagnetic oscillation table with control unit for oscillation test.

3.1.2.30 Adjustable twist arm and tool.

3.1.2.31 Wiper System (transmission, motor, arms and blades).

3.1.2.32 Air Supply capable of 5.5 bar to 6.9 bar (80 psi to 100 psi) output.

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3.1.2.33 Wire Harness. Wiring harness capable of running the wiper system from outside the vehicle/buck.

3.1.2.34 Clamping device.

3.1.2.35 Arm head torque fixture.

3.1.2.36 One (1) Full size, 1:1 ratio drawing of wipe zones.

3.1.2.37 External water sprayer with a fine spray nozzle capable of delivering varying fluid volumes.

3.1.2.38 Glass Cleaner – approved by GM Subsystem Validation Engineer (SVE)/Design Engineer (DE).

3.1.2.39 Handheld water sprayer.

3.1.2.40 Manual Torque wrench.

3.1.2.41 Production released wiper system fasteners (including arm nut cover caps).

3.1.2.42 Snow Maker. Specially engineered snow launcher gun for purposes of snow making on a vehicle windshield in outdoor ambient. Manufacturer – Ratnik Industries, Inc., Rochester NY, or similar approved by General Motors SVE and DE.

3.1.2.43 Vehicle.

3.1.2.44 Fixtures. Fixture to represent the glass design curvature in park position. This procedure can also be completed on a flat plate with SVE and DE agreement.

3.1.2.45 Windshields – Clear.

3.1.2.46 Shipping container or simulation.

3.1.2.47 Air Inlet Panel (AIP)/Cowl Screens.

3.1.2.48 Proper Safety Equipment to run test safely.

3.1.2.49 Blocking Disk.

3.1.2.50 Output shaft holding fixture.

3.1.2.51 Emulin or LIN-master.

3.1.2.52 Battery Jumper Cables.

3.1.3 Test Vehicle/Test Piece.

3.1.3.1 Test samples shall be of production intent design and material for design validation (DV); or, production intent design and materials manufactured with production processes (home line) for product validation (PV). Any changes to the components or material, e.g., design, fit, form, function, properties, manufacturing process, and/or location of manufacture require revalidation. GM shall approve validation methods for product/process changes before the supplier is committed to the change. Refer to GMW3600.

3.1.3.2 Unless otherwise specified, three samples of components or systems shall be tested.

3.1.3.3 All components/systems used in testing shall be within drawing specifications and have supporting data prior to start of test.

3.1.3.4 Glass used for test bucks or vehicles shall be within drawing tolerances and no cracks or known deformities are allowed. Wiper supplier to provide source warrants or surface data from glass supplier for each test piece. If requested by GM DE or SVE.

3.1.4 Test Time. Time is dependent on test being performed.

3.1.5 Test Required Information.

3.1.5.1 Notification. GM Validation shall be notified of test failures within 24 h period of occurrence.

3.1.5.2 Five (5) Phase. Supplier to develop five phase document (CG180) for all test failures.

3.1.5.3 Product Security. Security protocol for the test vehicle must be followed per GM Security Guidelines.

3.1.6 Personnel/Skills. Person with previous wiper test experience and has run similar tests for GM.

3.2 Preparation. Refer to Appendix A, Figure A1 and Figure A2 to understand the test sequencing for all test samples included in this procedure. This is only a suggested test flow to help optimize test samples.

This standard has been developed to reflect customer usage for markets which have developed road systems (more stable road systems and lesser amounts of unpaved and rough roads). Other regional or local requirements may necessitate additional test options. For further information, consult regional Engineering Center.

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3.2.1 Glass Preparation. Properly clean glass before every new test with GM approved Windshield Cleaner. The test engineer must assure after cleaning water sheeting action is present.

3.2.2 Blade Quality. Properly clean blade element before every new test by wiping the element with a cloth soaked in windshield washer solution.

3.2.3 System Preparation. Prior to test start up; operate wiper system on wet glass for 20 minutes $\pm$ 5 minutes to achieve operating temperature unless otherwise specified for specific test.

3.2.4 Torque Requirement. Arm to pivot shaft nut torque shall be established according to 4.1 before system testing can be started. Use dynamic torque and representative manufacturing tool.

3.2.5 Attack Angle. Attack angle and arm load need to be within design specifications at park position on test buck before start of any system level test.

3.2.6 Fastener. Nominal fastener torques unless otherwise specified.

3.2.7 Motor Preparation. Before attaching the wiper arms to the wiper motor, the motor shall be activated once.

3.2.8 Measurement of the surface shall be provided by customer or supplier of the windshield.

3.2.9 Distance between Park Position and Window Frame. Activate the wiper system for one cycle on wet glass during idling. Measure the distance between the tip of the wiper blade and the lower window frame. This shall be done for Driver Side (DS) and Passenger Side (PS).

3.2.10 Distance between Reversal Point and A-pillar. Activate the wiper system for one cycle on wet glass during idling. Measure the distance between the tip of the wiper blade and the A-Pillar. This shall be done for DS and PS.

3.2.11 Arm Load and Attack Angle. Use a force gauge at the wiper arm tip to determine the force in park and reversal point for PS and DS. Before measuring, move the wiper arms into and out of service up position, three on wet glass. Measure the attack angle in park and reversal point for PS and DS.

3.2.12 Blade Location. The wiper blade shall conform to the windshield, over the entire length of the wiper blade element, from park position to the out wipe position. After the wipe pattern has been designed to meet required regulatory wipe zone coverage requirements, it shall also follow any and all GM best practices regarding wiping patterns. The blade park position must be located $\pm$ 5 mm from the windshield assembly aid indicators. The wipe pattern durability size tolerance calculations will include this value. All testing shall locate the blades in this manner prior to start of the test.

3.3 Conditions.

3.3.1 Environmental Conditions. Symbol definitions required for test methods contained in this procedure are listed in Table 1. Actual requirement values for the symbols shall be obtained from the Subsystem Technical Specification (SSTS) or the respective specification and recorded on Data Sheet B1, Appendix B.

The driving test can be performed in all types of weather. However, in situations where severe weather makes certain driving maneuvers unsafe, Test Procedure Subsections using those maneuvers shall be postponed until road conditions improve.

The following conditions apply to all tests unless otherwise specified:

- Ambient temperature: $+23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$
- Voltage: $V_{\text{nom}} \pm 0.3\text{ V}$ at motor terminals
- Humidity shall be 50% to 75% for all tests unless otherwise specified
- T_{min} is $-40\text{ }^{\circ}\text{C}$ unless otherwise specified
- T_{max} is $+85\text{ }^{\circ}\text{C}$ unless otherwise specified

3.3.2 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.

Deviations from the requirements of this standard shall have been agreed upon between GM SVE and/or DE and the supplier. Deviations shall be approved by the GM Validation Engineer and specified on the GM1829 Analysis Development and Validation Plan and Report and all effected test reports. The deviations to SSTS requirements shall be documented with the DE.

3.3.2.1 Unless otherwise specified, use a dynamic gun at 50 min^{-1} (rpm) to dynamically torque the nut for all tests.

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3.3.2.2 Part Orientation. Parts shall be tested in vehicle orientation unless otherwise specified.

3.3.2.3 Water Hardness. Verify that the hardness of the water does not exceed 205 mg/L (12 grains/gal). The water hardness certification may be obtained from the local water supplier. Otherwise, contractor shall obtain an equivalent certification or conduct such test within 60 days of beginning of compliance test run. A suitable water softener shall be used if required.

3.3.2.4 Emerging Market Environmental Conditions. Emerging Markets are to use the following unless stated otherwise in the program specific SSTs.

- $T_{min} = -20\text{ }^{\circ}\text{C}$ for India
- $T_{min} = -40\text{ }^{\circ}\text{C}$ for Russia
- $T_{min} = -15\text{ }^{\circ}\text{C}$ for South America Only

3.4 Instructions. Refer to Figure A1 and Figure A2 to understand the test sequencing for all test samples included in this procedure.

3.5 Data. Not applicable.

3.6 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.

3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM Department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

3.7.1 Test Results. Test reports with supplier letterhead shall be generated by supplier performing test and electronically distributed to GM Validation. All test reports shall be in the English language.

Record measurements and results as specified by individual procedures in the final test report.

3.7.2 Test Documentation. Results Table (see example in Appendix E, Data Sheet E1). Include photographs of the test setup and the individual test results. Design Review Based on Test Results (DRBTR) results to be documented.

3.7.2.1 Evaluation Reports.

3.7.2.1.1 Document the test results in a test certificate or report.

Test reports shall include all of the following: test equipment serial numbers, calibration information, description of test material (including design revision, lot or batch, options, etc.) test specification date, pertinent setup information, and photographs. The supplier shall write evaluation reports to document the results of all their validation activities and shall make the test results and evaluation reports available to GM Engineers upon request (see GMW3600). All reports shall be in English language. Document all test results, parameters and findings.

Test reports with supplier letterhead shall be generated by supplier performing test and electronically distributed to GM Validation.

The supplier shall write evaluation reports to document the results of all validation activities and shall make the test results and evaluation reports available to GM engineers upon request. See GMW3600. All test reports shall be in English and available 2 weeks after test completion.

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3.7.2.2 Required Documentation. The following is also required for ALL test reports (see Appendix E, Data Sheet E1):

- Procedure number and section numbers on all test reports
- Requirement being met and SSTS requirement number
- All test parameters for environment and equipment
- Any authorized deviations to the plan
- Test setup shall be photographed

3.7.2.3 Photos. Photos of the test fixture and test sample.

4 Requirements and Procedure

4.1 Component and Subsystem Procedures.

4.1.1 Arm Strip Torque.

Note: This test shall be completed before all other tests in this standard.

4.1.1.1 Purpose. The purpose of this test is to ensure that a wiper arm joint will not come loose during normal and restricted wipe operation.

4.1.1.2 Two (2) Procedures. There are two procedures listed; one for developing the arm nut torque (4.1.1.5) and the other for confirming it (4.1.1.6).

4.1.1.3 Test Equipment. See 3.1.2.1.

4.1.1.3.1 Clamping device.

4.1.1.3.2 Electric dynamic torque tool equipment.

4.1.1.3.3 Manual Torque wrench.

4.1.1.3.4 Arm head torque fixture.

4.1.1.3.5 Dynamic torque wrench.

4.1.1.3.6 Thermal chamber.

4.1.1.4 Test Preparation. Not applicable.

4.1.1.5 Test Procedure for Nut Static Torque Development.

Note: If supplier has known nut torque value, skip this step and verify using nut torque confirmation test according to 4.1.6.

4.1.1.5.1 Test Samples. Minimum 14 painted arm heads, pivot shafts, and fastening nuts.

4.1.1.5.2 Determine maximum STATIC output torque at pivot shaft with 16.0 V, low and high speed, maximum highest torque motor expected to be produced and arm restricted.

4.1.1.5.3 STATIC Condition: Attach the wiper arm head to the shaft using a manual torque wrench.

DYNAMIC Condition: Attach the wiper arm head to the shaft using a torque gun with a constant 50 min⁻¹ speed. Set torque-apply equipment to a constant 500 min⁻¹ (rpm) and attach wiper arm heads onto pivot shafts. (Dynamic Condition) At least six samples of each shall be tested at torque values of 20, 22, 24, 26, 28, 30, 32, 36, 38, 40, 42 and 44 Nm. Check with the program specific SSTS or the GM DE or SVE for program specific torque values.

4.1.1.5.4 Condition. Place pivot shaft assemblies in environmental chamber and set temperature to +90 °C ± 3 °C. Maintain temperature for 16 h and then reduce temperature to +23 °C ± 3 °C for 14 h.

4.1.1.5.5 At room temperature, block arm head so it can withstand torque values up to 200 Nm. If a clamp is used to block/support the arm head, ensure minimum clamp load is used and that there is a minimum distance of 35 mm from applied clamp load to the pivot shaft to avoid inducing hoop stress into the joint.

4.1.1.5.6 Torque Application. Using pivot shaft torque fixture with a torque transducer apply torque in a clockwise rotation (nut tightening direction) at a speed of 100 min⁻¹ (rpm) until arm head disengages from pivot shaft causing a strip condition. Record maximum strip torque vs. nut torque on all samples and chart data according to Figure B1. Sample test setup can be seen in Figure 1, Figure 2 and Figure 3.

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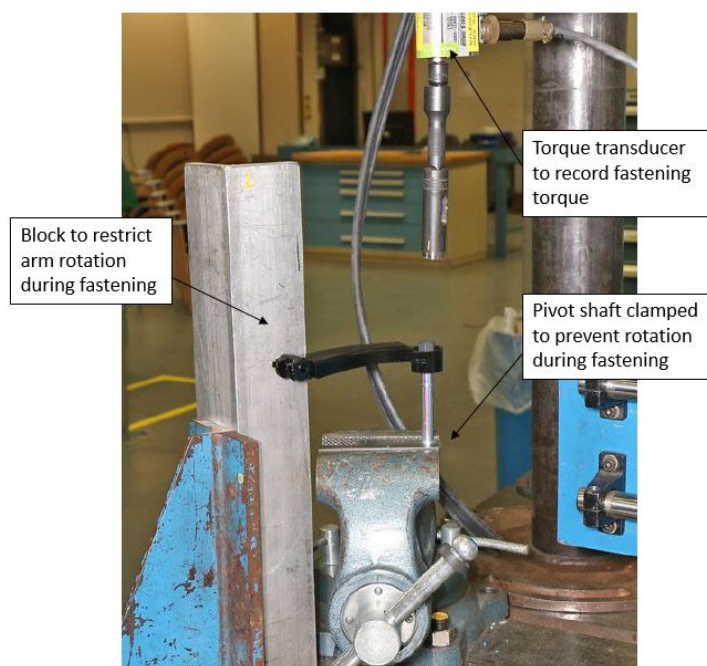


Figure 1: Sample Test Setup

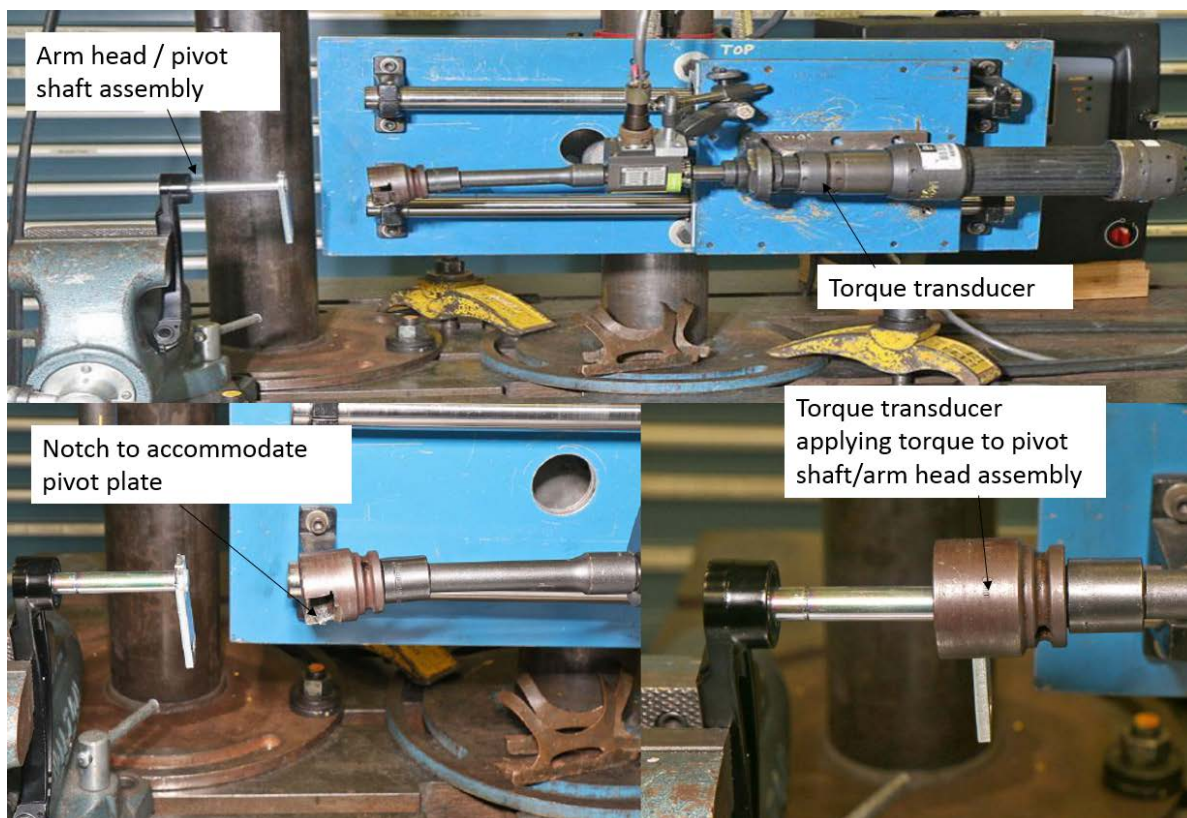


Figure 2: Sample Test Setup

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4.1.1.5.7 Figure B1 shows a graphical approach in determining the minimum nut torque value required. Follow the instructions below to understand how to create and use this chart.

4.1.1.5.7.1 Plot strip-out torque vs. nut torque data on an X-Y scatter plot; nut torque on the X axis and strip-out torque on the Y axis.

4.1.1.5.7.2 On Figure B1, add horizontal lines at the maximum pivot shaft torque value and 125% of that value determined earlier in this procedure.

4.1.1.5.7.3 Draw a best-fit line through the data from low to high nut torque.

4.1.1.5.7.4 Draw two lines parallel with the best-fit line that intersects with the highest and lowest data points to get a measure of the unexplained variation.

4.1.1.5.7.5 Find the intersection between the lower parallel line and the 125% pivot shaft output torque. Read down to the X axis to find the minimum nut torque value using a whole number. In the example in Figure B1, the minimum value is 24.2 Nm so minimum nut torque is 24 Nm.

4.1.1.5.7.6 Nominal Nut Torque. Calculate nominal nut torque value by increasing minimum value by 10%. Next, calculate maximum torque value by increasing nominal by 10%. All values must be whole numbers. (For example, minimum is 24 Nm, nominal is 26 Nm, and maximum is 28 Nm).

4.1.1.5.7.7 Test Procedure for Nut Dynamic Torque Development. Repeat 4.1.1.5.1 thru 4.1.1.5.7.6 for Dynamic Torque (Replace Dynamic for Static in test procedures).

4.1.1.5.7.8 Run correlation between Static and Dynamic Torques – plot.

4.1.1.6 Test Procedure for Nut Torque Confirmation.

4.1.1.6.1 Test Samples. Three painted arm heads per cavity and corresponding number of pivot shafts and fastening nuts.

4.1.1.6.2 Determine maximum output torque at pivot shaft with 16.0 V, low and high speed, and arm restricted.

4.1.1.6.3 Set torque-apply equipment to a constant 50 min⁻¹ (rpm) and attach wiper arm heads onto pivot shafts. At least three samples from each cavity (minimum six (6) samples) are to be tested at torque values of 2 Nm below MIN, MIN, NOM, MAX, 2 Nm above MAX.

Example: Confirm torque 34 Nm ± 3 Nm would test 29 Nm, 31 Nm, 34 Nm, 37 Nm, 39 Nm

4.1.1.6.4 Conditioning. Place pivot shaft assemblies in environmental chamber and set temperature to +90 °C ± 3 °C. Maintain temperature for 16 h and then reduce temperature to +23 °C ± 3 °C for 14 h.

4.1.1.6.5 At room temperature, clamp pivot shaft in clamping device so it can withstand torque values up to 200 Nm.

4.1.1.6.6 Strip Condition. Using wiper arm head torque fixture and torque wrench apply torque in a clockwise rotation (nut tightening direction) at a speed of 100 min⁻¹ (rpm) until arm head disengages from pivot shaft, causing a strip condition. Record maximum torque value on all samples and chart data according to Figure B1.

4.1.1.7 Test Requirement. Requirement for Nut Torque Confirmation is that all sampled parts must have strip out values > 125% of maximum pivot shaft output torque.

4.1.2 Arm Head Burst Strength (Static).

4.1.2.1 Purpose. The purpose of this test is to verify that the arm head design and pivot shaft are strong enough to survive over torque conditions of fastening nut.

4.1.2.2 Test Equipment.

4.1.2.2.1 Clamping device.

4.1.2.2.2 Electric dynamic torque tool equipment.

4.1.2.2.3 Torque Wrench for manual torque.

4.1.2.3 Test Samples. Three painted arm heads from each cavity and corresponding number of pivot shafts and fastening nuts.

4.1.2.4 Test Preparation. Not applicable.

4.1.2.5 Test Condition. See 3.3.

4.1.2.6 Test Procedure. Assemble wiper arm head to pivot shaft with fastening arm nut using static torque tool. Torque the arm nut to 1.5 times maximum specified static torque determined by 4.1.1.5. If no failure mode is

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observed during torque remove arm nut and inspect parts for cracks, elongation, or other failure modes. If no failure mode is observed at inspection, reassemble and torque to ultimate failure and record torque value and ultimate failure mode. Use magnification to determine if cracks appear under the nut.

4.1.2.7 Test Requirement. Arm head, pivot shaft, and nut shall withstand a torque at least 1.5 times the maximum specified arm nut installation torque.

4.1.3 Arm Head Burst Strength - Dynamic.

4.1.3.1 Purpose. The purpose of this test is to verify that the arm head design and pivot shaft are strong enough to survive over torque conditions of fastening nut.

4.1.3.2 Test Equipment.

4.1.3.2.1 Clamping device.

4.1.3.2.2 Electric dynamic torque tool equipment.

4.1.3.3 Test Samples. Three painted arm heads from each cavity and corresponding number of pivot shafts and fastening nuts.

4.1.3.4 Test Preparation. Not applicable.

4.1.3.5 Test Condition. See 3.3.

4.1.3.6 Test Procedure. Assemble wiper arm head to pivot shaft with fastening arm nut using dynamic torque tool. Torque the arm nut at a constant 100 min^{-1} (rpm) to 1.5 times maximum specified dynamic torque determined by 4.1.1.5. If no failure mode is observed during torque remove arm nut and inspect parts for cracks, elongation, or other failure modes. If no failure mode is observed at inspection, reassemble and torque to ultimate failure and record torque value and ultimate failure mode.

4.1.3.7 Test Requirement. Arm head and/or pivot shaft shall withstand a torque at least 1.5 times the maximum specified arm nut installation torque.

4.1.4 Wipe Speed.

4.1.4.1 Purpose. The purpose of this test is to confirm the wiper system design meets GM's and legal operating speed requirements.

4.1.4.2 Test Equipment. See 3.1.2.

4.1.4.3 Test Samples. One system.

4.1.4.4 Test Preparation. See 3.2.

4.1.4.5 Test Condition. See specific procedure. Test shall be run with wet glass. Glass shall be wetted with $820 \text{ cm}^3/\text{minute}$ minimum during the test.

4.1.4.6 Test Procedure. Refer to Figure 3 for test flow. At $+23^\circ\text{C} \pm 3^\circ\text{C}$, operate wiper system for one minute on wet glass and record wipe cycles during the following conditions.

- V_{nom} , Low speed and high speed
- 9.0 V, Low speed and high speed
- 16.0 V, Low speed and high speed

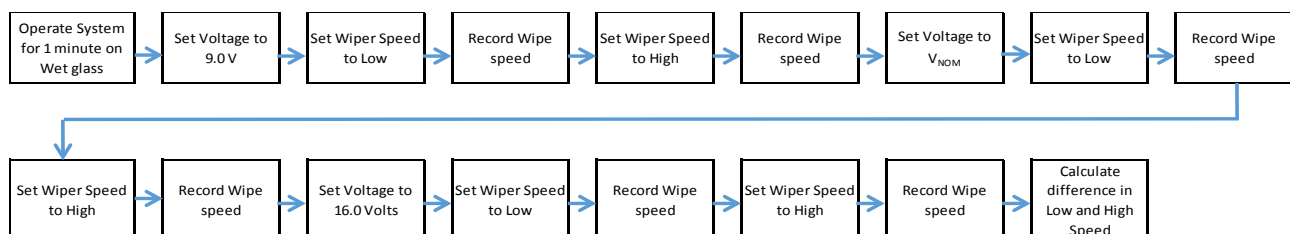


Figure 3: Wipe Speed Test Flow

4.1.4.7 Test Requirement. At V_{nom} , Low and high speeds per SSTs. The wiper system shall function properly at 9.0 V, V_{nom} and 16 V.

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4.1.4.7.1 High vs. Low Speeds. Difference between high and low speed at V_{nom} shall be at least 15 cycles per minute (CPM).

4.1.4.7.2 One wiper speed shall be ≥ 45 cycles/minute (CPM) at V_{nom} .

4.1.4.7.3 No interference or contact with surrounding components is allowed anytime during test.

4.1.4.7.4 Rate noise level and wipe cleanability if specified using GM rating scale according to GMW14264.

4.1.5 Wiped Area.

4.1.5.1 Purpose. This test is used to verify the wiper system meets its design intended wipe coverage.

4.1.5.2 Test Equipment. See 3.1.2.

4.1.5.2.1 Full size, one to one ratio drawing of wipe zones.

4.1.5.2.2 Dry erase marker.

4.1.5.2.3 External water sprayer with a fine spray nozzle capable of delivering varying fluid volumes.

4.1.5.3 Test Samples. One system.

4.1.5.4 Test Preparation. See 3.2.

4.1.5.4.1 Calculate total area of windshield.

4.1.5.5 Test Condition. See 3.3.

4.1.5.6 Test Procedure. On a wet windshield, operate wiper system at V_{nom} on high speed and trace outline of actual wipe pattern on inside glass surface. Turn wipers off and dry windshield. Follow the test flow described in Figure 4.

4.1.5.6.1 Wipe Pattern. Tape full size drawing on outside of windshield, aligning blackout lines, and transfer previously marked wipe pattern onto drawing.

4.1.5.6.2 Analysis. Calculate actual wipe angles, the actual wiped area, and the corresponding percentage of each wipe zone.

4.1.5.6.3 Test Requirement. Percentage of wipe zone coverage must meet applicable GM and legal requirements specified in SSTs and the design intent wipe pattern shall be met.

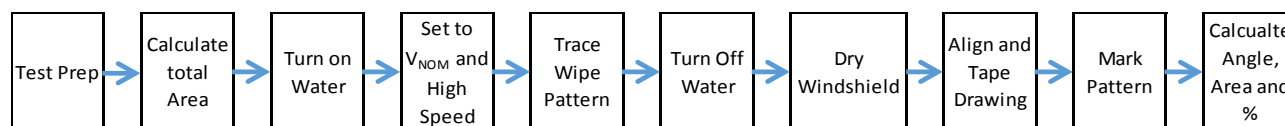


Figure 4: Wiped Area Test Flow

4.1.5.6.4 Repeat 4.1.4 thru 4.1.6.3 for low speed if required in the program specific SSTs.

4.1.5.7 Wipe Area After Durability.

4.1.5.7.1 Purpose. The purpose of this test is to verify the wiper system meets its design intended wipe coverage after the system has completed One Durability Life Cycle.

4.1.5.7.2 Test Equipment. See 3.1.2.

4.1.5.7.2.1 Drawing. Full size, one to one ratio drawing of wipe zones.

4.1.5.7.2.2 Dry erase marker.

4.1.5.7.2.3 External water sprayer with a fine spray nozzle capable of delivering varying fluid volumes.

4.1.5.7.3 Test Samples. One system after one life of durability cycling.

4.1.5.7.4 Test Preparation. See 3.2.

4.1.5.7.4.1 Calculate total area of windshield.

4.1.5.7.5 Test Condition. See 3.3.

4.1.5.7.6 Test Procedure. Place full size design pattern layout over windshield aligning blackout lines. From inside of windshield, trace wipe pattern and wipe zones with dry erase marker.

4.1.5.7.6.1 Amount of Water Required. Calculate how much water shall be sprayed on windshield surface using the following formula; 20 ml/m² water of windshield area.

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(Example: W/S area $2.38 \text{ m}^2 \times 20 \text{ ml} = 47.6 \text{ ml}$ of water to be sprayed in a 3 s period.)

4.1.5.7.6.2 Spray Volume. Fill external sprayer with water. Adjust spraying device nozzle flow so calculated spray volume from 4.1.5.7.6.1 is achieved in 3 s period.

4.1.5.7.6.3 Spray Application. While standing on driver side of test buck/vehicle reach across to passenger side and position external spray nozzle (500 to 600) mm above windshield. Start spraying windshield from top to bottom for 3 s so entire surface is coated with water. Immediately operate wipers on high speed for three (3) wipes. Spray and wiper cycles can be repeated two additional times if needed to remove smearing.

4.1.5.7.6.4 Wiped Area Documented. Mark the cleaned wiped area pattern with dry-erase marker on inside surface of windshield.

Note: If an opaque windshield is being used mark on outer surface.

Note: Fluid that dribbles back into wiping pattern is not to be considered a non-wiped area.

4.1.5.7.6.5 Document Pattern. Tape full size drawing on outside of windshield, aligning blackout lines, and transfer previously marked wipe pattern onto drawing.

4.1.5.7.6.6 Calculations. Calculate actual wipe angles, the actual wiped area, and the corresponding percentage of each wipe zone.

4.1.5.7.7 Test Requirement. Percentage of wipe zone coverage must meet applicable GM and legal requirements specified in SSTs and the design intent wipe pattern shall be met.

4.1.6 Wiper Arm Lock Back/Service Up Retention.

4.1.6.1 Purpose. The purpose of this test is to ensure that once an arm/blade assembly is put into its lock back position for servicing the blade, it cannot easily fall and damage windshield glazing. This test is applicable for driver and passenger side arm/blade assemblies.

4.1.6.2 Test Equipment. See 3.1.2.

4.1.6.2.1 Force gage.

4.1.6.2.2 Test buck.

4.1.6.3 Test Samples. See 3.1.3.

Three (3) arms/blades for driver side and three arms/blades for passenger side.

4.1.6.3.1 Wiper Arms with Minimal Arm Load. Arms shall be adjusted or sorted to the minimum requirement per the program specific SSTs. This value can also be found on the product drawing. The arms shall be installed on a test buck or fixture.

4.1.6.4 Test Preparation. Not applicable.

4.1.6.5 Test Condition. See 3.3.

4.1.6.6 Test Procedure. Install arm/blade on wiper system pivot and cycle up/down five times.

4.1.6.6.1 Put arm/blade assembly into lock back position.

4.1.6.6.2 Measure Force. Place force gage at arm/blade connection and apply a force perpendicular to this area until arm/blade starts free falling.

4.1.6.6.3 Document. Record the peak/maximum force to start free fall condition. Also document the tip force. Repeat the check six (6) times. Note first and last time or for all six (6) repetitions.

4.1.6.7 Test Requirement. Wiper arm/blade assembly cannot freefall with $< 2 \text{ N}$ of force.

4.1.7 Wiper Arm Beauty Cap Retention.

4.1.7.1 Purpose. The purpose of this test is to ensure a beauty cap will maintain retention when exposed to external forces such as a car wash.

4.1.7.2 Test Equipment. See 3.1.2.

4.1.7.2.1 Force gage with hook attachment.

4.1.7.2.2 Thermal Chamber – for aging parts.

4.1.7.3 Test Samples. Three (3) new caps and four (4) aged caps for each cavity and each arm head tool.

4.1.7.4 Test Preparation. See 3.2.

4.1.7.5 Test Condition. See 3.3.

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4.1.7.6 Test Procedure. Create aged cap samples by exposing them in environmental chamber at $+80\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for 4 h on a flat surface to relieve molding stresses.

4.1.7.6.1 At ambient, install wiper arm onto pivot shaft using maximum and minimum nut torque specification.

4.1.7.6.2 Install all cap new samples and two (2) aged cap samples on wiper arm. Set force gage to record peak force and pull each cap from edge, removal feature, or if applicable opposite of hinge feature. Direction of pull shall be along pivot shaft vector measuring peak removal force.

4.1.7.6.3 Install and remove all cap samples five additional times for serviceability requirement.

4.1.7.7 Test Requirement. The following requirements shall be met:

- There shall be no damage to the attachment scheme
- Force to remove wiper beauty cap, either new or aged, after first installation must be $> 10\text{ N}$ each time
- When removed for serviceability, force to remove cap, either new or aged, shall be $> 10\text{ N}$ each time. Record the first and last removal
- When installed for serviceability, the force, either new or aged, shall be within ergonomic requirements - this can be found in the ergonomic guidelines. Record the first and last installation

4.1.7.8 Repeat 4.1.7.6.1 thru 4.1.7.7 for remaining two (2) aged cap samples and three (3) new cap samples after a 4 h cold soak at $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.

4.1.8 Wiper Blade Slam-Down.

4.1.8.1 Purpose. The purpose of this test is to verify that a wiper blade design can withstand being slammed down onto the windshield surface without functional loss.

4.1.8.2 Test Equipment. See 3.1.2.

4.1.8.3 Test Samples. See 3.1.3. One (1) set of blades per cavity for driver and passenger wiper arm. Minimum of three (3) blades if only one (1) cavity.

4.1.8.3.1 Wiper arms with maximum arm load as specified in the program specific SSTs or the commodity drawing.

4.1.8.4 Test Preparation. See 3.2.

4.1.8.5 Test Condition. See 3.3.

4.1.8.6 Test Procedure. Check wipe quality of all blades prior to freeze test. Only blades that have a 9 or 10 wipe quality rating shall be used for this test. Submerge blade samples in room temperature water for 5 s to 10 s and place in thermal chamber at $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for 4 h. Orient blades in vehicle position in chamber.

Note: A holding fixture maybe required to ensure proper vehicle position. With agreement from GM SVE and/or DE, blades maybe placed face down in the chamber without the use of a holding fixture.

4.1.8.6.1 With test buck at room temperature, remove first set of blade samples from $-30\text{ }^{\circ}\text{C}$ chamber and perform 4.1.8.6.2 and 4.1.8.6.3 within 5 minutes.

4.1.8.6.2 Install blades onto test buck arms and place both driver and passenger arm/blade assembly in lock back position. If the system has a limited service up, use the maximum service height of the arm per the program specific SSTs or the commodity drawing.

Note: It is permissible to remove ice buildup on the arm in the attachment location to allow for installation on to the test buck. Document the ice buildup with pictures and document that ice was removed and how.

4.1.8.6.3 Apply minimal force at arm to blade connection and allow assembly to free-fall onto glass surface. Repeat slam-down condition 70 times.

4.1.8.6.4 Repeat 4.1.8.6.2 and 4.1.8.6.3 on remaining 2 blade sets.

4.1.8.7 Test Requirement. After completion of 70 slam downs, there shall be

- No damage to blade structure or element
- The wiper blade elements are required to provide a wipe quality rating no less than 7 per GM Wipe Quality Rate Scale Table C1
- No damage to the Glazing or molding

In addition:

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- Document if the heel contacts before the tip
- If the test fixture has a hood or representation, the arm is not allowed to contact

4.1.9 Motor Stall/Thermal Trip.

4.1.9.1 Purpose. The purpose of this test is to verify that the wiper motor will not be damaged if the wiper system is activated with an obstruction and not able to move for an extended period of time.

4.1.9.2 Test Equipment. See 3.1.2.

4.1.9.2.1 Electric motor dynamometer.

4.1.9.2.2 Output shaft holding fixture.

4.1.9.3 Test Samples. Two motors.

4.1.9.4 Test Preparation. See 3.2.

4.1.9.5 Test Condition.

- $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$
- $+80\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$

4.1.9.6 Test Procedure. Prior to test, subjectively evaluate the module noise (including but not limited to whine, growl, clicks, clunks, etc.) per Subjective Rating Scale for Component Noise in Table D1 under the following conditions: V_{nom} , no load.

4.1.9.6.1 Mount each motor to a dynamometer and run at V_{nom} with a 2.5 Nm constant load for 30 minutes. After warm up period, obtain motor performance via a speed-torque curve from free speed to stall. Allow motors to cool for 1 h before start of test.

4.1.9.6.2 Place first motor sample in holding fixture with output shaft restricted.

4.1.9.6.2.1 Condition. Soak motor at $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for 4 h.

4.1.9.6.2.2 At $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$, energize restricted motor in high speed for 3 h.

4.1.9.6.2.3 De-energize motor and continue to soak at $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ for additional 2 h.

4.1.9.6.2.4 At $-30\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$, energize restricted motor in low speed for 3 h.

4.1.9.6.3 Repeat 4.1.9.6.2 thru 4.1.9.6.2.4 on second motor sample except change thermal temperature to $+80\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$.

4.1.9.6.4 Upon completion of stall conditions, allow for cool-down period of at least 4 h. After cool-down period, record motor performance via a speed-torque curve from free speed to stall.

4.1.9.6.5 Repeat motor noise evaluation described in 4.1.9.6 on both motors.

4.1.9.7 Test Requirement. Both high and low wiper motor speeds with 2.5 Nm load shall not degrade more than 10% from initial speed OR torque as specified in the program specific SSTs.

4.1.9.7.1 Wiper motor low speed stall torque shall not degrade more than 10% from design torque OR speed as specified in the program specific SSTs.

4.1.9.7.2 Wiper motor current draw for both low and high speeds shall be within design specification. Document the current draw under all conditions.

4.1.9.7.3 Initial motor noise Subjective Rating shall be 9 or better and after test it shall be 8 or better. Check the program specific SSTs for additional requirements.

4.1.10 Wipe Pattern Verification. (See Figure 6.)

4.1.10.1 Purpose. The purpose of this test is to verify the wiper system meets its intended wipe pattern design including inertial expansion of the loaded system. This procedure is also to ensure that the wipe pattern meets the regulatory requirement set forth in the program specific SSTs and countries the vehicle shall be sold in.

4.1.10.2 Test Equipment. See 3.1.2.

4.1.10.2.1 Wipe angle gage/reader.

4.1.10.2.2 Measuring scale/ruler.

4.1.10.2.3 Dry erase marker.

4.1.10.3 Test Samples. One system.

4.1.10.4 Test Preparation. See 3.2.

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4.1.10.5 Test Condition. See 3.3.

4.1.10.6 Test Procedure. Record initial wiper blade park position and mark on inside glass surface with dry erase marker.

4.1.10.6.1 On wet glass, operate wiper system at V_{nom} on low speed. During operation measure and record the distances A thru H called out in Figure 5 and, using the wipe angle gage/reader, calculate and record the wiping angle.

Note: Distances A thru G are measured relative to the Edge of Glass. Distance H measures the amount of passenger side (PS) to driver side (DS) pattern crossover. All measurements are to the wiper blade element centerline. Suggested method of measurement is to use a scale to measure from the edge of glass to the wiper blade tip, blade cover or protective cover, indexing down to find the proper measurement. Then add the distance from the edge of the cover or tip to the centerline of the blade element using math data. Do this for both low and high speed.

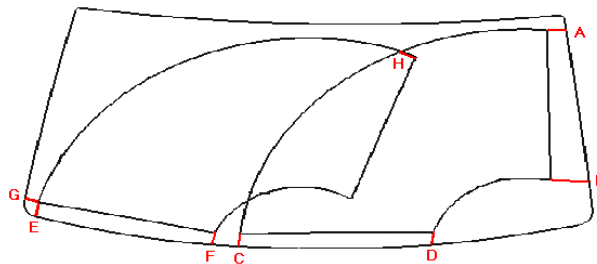


Figure 5: Wipe Pattern Check

4.1.10.6.2 Park Position. After measurements are recorded, park the wiper system and record wiper blade park positions.

4.1.10.6.3 Repeat 4.1.10.6.1 and 4.1.10.6.2 at V_{nom} on high speed.

4.1.10.7 Test Requirement. Wipe angles shall be within tolerances provided in SSTS specifications.

4.1.10.7.1 Inertial expansion, from low speed to high speed, shall not increase the wipe angle at in-wipe or out-wipe more than requirement stated in SSTS for the program.

4.1.10.7.2 Wiper arms and blades under wet glass conditions shall park within SSTS specifications.

4.1.10.7.3 The measured distances are to be within design specifications.

4.1.10.7.4 Repeat 4.1.10.6.1 and 4.1.10.6.2 at V_{nom} after every 500k first Durability Cycles and end of RC requirement.

4.1.10.7.5 Repeat 4.1.10.6 thru 4.1.10.7.4 for high speed if specified in the program specific SSTS.

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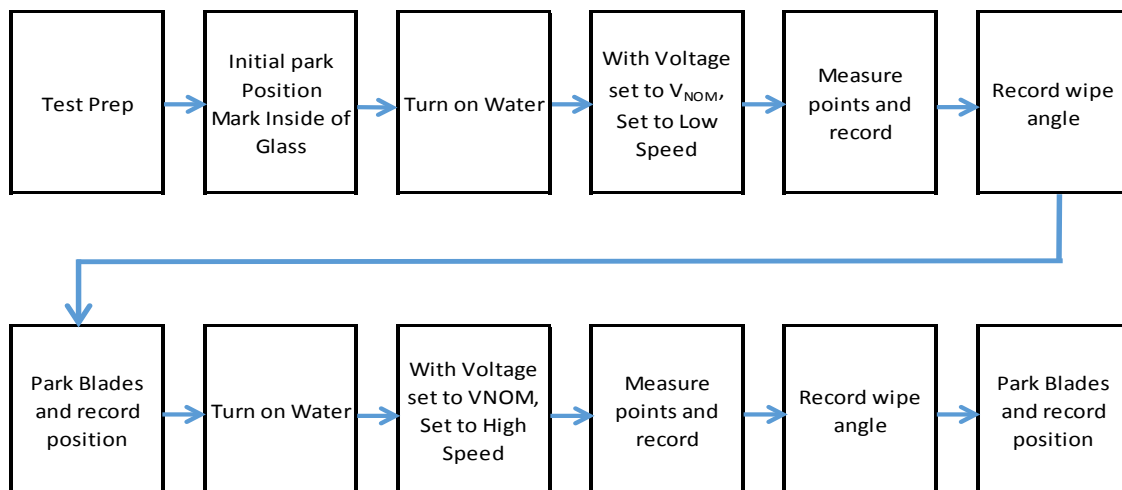


Figure 6: Test Flow for Wipe Pattern Verification

4.1.11 Wipe Quality Check.

4.1.11.1 Purpose. The purpose of this test is to verify the clearing capability of the wiper system with a new blade.

4.1.11.2 Test Equipment. See 3.1.2, three samples.

4.1.11.2.1 Black windshield, paint or film on inside.

4.1.11.2.2 Digital camera.

4.1.11.2.3 Light diffuser or similar to ensure sufficient lighting is available to highlight defects.

4.1.11.3 Test Samples. See 3.1.3.

4.1.11.4 Test Preparation. See 3.2.

4.1.11.5 Test Condition. See 3.3.

4.1.11.6 Test Procedure. On wet glass, operate wiper system at V_{nom} for 5 minutes. Lift arms/blades off glass and clean windshield with GM approved Windshield Cleaner must assure water sheeting action. Refer to test flow in Figure 7.

Note: When validating a new blade design, rubber change, etc., wipe Quality shall be checked every 100 000 cycles.

4.1.11.6.1 With wiper parked, spray water onto glass for (5 to 10) s. Operate wipers on low speed for a half cycle to out wipe position. Within 3 s after reaching out wipe, evaluate wipe quality of driver side blade according to GM Wipe Quality Rating Scale in Table C1.

4.1.11.6.2 With wiper in out wipe, spray water onto glass for (5 to 10) s. Operate wipers on low speed for a half cycle to park position. Within 3 s after reaching park position, evaluate wipe quality of driver side blade according to GM Wipe Quality Rating Scale in Table C1.

4.1.11.6.3 Passenger Side. Repeat 4.1.11.6.1 and 4.1.11.6.2 for passenger side blade.

Note: Document all wipe quality results with pictures within 3 s of reaching park position and videos as necessary.

4.1.11.7 Test Requirement. Wiper shall provide smooth wiping operation with wipe quality rating of 9 per GM Wipe Quality Rating Scale in Appendix C.

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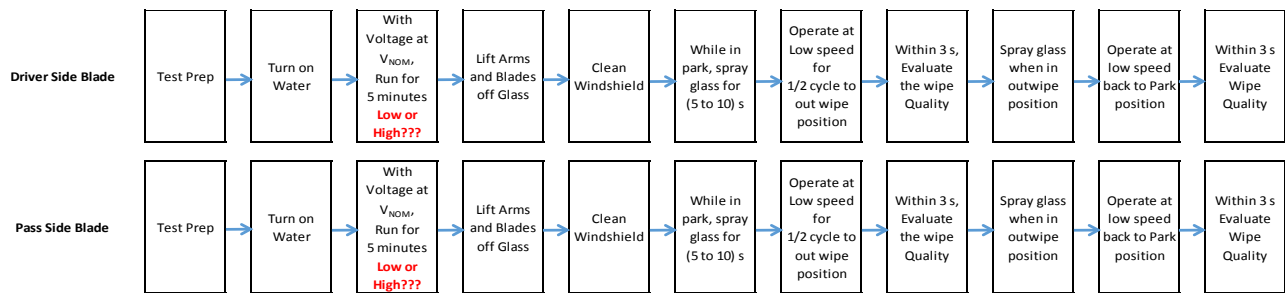


Figure 7: Wipe Quality Check Test Flow

4.1.12 Durability/Reliability.

4.1.12.1 Purpose. The purpose of this test is to verify a wiper system will meet specified performance requirements during a vehicle's lifetime with reliability and confidence level of R95C50 at one life. One life is defined in program SSTS.

4.1.12.2 Test Equipment. See 3.1.2.

4.1.12.2.1 Cycle counter/encoder.

4.1.12.2.2 Oscilloscope.

4.1.12.2.3 Thermal chamber.

4.1.12.3 Test Samples. See 3.1.3, three samples minimum.

4.1.12.3.1 Replace blade elements every 500 000 cycles. If elements are not serviceable, replace assembly.

4.1.12.3.2 Replace blade assembly/structure every 1.5 Million cycles.

4.1.12.4 Test Preparation. See 3.2.

4.1.12.4.1 If GM validation engineer is not available to view test, provide video record showing test setup and initial system operation.

4.1.12.4.2 Reliability requirement can be met through either Success or Failure testing. Review with GM Validation Engineer and get agreement on which method will be used before start of test.

4.1.12.4.2.1 Failure Test. Required unless specifically stated in the program specific SSTS for DV Testing. Repeat durability test profile, replacing blades and/or structure as specified, until a failure defined in Test Requirements is detected. Analyze the resulting failure data using a Weibull probability plot to estimate the reliability. The estimate shall be R95C50 or better at one life. Deviations to this must have Approval by the GM SVE and DE for the program.

Note: A Beta slope of 1.5 shall be used as a default and for new suppliers or new designs. The value can be increased based on the following:

1. Experienced Supplier
2. Similar Designed Systems with historical data (Carryover motor, carryover linkage, etc.)
3. **AND** Approval by the SVE and DE for the program

Supplier shall notify SVE and DE of the Beta slope used and whether Success or Failure test Method will be used prior to start of any testing.

Table 1: Reliability 95% with 50% Confidence

R95C50 Chart Using Beta = 1.5	
Sample Size	Number of Life Cycles
3	2.73
6	1.72
R95C50 Chart Using Beta = 2.0	

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Sample Size	Number of Life Cycles
3	2.12
6	1.50
R95C50 Chart Using Beta = 3.0	
Sample Size	Number of Life Cycles
3	1.65
6	1.31

4.1.12.4.2.2 Success Test. Recommended for PV Testing if test to failure was used during Table 1 provides direction for required test duration with three samples. Repeat durability test profile, replacing blades and/or structure as specified, until life cycles have been run without failure. See 4.1.12.7 for definition of failure.

4.1.12.5 Test Condition. See specific procedure.

4.1.12.6 Test Procedure. Prior to test, subjectively evaluate the module noise (including but not limited to whine, growl, clicks, clunks, etc.) per Subjective Rating Scale for Component Noise in Table D1 under the following conditions: V_{nom} , low and high speed, wet glass. Record wipe speed, current draw, and park signal.

4.1.12.6.1 Conduct durability/reliability test using front wiper durability test profile in Figure 8 for Passenger vehicles and Figure 9 for Trucks and SUVs. Verification of system operation and data monitoring equipment shall be done at least twice a day.

Note: During cold temperature durability cycling, a cloth wrap shall be used. No water shall be sprayed during these cycles. Cloth wrap to have a coefficient of friction which represents a blade on wet glass.

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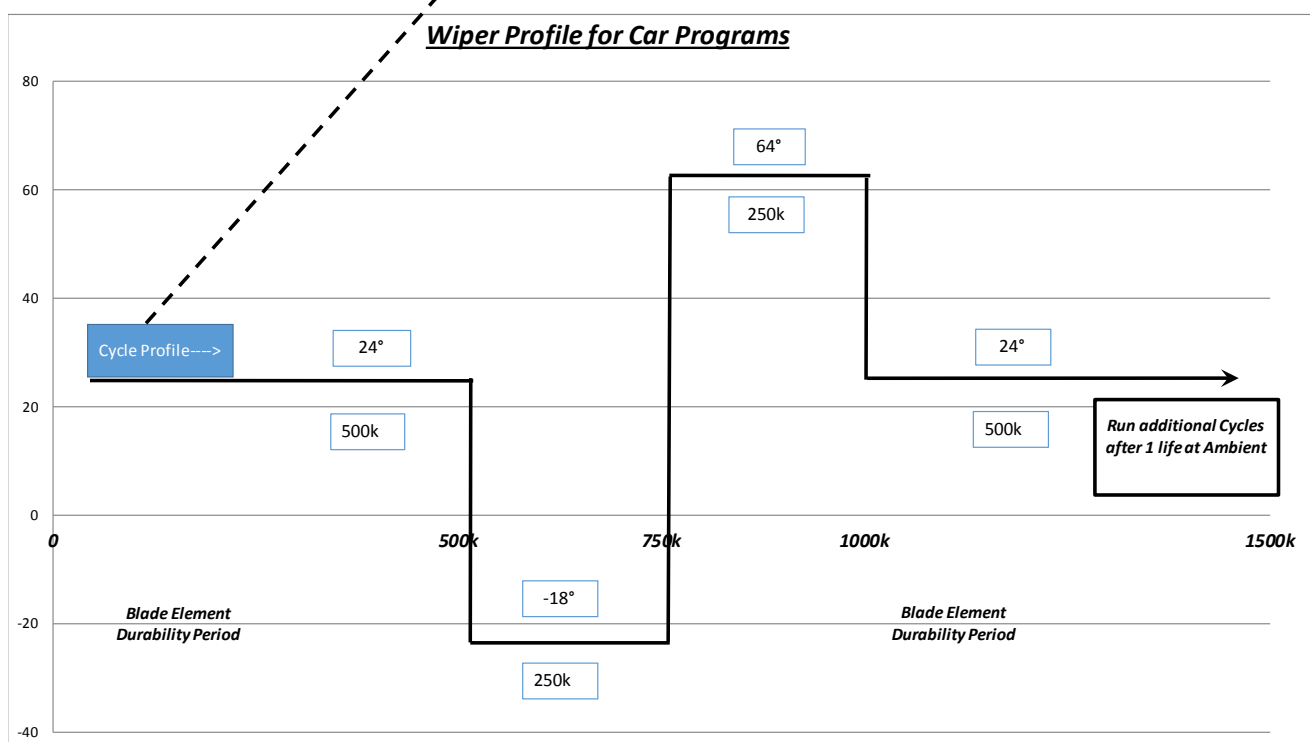
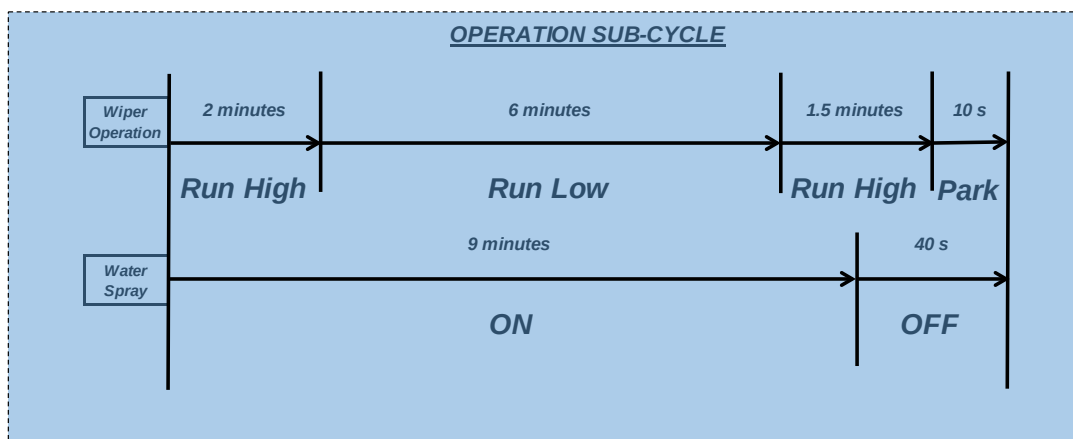


Figure 8: Front Wiper Durability Profile for Passenger Vehicles

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