



Wet Road Spray Evaluation for Splash Shields and Brake Corner Components

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. The purpose of this standard is to provide a repeatable and customer-based method to evaluate the spray pattern experienced by the brake corner components of a vehicle when driving in wet conditions.

1.2 Applicability. This standard is applicable to all vehicles.

1.3 Remarks. The spray pattern on brake corner components due to wet road driving can be difficult to predict. Underbody components can experience both direct splash, as well as airborne spray/debris. In addition to the splash/spray created by the test vehicle itself, real world driving often includes driving through spray from following other vehicles, especially at highway speeds.

This test procedure is an attempt to recreate the spray situations by driving a test vehicle behind a lead vehicle at speeds simulating both city traffic, as well as highway driving. The total wet road exposure of approximately 5 km is an attempt to provide sufficient exposure time to show the same spray patterns that would be seen during prolonged driving exposure. By coating the components under study with a leak trace powder, the resulting spray pattern can be visualized and studied.

This test procedure is intended to be used as a development tool to aid in the design of the brake system to help minimize exposure of sensitive brake corner components to high levels of spray. Best Practices 112957-V1 Brake Corner Splash Shield Playbook and 112519-V3 Brake Corner Splash Shields provide additional information. The supplier shall work with the GM Design Responsible Engineer to comprehend these requirements.

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.

- Best Practice 112519-V3 Brake Corner Splash Shields (ID)
- Best Practice 112957-V1 Brake Corner Splash Shield Playbook (ID)
- Global Document Management (GDM) system (<https://documents.naeng.gm.com>) (ID)
- GM Evaluation Report Template (ID)
- Kent Automotive (Lawson Products), Chicago, Illinois (www.kent-automotive.com)

(ID) = These documents/systems are limited to internal distribution/use within General Motors and shall not be distributed outside the company. Contact the GM Lead Engineer for further instructions.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

November 2015

Page 1 of 15

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 that direct comparisons between tests run on different surfaces may not be valid. Alternate test facilities can be utilized assuming that all A to B comparisons are performed using the same facility with the same road wetting method. An example of an alternative test facility would be the Milford Proving Ground (MPG) Vehicle Dynamics Test Area (VDTA), using a water truck to wet a specified area.

3.1.3. Test Roads. A paved, level, straight test road with a method of wetting the surface is required. The wetted road should have length of not less than 0.8 km and should have sufficient access for a vehicle to approach the wetted surface at a speed up to 100 km/h.

3.1.3.1 GM North America, MPG Facility. At the GM North America, MPG facility, the test should be run on the Interior Noise Road, located adjacent to the Ride and Handling Loop. The Noise Road can be wetted along the 0.8 km straightaway with the sprinkler system. The sprinklers are operational from approximately April to November, depending on weather conditions.

3.1.3.1.1 The Noise and Vibration (N&V) group has priority on the Interior Noise Road. N&V testing is usually performed early in the morning when there is less ambient wind noise. Brake testing should be run later in the day (after 10 A.M. Eastern Standard Time) whenever possible, to accommodate the N&V testing. No hard braking, acceleration, or cornering maneuvers are allowed on the Interior Noise Road. See Appendix C (Figure C1) for more information on the Interior Noise Road.

3.1.4 Hoists. Vehicle hoist area for removal of wheels and brake components is needed. Alternate lift methods may be used if necessary.

3.1.5 Vehicle Weighing Station. Equipment is required to measure the vehicle weight at each wheel.

3.2 Equipment.

3.2.1 Digital camera for taking pictures before and after test runs.

3.2.2 Leak trace powder (Kent Automotive brand or equivalent) for coating components under study in order to determine areas of spray contact. Coating used must clearly show areas of spray contact.

3.2.3 Inboard pad(s) with friction material removed to install in calipers during evaluation.

3.2.4 Second vehicle to drive in front of test vehicle. This vehicle should preferably be a high ground clearance vehicle with relatively large tires (such as a Sport Utility Vehicle) in order to provide maximum spray. The same lead vehicle should be used for all test runs if comparisons are to be made between runs.

3.3 Test Vehicle/Test Piece.

3.3.1 Test vehicle should be representative with respect to vehicle mass, vehicle mass distribution, ride height, front fascia design, wheel liner design, wheel vent area, brake cooling enhancements (if any), brake corner hardware, and corner suspension.

3.3.2 New brake hardware is not required. However, the surface smoothness of the hardware under study should be good enough to allow for even coverage of the leak trace powder. For example, a highly corroded rotor with an irregular surface may not show the evidence of spray as well as a rotor with a smooth surface.

3.4 Test Time.

Calendar time: 0.5 days/run

Test hours: 1 hour

Coordination hours: 3 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills.

3.6.1 Test personnel to set up vehicle for test, including removing/installing parts and evenly spraying all parts under study with leak trace powder.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

November 2015

Page 2 of 15

Documents
Document Sharing Hub

3.6.2 Test driver sufficiently skilled to follow closely behind a lead vehicle while driving through heavy spray in the test vehicle.

3.6.3 Additional test driver sufficiently skilled to drive the lead vehicle in a safe manner given the short following distance of the test vehicle.

4 Procedure

Note: See Table 1 for a brief description of the procedure. Also see Appendix D (Figure D1) for an example test run sheet.

4.1 Preparation.

4.1.1 Obtain signoff that the vehicle is representative. Check and adjust tire pressures as needed. Weigh vehicle. Document the information on the test run sheet (Appendix D (Figure D1)).

4.1.2 If studying the brake rotor friction surface spray pattern, determine the best method for disabling the hydraulic pressure of the brake system from reaching the corners under study for the test vehicle. The corner under study must be disabled so that the pad(s) on that corner will not contact the rotor during testing.

Note: Disabling both front brake corners will result in poor directional stability on the wetted road. Disabling both corners on one side can result in unstable yaw under braking on the wetted road. The safest method is to disable either a single brake corner or diagonally opposed brake corners.

4.1.2.1 Half System (Diagonal Split Systems Only). A brake half system can be installed. The diagonal system still allows enough braking capability with the active diagonal to safely slow the vehicle. A Left Front + Right Rear or a Right Front + Left Rear corner combination can simultaneously be studied with the use of a half system.

4.1.2.2 Brake Hose Clamp. Brake hose clamps can be used to clamp off a single brake corner or diagonally opposed brake corners. The hose clamp must be applied tightly enough to ensure no brake fluid pressure at the corner under study. If brake hose clamps are used, the brake hoses should be replaced after testing is completed since undetectable damage may have been done to the brake hoses.

4.1.2.3 Welded Banjo Bolt. An alternate method that can be used to clamp off a brake corner(s) is to obtain banjo bolts that will fit the brake corners under study and then weld the fluid port on the bottom of the banjo bolt closed. These bolts can then be installed and will effectively block hydraulic pressure from reaching the brake corners.

4.1.3 Apply an even coating of leak trace powder to all components under study. If the coating is applied too thick, water content will remove coating. If the coating is too light, the surface may be irregular in brightness, making it difficult to determine if an area had water contact or was not fully coated with leak trace powder initially. If multiple light coats are required, make sure the powder dries completely prior to application of the next coat. Note that some components, such as rotors, may be easier to coat prior to installation on the vehicle, while other components may be easier to coat after installation.

4.1.4 Take detailed pretest photographs of all areas under study after they have been coated with leak trace powder. Make note of the angle/zoom/lighting of each photograph so that similar posttest photographs can be taken. The comparison of the pretest and posttest photographs will be used to determine the spray pattern. Note that some components, such as rotor inboard cheeks or outboard splash shield surfaces, may be easier to photograph prior to component assembly, while others may be easier to photograph after assembly.

4.1.5 Install the proper brake hardware. Tighten fasteners to manufacturer's recommended torque requirements.

4.1.6 Install inboard pad(s), with friction material removed, in the brake corner(s) under study. The reason for this is the tendency for the backing plate of the inboard pad to block some spray/debris from reaching the inboard rotor surface. There is typically no need to install the outboard pad. Secure the inboard pad to the caliper, and then secure the caliper to the bracket if required (as for a colette-style caliper design). This tie-back is done to keep the caliper and/or pad from contacting the rotor surface during testing. See Appendix B (Figures B1 and B2) for examples.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 The test may be conducted in any ambient temperatures above freezing. Note, however, that the water evaporation rate will be greatly affected by the ambient conditions. Document the conditions in Appendix D (Figure D1).

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

November 2015

Page 3 of 15

Documents
Document Sharing Hub

4.2.1.2 Access road surfaces leading to and from the test facility should be dry.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 If comparing several vehicles, attempt to run the tests in similar ambient conditions.

4.2.2.2 Driver-only vehicle weight is recommended. This affords the highest vehicle ground clearance which should allow the highest level of splash/spray. Document the vehicle weight, as tested, in Appendix D (Figure D1).

4.3 Instructions.

4.3.1 Splash Road Facility.

4.3.1.1 Using the available source of water, evenly wet the road surface until a uniform glassy appearance is obtained. Avoid running the water source too long because water puddles will create too severe a splash condition.

4.3.1.2 At the Milford Proving Ground, proceed to the Interior Road Noise Facility. Drive to the control panel on the north end of the facility (just prior to the return loop at the north end). Locate the timer labeled Sprinkler Control. Rotate knob past 10 minutes and then place back at around 3 minutes to initially wet the road. Note that approximately 30 s will be needed for the water to reach all of the sprinkler heads (beginning at the south end). Run the sprinklers until the left hand lane takes on a uniform glassy appearance. It should take no more than 3 minutes to 5 minutes total run time to achieve the proper amount of water. The sprinklers are fed from a retention pond. If the sprinklers are left on too long, the pond will drain. Considerable time may be required to refill the pond from ground water sources, especially in dry weather.

4.3.2 Test Driving Instructions.

4.3.2.1 With the lead vehicle going first, make the first pass of the wetted road at 50 km/h. Use the facility access road to attain the test speed prior to entering the wet road section. Once on the wet road, the test vehicle should follow the lead vehicle as closely as is comfortable for the test driver (less than one car length, if possible). Runs should be made with the same following distance to allow for A to B comparisons.

4.3.2.2 Begin to slow the test vehicle **before** the end of the wetted road portion. **Do not** apply the brakes on the lead vehicle until the test vehicle has begun to slow down to allow more gap for the test vehicle to safely slow down with its limited brake system.

4.3.2.3 Use the facility access roads to return the vehicles for approach to the wet road. Again, obtain the test speed prior to entering the wet road. Make a second pass on the wet road at 50 km/h.

4.3.2.4 Repeat 4.3.2.3 for a third pass on the wet road at 50 km/h.

4.3.2.5 Return to the water source or sprinkler control panel and rewet the road to a glassy appearance.

4.3.2.6 Repeat steps 4.3.2.1 through 4.3.2.4 at 100 km/h test speed. Be sure to leave **greater** distance at the end of the wet road to slow down from this higher test speed.

4.3.2.7 Return to the garage area using dry roads.

4.3.3 Posttest Inspection. Take posttest photographs of the same components photographed pretest. Use similar camera angles/zoom/lighting as the pretest photographs for the best possible comparison.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

November 2015

Page 4 of 15



Documents

Document Sharing Hub

Table 1: General Instructions for Wet Road Test

Step	Description
1	Perform test preparations and document pretest conditions.
2	Proceed to Wet Road Facility.
3	Run sprinkler or other water source until driving lane appears uniformly glassy.
4	Make one (1) pass of lane at 50 km/h, following behind lead vehicle.
5	Repeat Step 3 for a total of three (3) runs at 50 km/h.
6	Rewet the driving lane to a uniform glassy appearance.
7	Repeat Steps 4 and 5 at 100 km/h (three (3) runs).
8	Proceed directly to garage for inspection.
9	Document posttest inspection with photos.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. There is no subjective or objective measurement scale for quantifying the splash experienced. The outputs of the testing are the pretest and posttest photographs taken of the components under study. These photographs are to be used to aid in the design and optimization of the brake rotor splash shield by providing information about the spray pattern experienced by the vehicle underbody during wet road driving.

5.3 Test Documentation. The test information, photographs, and comparison results should be documented and published using the GM Evaluation Report Template or similar document and Global Document Management (GDM) system. The test report should include pretest and posttest photos of the areas of study. See Appendix A (Figures A1 through A6) for examples.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

7 Notes

7.1 Glossary. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

#	Number
ABS	Antilock Brake System
Coeff.	Coefficient
Dir.	Direction
DRP	Dynamic Rear Proportioning
GDM	Global Document Management
GSSLT	Global Subsystem Leadership Team
IBT	Initial Brake Temperature
Int.	Interior
LR	Left Rear
MPG	Milford Proving Ground
N/A	Not applicable

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

November 2015

Page 5 of 15