



Hood System Slam Durability

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 procedure applies to all passenger cars and light duty trucks having a horizontally hinged, swing up/down, front-opening hood system. This procedure applies to hoods that are counterbalanced or non-counterbalanced, using prop rods, counterbalance springs, or gas springs. With careful consideration, this procedure can also apply to other engine covers (as occur on rear or mid-engine vehicles) and on rear opening hoods (tilt hoods). This procedure can be used to test a hood assembly with a single pivot hinge or a multi-pivot hinge.

1.2 Applicability. This procedure applies to passenger cars, multi-purpose vehicles and trucks with a hood closure panel system.

1.3 Remarks. This procedure can be performed on full vehicles or test bucks, as noted in 3.3.1. It is recommended that slam loads be measured before starting durability cycling (reference Slam Load Test procedure GMW16176). These loads can be compared against the Computer Aided Engineer (CAE) predictions. If measured loads are significantly different than the CAE predictions, there must be a meeting with the Design Engineer, Analytical Engineer and Validation Engineer to discuss the differences and determine the appropriate actions.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14274 (ID)	GMW14830	GMW15179
GMW14276	GMW15095 (ID)	GMW16176

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2.3 Additional References.

- CG190 - GM Evaluation Report (ID)
- CG583 - Development/Validation Test and Vehicle Review (ID)
- Subsystem Technical Specifications (SSTS) including the following:
 - a. Dependability
 - b. Open and Closing Cycles
 - c. Operational Performance
 - d. Reliability
 - e. Validation

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March 2018

Page 1 of 14

3 Resources

3.1 Facilities. The facility should have all of the equipment listed in 3.2 and be capable of providing the conditions required in 4.2. Local adaptation for equipment usages might be available.

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

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Actuators for opening and closing the hood (usually pneumatic or electric). The actuator used for durability should have travel sufficient to move the hood from fully closed to a fully open position. However, the actuators should not inhibit the motion of the system, such that when a system free rises, the actuator does not affect the speed. Actuators to operate the hood primary and secondary release handles (or similar release mechanisms) may also be needed.

3.2.2 Test rig/fixture with structural framing to mount actuators inside and/or outside of the test body as required. See Figure A2 and Figure A3 for examples.

3.2.3 A device to measure linear or angular velocity capable of SSTS required velocities ($\pm 3\%$) This should include a velocity meter and a flag attached to the hood.

3.2.4 A device to count cycles of the hood.

3.2.5 Torque wrenches with a capacity of approximately 1.5 times the maximum fastener torque referenced.

3.2.6 Force gauge(s) with a range of 1.5 times the specified requirements, or equivalent, for measuring operating efforts.

3.2.7 A device, such as a pneumatic cylinder, may be required to:

- Push the hood off the seal.
- Lift the hood to the full open position or to the free rise position.

3.2.8 Angle measuring device (for hood opening angles).

3.2.9 If the latch has a micro switch which provides information on latch status, then equipment must be provided to monitor the signal. This signal should be used to confirm that the latch has successfully latched/unlatched. If there are special conditions where the switch cannot be monitored, then the test engineer must be notified and a functional check must be performed at an agreed upon interval. Also, not using the micro switch will require that a check be performed with each cycle to assure that the hood is closed/open.

3.2.10 A closed loop velocity controlled cycle fixture should be utilized for hoods with counter-balance systems (for example, clock springs, gas struts). The fixture should be capable of slamming the hood at the various positions that are required and have adequate power to slam the hood at the required velocities. The programmable controller uses a specific hood closing velocity as an input parameter. The closing velocity of each cycle will be measured and used as feedback to automatically make the necessary adjustment to either maintain or attain the desired velocity on subsequent cycles.

Note: If a closed loop velocity controlled device is not used to cycle hoods with counter-balance systems, then the fixture to be used must be capable of closing the hood at the required velocities. Slamming hoods with gas struts in the hot chamber requires more energy at a specific velocity than closing the hood at the same velocity in ambient temperature.

3.2.11 Any hood system with primary or secondary release handles will require actuators to operate the release handles. The size of the actuators should be determined by the amount of space available for mounting as well as the handle force and handle travel requirements.

3.2.12 Heaters may be required for actuators when the test setup is used in a cold chamber.

3.2.13 Examples of various test setups are provided in Appendix A.

3.3 Test Vehicle/Test Piece.

3.3.1 Test Property. This can be a full vehicle or a Body-in-White (BIW). Due to the cost of full vehicles, BIWs are typically used.

3.3.2 Hood complete with all hardware and seals. For example:

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March 2018

Page 2 of 14

Documents
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- **Hood Hardware:** Hinges, primary and secondary latches, interior hood release system, strikers, counter balance, weather strips, fixed and adjustable bumpers, and windshield. If possible, the interior hood release system should include the trim that surrounds the handle so the fit and system performance can be monitored throughout testing. **Note:** For Instrument Panel (IP) mounted handles, an IP from a different test (17-Channel, for example) can be used. Due to the cost of the IP, a new IP for this test should only be used in very rare circumstances. **Note:** For kickpad mounted handles with unique mounting that is not common with another program, the kickpad should be included in the slam test.
- **Trim:** Hood blanket, hood moldings, fascia, grille, lamps, hood cowl, air inlet panel, cowl seal, radiator support seal, and beauty cover (radiator support to grille).

3.3.3 It is recommended that the hood, body, and fascia be subjected to the production-intent assembly and paint process to ensure representative strength characteristics. It is also recommended that the test parts/assembly be dimensionally certified and that closing efforts are within range before testing is started.

Note: The requesting engineer will determine how many hoods (sample size) will be tested.

3.4 Test Time. Test time may vary as a function of number of lives required and environments required. The requesting engineer will determine testing conditions.

Calendar time: 15 d (3 lives)

3.5 Test Required Information. The requesting engineer is responsible for providing specifications appropriate to the particular vehicle line being tested. (Submission of the program SSTs and requirement sections tested, DTS, part numbers for all subsystem components, along with the test request is recommended and should be attached to the CG583). Any unique test requirements/procedure deviation(s) must be listed in the CG583 form. The following information is required to be provided prior to starting the test:

3.5.1 Durability Cycle Requirement.

3.5.1.1 The total number of cycles of the hood per life, as well as the number of lives required to be tested.

3.5.1.2 The sequence and percentage of cycles at required velocities/drop heights at which the hood will be closed. For hoods with a counter balance the slam criteria must include slam velocities. For hoods with prop rods, the drop heights must be provided.

Note: Hoods which are designed with dampening systems (systems that limit hood closing velocity as the hood approaches the latch) will require their own durability schedule. Forcing these hoods to close at speeds designed for systems without dampening will result in test induced failures. When this document was created, there was no SSTs schedule for hoods with dampeners. The responsible Design Engineer, Validation Engineer, SSLT representative and Validation Technical Integration Engineer (TIE) should work together to establish a durability schedule. It is recommended that the minimum slam velocity be set to the minimum velocity to latch plus 10%, or as specified in the program specific SSTs.

3.5.1.3 The Sequence and percentage of cycle counts in each environmental condition (hot, cold, humid, ambient).

3.5.2 Effort measurements to be performed.

3.5.3 Additional hood operation requirements to be checked and/or monitored, e.g., squeaks, cracks, loosened fasteners. This information should be monitored throughout the test and documented per a table similar to that shown on Data Sheet A1.

3.5.4 The minimum frequency at which inspections/functional checks should be performed is indicated on Data Sheet A1. Greater frequencies may be required by the requesting engineer.

3.5.5 Gap and flushness specifications. This information should be monitored throughout the test and documented per a table similar to that shown on Data Sheet A2.

3.5.6 Fastener torques.

3.6 Personnel/Skills. Prior experience in setting up and running similar tests and experience in the use of the referenced test equipment is critical to achieving the estimated times shown in 3.4 Test Time.

4 Procedure

4.1 Preparation. Required: Prior to start of test; the responsible engineer for the test will provide an approval form (suggested CG583 form which is available in Global Document Management (GDM) in the Standard Forms

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March 2018

Page 3 of 14

and Templates folder). This form will provide approvals for proper test setup, representative product content, test buck attributes and test requirements (as referenced in 3.5.1 thru 3.5.6).

Typical signatures include: Design Engineer, Validation Engineer, Analytical Engineer, Test Engineer and other Subject Matter Team (SMT) Engineers as required.

4.2 Conditions.

4.2.1 Environmental Conditions. Reference the SSTS paragraph information to specify the Environment conditions.

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 The interface between the test fixtures and the test property should be designed to prevent excessive local damage.

4.3 Instructions.

4.3.1 Requesting engineer, Designing Engineers (DE) and Computer Aided Engineers (CAE) shall inspect the test items to ensure all material is of the correct design level.

4.3.2 When material is ready to test, inspect for any preexisting cracks, paint chips, dents, poor adhesion of inner to outer panel and document any variation/deviation in the assembly. Welds/clinches should be inspected for location and quality. Inspect the area around the latch, striker, bumpers, and hinge attachments for metal deformation and cracks. (These areas will be reviewed during testing and post-test for any subsequent damage.)

4.3.3 Inspect height of latch and hood bumpers to ensure adequate flushness between hood and fenders in addition to static tension between the latch and hood striker. This parameter of adjustment affects measurements such as hood static latching effort, minimum hood drop height required for latching, and primary release effort.

4.3.4 If a pre-production build test property is being used and are unable to simultaneously obtain flushness to the fenders, proper seal margins, bumper margins and proper gaps to fascia/lamps, then the first priority should be given to the gaps between the hood and fascia/grill/lamps. Gaps are achieved by adjusting the latch, bumpers and fascia supports. Flushness to the fenders has the lowest priority. The seal margin, gaps and flushness should be reported on Data Sheet A2.

4.3.5 Verify that all fasteners are torqued to the specifications provided by the requesting engineer.

4.3.6 Mark all fasteners and adjustable bumpers so that any loss of torque or change in adjustment can be identified.

4.3.7 Make a mark perpendicular to the gap from the body to the hood at several points around the perimeter of the panel. Note the gap and flushness values at these locations. About two locations per side should be marked.

4.3.8 Assemble an actuator to the interior hood release handle. Methods of attachment are provided in GMW14276. A typical setup is shown in Appendix A, Figure A2. It is important that the primary latch release mechanism be installed so that it does not attempt to extend the release lever beyond its fully extended position to avoid overstressing the handle.

4.3.9 Assemble an actuator to the hood secondary handle. It is recommended that a small hole be drilled in the secondary handle and that a cable loop be strung through this loop and then attached to the pneumatic cylinder. Care must be taken when packaging the pneumatic cylinder so that it does not interfere with the secondary full range of motion and is representative of customer usage. The cylinder must be fixtured so that it does not degrade the body structure and does not come in contact with the hood inner panel. See Appendix A, Figure A3 for a typical setup.

4.3.10 Assemble proper test equipment to the hood fixture that will allow hood to be raised to the full open position. The lift device should enter the gap between the hood and the front fascia with the hood in the pop-up position.

4.3.11 Fixture the hood with proper test equipment to slam the hood shut. See Appendix A, Figure A4 for typical setups. If a rotational type of slam arm is used, adjust the fore-aft and vertical adjustments of the pivot point of the closing arm such that the slam arm pivot is in line with the hinge pivot location. This will allow the contact point of the slam arm to follow the arc of the hood. If the test property has a multi-link hinge, the pivot point of the slam arm will need to be adjusted to the average point of rotation of the multi-link hinge.

4.3.12 For hoods with gas struts, the hood should be lifted to the point where it will free rise. It is important that the hood not be lifted too fast and only to the free rise point or the strut seals might be damaged. A maximum

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March 2018

Page 4 of 14

speed of approximately 0.5 m/s should be used. Lower speeds should be used if it appears that 0.5 m/s is imparting excessive force to the hood.

4.3.13 For closing a hood with gas struts, the closing fixture should be set up to lower the hood at a maximum speed of 0.5 m/s to an angle just above the free rise point and then accelerate to the specified slam velocity. The push pad must be in contact with the hood before accelerating to the specified slam speed.

4.3.14 Attach the flag portion of the velocity measuring device to the closure panel to monitor slam speed (see photograph in Figure A4). The current SSTS specifies that the closing speed be measured at the latch. Typically, it is not possible to place the speed flag in a position that correlates striker position so an alternative location must be selected. It will then be necessary to determine the appropriate speed at the flag so that the proper speed at the striker is obtained. Measure the distance from the pivot point to the speed flag location and the length from the pivot point to the striker latch up point. Lengths must be analytically measured as physical measurements are often difficult to make, especially with multiple link hinges. If the specification is in radians per second, then you must first convert the speeds to meters per second by multiplying the speed by the length from the latch to the hinge pivot point (in meters). See Figure A5.

- $Vel_{New} = Vel_{Spec} \times Radius_{New} / Radius_{Spec}$.
- Vel_{New} = Adjusted Velocity at flag, meters per second.
- Vel_{Spec} = Specified slam velocity, meters per second.
- $Radius_{New}$ = Swing radius from hinge axis to flag, in meters.
- $Radius_{Spec}$ = Swing radius from hinge axis to latch up point, in meters.
- For multiple link hinges, CAE must identify the location of the instant center. This will be used not only for locating the velocity flag, but also for locating the pivot point of the closing arm.

4.3.15 The velocity meter should be positioned so that after the flag passes through the meter, the hood will just be coming in contact with the hook of the secondary handle.

4.3.16 Switches should be installed around the hood assembly to verify that the hood reaches the full open position, that the hood fully closes/latches and that the hood releases to the pop-up position after the primary release cable has been pulled. The program on the cycle controller should acknowledge these switches to verify proper operation of the hood. If the incorrect reading is obtained from a switch, the program should stop the test. If the hood latch has a built-in switch, this switch should be used to monitor when the hood is fully latched and released.

4.3.17 Before performing any function checks, the hood should have been left in the closed position for at least 24 h in order to ensure proper weatherstrip set. Cycle the hood by hand five cycles (5 times) to ensure proper operation and to reduce any hysteresis in the system. Refer to the SSTS for the measurements required. Typical test procedures that might be required are:

- GMW14830
- GMW15179
- GMW14274
- GMW14276
- GMW15095

See Data Sheet A1 for an example data collection sheet. When obtaining measurements in hot, cold or humid, the test property must be allowed to acclimate to the temperature before any measurements are taken. A 4 h soak is recommended.

4.4 Hood Cycle.

4.4.1 The hood fixture will unlatch the primary and then the secondary release mechanism.

4.4.2 The hood will be pulled/lifted open and assisted to the auto rise point. The hood will be allowed to auto rise to the full open position. If hood does not auto rise, the hood will be assisted to full open position.

4.4.3 The hood will then be pushed and/or pulled-closed to the free fall angle. The hood will then be slammed shut to the speed specified in the SSTS. See picture in Figure A1 for reference. When setting up the slam fixture, ensure that the fixture can accelerate the panel up to the desired velocity and then lets the panel "coast" through the velocity gate to closure. The fixture must allow the panel's inertia to complete the slam and not be forcing

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March 2018

Page 5 of 14



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