



Door System - Slam Durability Test

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 determine the door slam durability of door structures, components, and related systems.

1.2 Applicability. This procedure applies to all passenger, multi-purpose and commercial vehicles having conventional swing open door systems, and may also apply to single- or dual-acting endgate systems. The fixtures referenced in this procedure work on any door system, which swings approximately parallel to the ground.

1.3 Remarks. There are two (2) methods of performing door slam durability testing for those door systems to which this test applies (see 1.2).

1.3.1 This procedure describes actuation using a linear pneumatic cylinder or a rotary pneumatic/electric cylinder mounted to the interior of the test body. See GMW15885 for an accelerated slam durability test utilizing an electrohydraulic/electromagnetic shaker.

1.3.2 The method in this procedure (GMW15094) is used for validation. The accelerated method (GMW15885) is used for the prediction of structural fatigue of the door inner panel.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14269 GMW15885

2.3 Additional References.

- CG190 - Evaluation Report Template
- CG2913 - GMW15094 Door Slam Durability Pre-Test Checklist
- CG2919 - GMW15094 Door Slam Durability Post-Test Design Review Based on Test Results (DRBTR) Checklist
- CG4394 - Side Closures door slam video external supplement to GMW15094
- Global Door Subsystem Technical Specification (SSTS)

3 Resources

3.1 Facilities.

- **Major Facility:** The facility should have all of the equipment listed in Section 3.2 and be capable of providing the conditions required in Section 4.2.

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. For this test, either pneumatic linear cylinders or pneumatic/electric rotary cylinders can be used. An automated robot can also be used (see Figure A5), as long as it provides the same data and/or data record, with equivalent accuracy as specified herein or by the requester.

Note: Using rotary cylinders with linked arm fixturing is the preferred method as it is felt the “pulling angle” on the door using this method is more customer representative (see Figure A6)

3.2.1 Fixturing. Door slam on a fixture will require a rigid hinge pillar fixture (or equivalent stanchions), and a metal frame to mount the door. The fixture should simulate the body opening by providing points of contact with the door frame, e.g., weatherstrip, overslam bumpers, striker, hinge mounting locations, etc.

Note: Although important information can be gained in testing the door on a fixture, it is highly recommended for most effective validation that the door slam durability testing be performed on a body buck or vehicle.

3.2.1.1 Structural Metal Framing (such as Unistrut brand) to mount the air cylinders. See Figure A1.

3.2.1.2 One (1) or two (2) air cylinders (typically, 20 mm bore) per door, of sufficient bore and stroke to actuate the inside and/or outside door handle.

3.2.1.3 A handle adapter(s) to attach a cylinder to the inside or outside door handle. See Figure A2.

3.2.1.4 One (1) pneumatic air cylinder, either linear or rotary, (with air line fittings and clevis head attachment) per door, of sufficient bore to reproduce the specified door closing velocities. Electric rotary cylinders can also be used to open/close doors.

3.2.1.5 A pull-cup adapter that mounts to the door slam cylinder clevis and attaches to the door interior trim by means of a removable shoulder bolt. The fixture design will depend on the door type and the test objectives outlined by the requesting engineer. See Figure A3.

3.2.1.6 One (1) “sloppy link” per door, to connect the door cylinder to the pull-cup adapter or eyebolt. See Figure A1 and Figure A3. Also see 4.3.1.7 for more information in sloppy links and their design.

3.2.2 Instrumentation.

3.2.2.1 Four-Channel Door/Window Controller. A programmable control unit which monitors door slam velocity and adjusts air pressure to the pneumatic slam cylinders (or power to electric rotary cylinders) to maintain the programmed slam velocity. Door slam cycles, window cycles, inside or outside handle actuators, etc., are monitored and controlled to operate per each test's programmed setting.

3.2.2.2 Velocity blade/flag (for mounting to the door - one (1) per door) and the associated velocity gate for velocity measurement. See Figure A4.

3.2.2.3 Electrical leads with appropriate connectors to operate the power window regulators (if applicable).

3.2.2.4 Torque wrenches with capacities of approximately 1.5 times the fastener torque specifications.

3.3 Test Vehicle/Test Piece.

3.3.1 The test material should include a fully assembled, trimmed, heat-cured (per the production paint and bake process), production-representative door with all fasteners torqued to specifications.

3.3.2 Discuss with the requesting engineer whether a manual or power window regulator should be used. A power window regulator is usually preferred due to its greater mass.

3.3.3 If slamming on a body, then all representative hardware and weatherstrips should be present on the body opening and torqued to specifications.

3.3.4 Testing may include only partial door assemblies and fabricated hardware items for tests conducted for engineering information only.

Note: It is recommended that the test parts/assembly be dimensionally certified before testing is started.

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

Calendar time: 24 d

Engineer hours: 43 h

Technician hours: 26 h

Note: These time estimates are approximate averages. Actual times vary considerably depending on early component failures (and subsequent availability of replacement parts), testing to varying multiples of cycle lives, varying requirements for frequency of environmental test conditions, scheduling problems for test facilities, test equipment malfunctions, scheduling of overtime and/or multiple shifts, scheduling of “witnesses” for tests, actual

readiness of test samples upon receipt, unique or additional requests for detailed test information, running multiple samples (times shown are for one (1) system), etc.

These times consider preparation and other downtime, actual test, and analysis of data in capturing a total calendar time. Report writing, approval, processing, etc., are not part of these times.

3.5 Test Required Information. Testing worst case scenarios may uncover some potential problems. Discuss with the requesting engineer if testing should include some worst case scenarios. Depending on which test is being performed and which level of parts or systems is being tested, consider if any of the following may apply: tolerance stack-ups, build variations, misalignment, minimum/maximum fastener torque(s), lubrication, environmental extremes, location of customer representative load application, symmetry (Left Hand vs. Right Hand), color, mold or die source, etc.

The following specifications or information are required to run this test:

3.5.1 The slam and inspection schedule, including environmental conditions, use of inside and outside handles, and slam energies or velocities (refer to Global Door Subsystem Technical Specification (SSTS), 3.1.5.1).

3.5.2 The points/locations at which gap and flushness measurements should be taken, if applicable.

3.5.3 Torque specifications and whether to use the upper or lower limit or nominal value for each fastener.

Note: Minimum torque specifications are usually used in setting up for this test.

3.5.4 Any critical part thicknesses.

3.5.5 Window cycles, if any, to be performed simultaneously.

3.5.6 Pre-test material, setup, and functional checks (refer to 3.1.5.1 of the Global Door SSTS and Pre-Test Checklist CG2913).

3.5.7 Location on inside and outside handles to attach the actuators (simulating typical customer use).

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

4 Procedure

4.1 Preparation.

4.1.1 Sample Inspection.

4.1.1.1 The test and requesting engineers should inspect the test items to ensure all material listed in 3.3 is of correct design level and assembled properly. Check for cracks, paint chips, dents, etc., and document any variation/deviation in assembly, etc.

4.1.1.2 Use an ultrasonic thickness tester (or other suitable measuring tool, such as a micrometer for non-metal panels) to measure critical part thicknesses specified by the requesting engineer. Typical measurements include three (3) or more randomly selected locations on each door. Verify thickness measurements with the requesting engineer before beginning test setup. If parts were made from the wrong stock, or are out of specification, it may be worthwhile to postpone the test until they are corrected.

Note: While it is not necessary to remove paint and primer, it is suggested, for the highest degree of accuracy, to carefully remove paint, Electrophoretic Priming Operation (ELPO), etc., where the thickness measurements will be recorded. Be sure to use non-destructive, non-abrasive means (such as liquid paint remover) so the thickness of the part being measured is not altered.

4.1.1.3 For door slam on a body, the dimensions between the door and body opening should meet the requested specifications. All discrepancies should be discussed with the requesting engineer and appropriate action taken.

4.1.1.4 Check all door components for proper function and determine if rivets are secure and all fasteners are torqued to specification. Mark all fasteners so movement can be detected.

4.1.2 Sample Preparation.

Note: This test is normally run on the test subject in an "as received" condition. If it is requested to be run in a specifically adjusted condition, follow the applicable procedure(s).

4.1.2.1 If a complete vehicle is used, it may be necessary to purge the fuel system to test in environmental chambers and certain major facility areas.

4.1.2.2 If a power window regulator is used, connect power to it, so that the window position can be changed and so that dynamic braking can be used to prevent glass slippage during slams.

4.1.3 Facilities and/or Equipment Preparation. Record the instrumentation calibration information on Data Sheet A1 or an equivalent document.

4.2 Conditions.

4.2.1 Environmental Conditions. Unless otherwise specified in this document's text or by the requesting engineer, the typical environmental conditions for this test are the temperature, humidity and pressure at the major test facility (3.1.1). Unless otherwise noted, these conditions are typically $22\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$, relative humidity of $40\% \pm 20\%$, and atmospheric pressure equivalent to the local barometric pressure (which is variable during any given day and from day to day). The test will typically be run in hot, cold and humid environments as well, as described in the Global Door SSTS, 3.1.5.1.

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. See CG4394 for a short video showing the test setup and operation.

4.3.1 Setup Instructions.

4.3.1.1 Perform any functional/operational tests/evaluations as requested or as may be referenced in Section 2 References. Specifically, cycle the door and its components through at least five (5) cycles to ensure proper operation and seating of all system components. As applicable, note any irregular sounds or erratic operation indicating a potential problem with design, manufacture, or assembly and verify observations with the requesting engineer.

4.3.1.2 If performing door slam on a fixture, build a fixture to simulate the body side frame. Door to fixture gaps must approximate those on the vehicle. All body hardware which interacts with the door must be included on the fixture in their design location, e.g., striker, weatherstrip, overslam bumpers, etc. Actual portions of the vehicle may be incorporated into the fixture to improve the accuracy of test results. Anchor the fixture to prevent movement.

4.3.1.3 If testing a full vehicle (or Body in White (BIW)), remove the seats and possibly the front console, if applicable, to allow for installation of door slam fixturing.

4.3.1.4 If testing a full vehicle (or BIW), use structural metal framing to construct a frame, which is to be attached to the interior floor pan at the seat mounting points.

4.3.1.5 Fasten the door slam cylinder(s) to the frame.

4.3.1.6 Attach the appropriate door inner panel adapter or door trim adapter. See Figure A3.

4.3.1.7 Position the cylinders to allow the sloppy link and rod end assembly to move without binding. The rod end attached to the trim or inner panel adapter must rest in the approximate center of the sloppy link with the door fully closed and the cylinder rod fully retracted. This will prevent the cylinder from applying a load to the trim or inner panel when the door is fully closed.

Note: This is a critical point, because if the rod end is not centered in the sloppy link, unintentional loads may be applied to the trim or door panel, and it could lead to non-customer represented cracks in these areas. Extra care should be taken in the design of the sloppy link so there is ample space for the inner panel or trim to freely reverberate after each slam and not "bottom out" against the hard stops in the sloppy link. The slot in the sloppy link should be made long enough so this "bottoming out" is not a possibility. Care should also be taken in design of the sloppy link so that any vertical loads applied to the door from the cylinder attaching point is minimized.

4.3.1.8 Attach the appropriate door handle cylinders and adapters to the inside or outside handles, choosing a location a passenger would normally grasp. See Figure A2. The cylinder should apply only enough pressure to unlatch the door. If the cylinder continues to apply pressure until the handle moves to its positive stop, fracture of the handle or its attaching area could occur.

4.3.1.9 Mount the velocity gate on the exterior of the body (see Figure A4). Mount the velocity flag on the outer panel of the door. Connect the velocity gate electrical cables to the Four-Channel Door/Window Controller or equivalent controller.

4.3.1.10 If performing the door slam simultaneous with window cycles, attach the connector between the controller and the power window regulator.

4.3.1.11 Program the specified velocities into the controller. The controller in this test uses slam velocity to maintain consistent slam levels. If slam energies are specified, use procedure GMW14269 to determine the slam velocities that correspond to the slam energies required, and program the controller accordingly.