



Door Hinge System - Checkload Cycle 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 test is performed to determine the effects of repetitive checkloading on the entire door, hinge, check link, door pillar, and body pillar system. A checkload is a condition where the door is forced open beyond its already full open position.

1.2 Applicability. This procedure applies to all passenger, multipurpose and commercial vehicles having swing open doors. The check link may be integral to the hinge or it may be a separate component.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15612

2.3 Additional References.

- CG583 - Development/Validation Test and Vehicle Review Sign Off Sheet
- CG2914 - Door Checkload Rigidity and Durability (Test Procedure GMW15093) Pretest Checklist
- CG2920 - Posttest Design Review Based on Test Results (DRBTR) Check Sheets – Checkload Durability
- CG4393 - Side Closures Checkload Durability Video External Supplement to GMW15093
- Global Door Subsystem Technical Specification (SSTS)

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.

3.1.3 Major Facility. GM North America (GMNA) Body Test Laboratory or a similarly equipped test facility.

3.1.3.1 Minor Facility. An area that provides capability to tie down fixturing, e.g., flooring that incorporates T-Slots or a surface plate/bedplate. Refer to Appendix A, Figure A1.

3.2 Equipment.

Note: The following list(s) include fixturing and instrumentation typically used by the GMNA Body Test Laboratory to perform this test. Appendix A, Figure A1 shows the overall test setup that contains the fixturing and instrumentation in 3.2.2. Other equipment may be substituted at the discretion of the testing facility as long as it provides the same data and/or data record, with equivalent accuracy as specified herein or by the requestor.

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3.2.1 Fixturing.

3.2.1.1 Fixturing assembly that secures to the tie-down or bed plate area and holds the velocity sensor that measures the door's opening velocity at the latch area. Refer to Appendix A, Figure A1 and Figure A5.

3.2.1.2 Cushion(s) that will prevent the door from latching when it returns to its ajar position after each cycle. Refer to Appendix A, Figure A6.

3.2.1.3 If not using a body, a rigid hinge fixture, rigid hinge plate that simulates the body pillar, and a lock pillar fixture with cushion are all needed.

3.2.1.4 Rotary Arm Door Checkload Cycle Fixture Assembly. Refer to Appendix A, Figure A2, Figure A3, and Figure A4.

3.2.1.5 Two hundred millimeter (200 mm) spacer bar to hold the door open at a consistent position during door height measurements. Refer to Appendix A, Figure A7 and Figure A8.

3.2.2 Instrumentation.

Note: In the simplest form, a programmable controller is required that is capable of the following:

- Turning on and off individual pneumatic solenoids/valves to open and close the door.
- Keeping track of the cycle count.
- Measuring door velocity (this can either be part of the controller unit or a separate stand-alone device).

3.2.2.1 Historically, the GMNA Body Test Laboratory uses a Micromaster Brand programmable controller.

3.2.2.2 Pneumatic solenoid valve assembly with **center off** position and dual manual air pressure regulators, one (1) for each port. Two (2) inline flow control valves, per door; one (1) for door opening and one (1) for door closing.

Note: In the programmable controller mentioned in 3.2.2.1, the proportional air regulator takes the place of the manual regulators.

3.2.2.3 Velocity blade/flag, mounted to the door, one (1) per door, and accompanying velocity gate sensor for velocity measurements. Refer to Appendix A, Figure A1 and Figure A5.

Note: The preferred programmable controller in this case is one (1) capable of controlling the door opening velocity in a closed loop fashion, (i.e., the controller monitors the door opening velocity and makes any fine tune pressure adjustments to a proportional air regulator after each cycle in order to maintain the prescribed door opening velocity to a very consistent level).

3.2.2.4 Torque wrench(es) with a range approximately 1.5x the maximum torque(s) specified. Refer to 3.5.

3.2.2.5 Height gage to measure the door's vertical rise/sag height at the 200 mm door open position. Refer to Appendix A, Figure A9.

3.2.2.6 Proximity Sensors to detect successful door open and door ajar positions. Refer to Appendix A, Figure A1.

3.3 Test Vehicle/Test Piece.

3.3.1 Test Material.

3.3.1.1 A vehicle body is preferred, but may be replaced by fixtures. The test system should include fenders, fully assembled doors, and door hinging system with integral or separate check link. The body, doors, and hinges should have been through the production paint/bake process to fully cure all paint, all adhesives, and to anneal the hinges, and the internal hinge springs, if applicable. It is recommended that the door and door hinge assembly be dimensionally certified before testing is started.

3.3.1.2 If a fully assembled door is not available, a door with no content may be used as long as it has been through the production paint/bake process. The missing mass, however, must be added to the incomplete door system at the approximate center of gravity to simulate a fully built door system. Special care should be taken when securing the added mass to prevent its movement during testing.

3.3.1.3 For off-body testing, determination of the hinge locations should be obtained from release drawings.

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

Calendar time:	16 d
Engineer hours:	17 h
Technician hours:	15 h

Note: These time estimates are approximate averages. Actual times vary considerably depending on many factors, including early component failures and subsequent availability of replacement parts, testing to varying multiples of cycle lives, varying requirements for frequency of environmental test conditions, test facility scheduling conflicts, 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. The requesting engineer is responsible for providing specifications appropriate to the particular vehicle line being tested (refer to Global Door SSTs).

Test properties are usually set to nominal torques, gaps, etc., but 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 versus right hand), color, mold or die source, etc.

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.

4 Procedure

4.1 Preparation.

4.1.1 Sample Inspection. The test and requesting engineers should inspect the test items to ensure all material listed in 3.3.1.1 is of correct design level and assembled properly. Document any variation/deviation in assembly, etc.

4.1.2 Sample Preparation. 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 any applicable procedure(s).

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

4.1.4 Pretest Checklist. For additional information on correct test and material preparation, reference document CG2914, Door Checkload Rigidity and Durability (Test Procedure GMW15093), the pretest checklist for the checkload durability evaluation.

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 °C ± 3 °C, relative humidity of 40% ± 20%, and atmospheric pressure equivalent to the local barometric pressure which is variable during any given day and from day to day.

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 CG4393 for a short video showing the test setup and operation.

4.3.1 Setup Instructions. Perform any functional/operational tests/evaluations as requested in the test checklist for door checkload rigidity in GMW15612, and check cycle durability in Appendix A, Data Sheet A3 of this standard, or as may be referenced. 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.

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4.3.1.1 If testing doors on a body, position the body in the center of the tie down slot area. Tie down the body to the slot using turnbuckles. Refer to Appendix A, Figure A10. This is typically done through the body's shock towers.

4.3.1.2 If not mounted to a body or vehicle, mount the door, with production intent hinges, to the hinge pillar fixture in body position. Position the lock pillar fixture in approximate body position.

4.3.1.3 Torque all hinge bolts/nuts as specified by the requesting engineer (refer to 3.5).

Note: Due to past experience, deliberate misalignment of the hinge centerlines may be of interest to the requesting engineer. Maximum misalignment may be used to represent production build variation (refer to 3.5).

4.3.1.4 Scribe or mark the position of the hinges relative to the door and body (or fixture) to detect any movement. Scribe a line around the door hem flange to detect any movement or separation of the hem.

4.3.1.5 Paint or mark the hinge bolts/nuts to detect bolt/nut movement, both shifting and any loss of torque

4.3.1.6 Open the test door, and install the 200 mm spacer bar between the door latch and the body striker. With the door in the 200 mm open position, scribe a horizontal line on the latch face of the door using the height gage with scribe attachment to aid in determining door rise/sag during the test. Refer to Appendix A, Figure A7 through Figure A9.

4.3.1.7 Position the rotary cylinder pivot/axis of rotation as close as possible to the door's hinge-pin centerline and then secure the Rotary Arm Door Cycle Fixture to the tie-down slot or surface plate (i.e., ground). Refer to Appendix A, Figure A2.

4.3.1.8 Mount the slider block assembly to the bottom rearward hem flange of the door (refer to Appendix A, Figure A2, Figure A3, and Figure A4) and adjust the receiver assembly to mate with the slider block.

4.3.1.9 Adjust the rotary cylinder so that the door can travel its full arc without the rotary cylinder reaching its end stroke and without any binding of the slider block assembly to the receiver assembly.

4.3.1.10 Attach a cushion to the striker area on the body to prevent the door from closing completely to a latched condition. Refer to Appendix A, Figure A6.

4.3.1.11 Mount the velocity meter so that it can measure how fast the door is traveling linearly at the latch face. Position the meter to capture the speed as close as possible to when the door reaches its full open position; but the speed must be captured prior to any influence from check link damping or other means of energy absorption. This should result in a position between the last and the second (2nd) to last detent position prior to door full open. Refer to Appendix A, Figure A6.

4.3.1.12 With the air supply turned off; connect the air lines from the pneumatic valve assembly to the rotary cylinder.

Note: Whether using a simple control system or a fully automated closed-loop system, the fundamental cycle needs to consist of the following control variables:

1. Time, pressure, and flow rate control/adjustment when supplying air to open the door prior to recording the opening velocity.
2. The means to measure the door's opening velocity after the opening pressure has been turned off and prior to the door inertia carrying it into the full open and checkload condition.
3. Pause time between the door opening and closing events as the door is traveling freely into its full open checkload position and then bouncing back.
4. Time, pressure, and flow rate control/adjustment when supplying air to close the door to its ajar position after it has started to bounce back from its checkload event.
5. The means to determine if the door has completed a successful cycle and then count and control the number of cycles to be performed.

Note: The sequence of events listed in 4.3.1.12 through 4.3.1.15 pertain to a **simple** Micromaster type controller.

4.3.1.13 For either the simple or advanced control system being used for this test, enter the appropriate starting values for the control variables listed in 4.3.1.12 (1 through 5).

Note: An example of a typical Micromaster Controller Program is provided in Appendix A, Table A1. Modify the program as needed to obtain the desired test cycle as described in 4.3.1.12. There are many combinations of

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airflow, air pressure, and valve timing when opening, closing, and pausing the valves that may be used to obtain a desired cycle.

4.3.1.14 Adjust the flow control valves to an almost closed position to ensure that the first cycle will not exceed the desired door opening velocity or close the door with excessive force, turn on the air supply, start the program, and then open these flow control valves, adjust times, adjust pressures, etc., to achieve the desired cycle outcome.

Note: If the specification requirements list a velocity to run each durability cycle to, the flow control valve pressure will be adjusted to achieve that desired result. However, if the requirements given are defined by a check force, then record the velocity required to reach the same deflection as is achieved under the prescribed check force, and run the durability cycles to that corresponding velocity (4.3.2.3).

Note: If **damping** features are included in the design of the check link, consult with the validation engineer and product engineer to confirm the appropriate velocity determination.

4.3.1.15 Recommended cycle rate is 300 cycles/h.

4.3.2 Test Operation Instructions.

4.3.2.1 Perform the Door System Checkload Rigidity Structural Test (GMW15612) prior to beginning the Door Hinge System - Checkload Cycle Durability Test (GMW15093). Follow the instructions per procedure GMW15612. The loads and number of cycles administered for the rigidity test are dictated by the Subsystem Technical Specification (SSTS) and this information will be provided by the requesting engineer (refer to 3.5).

Note: This test may be destructive to the door system. As a result, some product platforms have requested that the abusive checkload cycle be conducted on a separate door system.

4.3.2.2 Using the 200 mm spacer bar and the initial scribe mark at the latch face of the door, recheck the door height. Record the amount of door rise or sag.

4.3.2.3 Turn on the air pressure, start up the controller, and begin the checkload cycle portion of the test, making sure to adjust the control variables to get the required door opening velocity (if not using a closed loop velocity control system).

4.3.2.4 Run a specified total number of cycles in specified cycle increments (refer to 3.5). For each specified set of cycles, check the hinges, spot welds, DIW (door in white) etc., for cracking. Check the fasteners and hinges for any loss of torque or shifting/movement. Perform any other checks specified by the requesting engineer.

4.3.3 Posttest Instructions.

Note: Every posttest operation/measurement/inspection must typically have a pretest equivalent to have any meaning or significance. A crack detected at end of test means nothing unless there is pretest documentation verifying no crack existed prior to start of test.

At the end of specified cycles, check and record all areas for visible deformation, such as hinge mounting surfaces on the door and hinge pillar, hem and/or hinge separation or movement, and weld and hinge failures. Also inspect the door for interference with the body structure or fixture. Use crack detection spray to check the door, hinges, hinge pillars, and check links (if applicable) as needed to confirm any suspected cracks. Perform all functional tests and measurements as requested.

Refer to CG2920 Posttest DRBTR (Design Review Based on Test Results) Check Sheets – Checkload Durability located in the Global Document Management (GDM) database, for more posttest checks and information.

5 Data

Unless otherwise requested in 3.5, no specific format for data presentation is required (other than as may be required by various report record systems). Appendix A, Data Sheet A2 is provided for convenience only, and is not required to be used, but any alternative data sheet(s) should record equivalent data.

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. Not applicable.

5.3 Test Documentation. Fill out information on Appendix A, Data Sheet A2 to document other items.

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6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

Check Link: A device that limits the angular travel of a door. It typically includes check stops (for maximum open position) and detent positions (to hold the door in intermediate positions between closed and check positions).

Checkload: A load applied to a door structure when attempting to open it beyond the full open position.

7.2 Acronyms, Abbreviations, and Symbols.

A	Analysis
D	Development
DIW	Door in White
DRBTR	Design Review Based on Test Results
GDM	Global Document Management
GMNA	GM North America
GSSLT	Global Subsystem Leadership Team
LF	Left Front
LR	Left Rear
Max.	Maximum
Min.	Minimum
No.	Number
OSRV	Outside Rearview
RF	Right Front
RR	Right Rear
SSTS	Subsystem Technical Specification
V	Validation

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW15093

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