



Body Structure General Fatigue and Durability and Test Setup Procedure

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 procedure is to document general fixturing and load application techniques to be used when testing Body-In-White (BIW), portions thereof and their interfaces. This procedure is intended to provide guidance with respect to fixturing when a test of a BIW is to be developed to solve a particular problem or concern. These fixturing techniques are general in nature and are based on the cumulative experience of running similar tests to resolve various problems. They are intended to be adapted, to the particular requirements of the problem or incident to be addressed.

1.2 Applicability. This procedure applies to all passenger cars, light-duty trucks, and medium-duty trucks. There are many applications for this type of procedure including, but not limited to, front and rear strut towers, spring seats, rear package shelf, and cradle attachments. This procedure may be run for the purposes such as product problem solving, analysis model verification, development, or in limited circumstances validation.

1.3 Remarks. This test procedure describes test techniques for fixturing a full or partial body structure or subsystem for loading. The techniques described in this procedure can be used regardless of the type of load input, whether it is real time multi-axial, block cycle, constant amplitude, or quasi-static.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14048 (ID)	GMW15223	GMW15243	GMW15245
GMW15219	GMW15232	GMW15244	GMW15269

(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.

2.3 Additional References.

Body Structure Subsystem Technical Specification (SSTS)
CG190 GM Evaluation Report Format Template
CG583 Test and Vehicle Review Form
Component Technical Specification (CTS)
Vehicle Technical Specification (VTS)

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.

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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. Use facilities that have the test equipment described in 3.2, provide the conditions listed in 4.2, and are able to support servo hydraulic testing.

3.1.4 Minor Facility.

3.1.4.1 Bedplate and Surrounding Area. Approximately 5 m (length) x 4 m (width) of bedplate space is needed, depending on the length and width of the body structure and size and placement of the actuators.

3.1.4.2 Overhead Crane. An overhead crane (or other lifting device) of sufficient capacity to lift the body structure and allow installation onto bedplate.

3.1.4.3 Hydraulic System. The system should be capable of supplying pressurized oil at a sufficient flow rate to meet the maximum test rig demand. The load input equipment may include one or more hydraulic actuators under closed loop control.

3.2 Equipment. The following list(s) include fixtures and instrumentation typically used to perform this test. 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.

3.2.1 Actuator(s). Servo-hydraulic actuator(s) and controller capable of reproducing the loads and motions referenced in 3.5.

3.2.2 Fixtures. See Appendix A, Figure A1 thru Figure A16.

Note: The specific fixturing required will vary depending on the area of the body to be evaluated.

3.2.2.1 Sufficient stanchions, braces, angles, beams, pivots, etc., (and associated attaching hardware) to mount the BIW or portion thereof under test. **Note:** Depending on the structural components under analysis, the following may be needed:

3.2.2.1.1 C-clamp Fixtures. The clamps should be large enough to fit around the rocker panels. See Figure A9.

3.2.2.1.2 Shock Tower or Strut Mounts. See Figure A2, Figure A3, Figure A7, Figure A10, Figure A11, Figure A12, and Figure A15. **Note:** When the area of interest is local to where the actuators are to be attached, it is important that the attachment utilize the actual interfacing part (or portion thereof) in order to achieve a representative load path.

3.2.2.1.3 Fixture to support the actuator at the desired position and be of the appropriate stiffness so as to induce representative loads. This may be accomplished by using a variety of angle stands, bars, brackets or other hardware.

3.2.2.1.4 Depending on the body structure geometry, various hardware (e.g., bell cranks) may be needed to connect to the loading fixture to allow for clearances around other structural components.

3.2.2.1.5 Torque wrench.

3.2.2.1.6 Scriber, paint pen, or similar marking device.

3.3 Test Vehicle/Test Piece.

3.3.1 One (1) BIW is generally recommended. If a body section is deemed acceptable by the requesting engineer, it may be substituted. If only a section of the BIW is to be used, it should be large enough to allow it to be fixtured such that loads, deflections, and strains in the areas of concern are representative. The test properties may be prototype, or production depending on availability and level or design correctness desired.

3.3.2 As applicable, the BIW or portion thereof should be baked and cured per the production paint process before the analysis begins. This assures proper curing of any adhesives or sealants. Fixed glass, closure panels, sub-frames, or other structural contributors should also be installed when they are expected to affect the results.

3.3.3 It is recommended that the parts/assembly be dimensionally certified before analysis is started.

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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, i.e., Test hours: 11 days; One (1) Front Strut Tower. See Figure A18 for a typical test plan.

Calendar time: 10 days

Test hours: 25 hours

Coordination hours: 5 hours

Note: These time estimates are approximate averages. Actual times vary considerably depending on early component problems (and subsequent availability of replacement parts), testing to varying multiples of cycle lives, varying requirements for frequency of environmental test conditions, scheduling of test facilities, test equipment malfunctions, scheduling of overtime and/or multiple shifts, actual readiness of test samples upon receipt, unique or additional requests for detailed test information, running multiple samples (times shown are for one 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. The methods described in this procedure are typically used to address a specific concern or issue. The input of the Test, Design, Analysis, and Validation engineers is valuable in developing a test to address the particular issue or concern.

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 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 may be required to run this test.

3.5.1 Durability Cycle Requirement. These specifications can be found in the Body Structure Subsystem Technical Specification (SSTS).

3.5.2 Fastener Torque Specifications. Unless otherwise specified, using the minimum torque values for any fasteners is recommended. Critical components should be assembled using the production representative tools and processes when it is expected that it will affect the results.

3.5.3 Known concerns or issues to be addressed and the conditions or inputs which are believed to have contributed to it.

3.5.4 Loads Data. Data may come from several sources. A common source is Road Load Data Acquisition (RLDA) and can also be created from past program tests, and analytical models, or lab created data profiles.

3.6 Personnel/Skills. Prior experience/training in setting up and running similar tests and experience/training in the use of the referenced test equipment are preferred for a successful evaluation. This experience is also critical to achieving the estimated times shown in 3.4.

4 Procedure

4.1 Preparation.

4.1.1 Test Setup Agreement. Prior to commencement of testing, the responsible test engineer, and product engineer or engineers, if applicable, shall agree and document the agreement on a CG583 Test and Vehicle Review Form (e.g., GM CG583).

4.1.2 Test Planning. Create a test plan that details the timeline of events that are to take place in executing this procedure. See Figure A18 for a typical test plan.

4.1.3 Pretest Sample Inspection. The test and requesting engineer(s) should inspect the test items to insure all material listed in 3.3 is of correct design level and assembled properly. Note and record areas of visible metal deformation, cracks, etc., at or near the area being studied (See 3.5). The requesting engineer should be notified if these conditions exist and determine if the body structure should be replaced before testing begins.

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

4.1.4.1 If a change to the body structure includes adding hardware to the body structure or adjusting component position and specific directions are not given, then the change should be done following

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appropriate product assembly specifications, orientation, fit, assembly specifications, etc., for the system being evaluated.

4.1.4.2 Spray white stencil ink on areas of particular interest. This will enable visual inspections of the areas for cracks, etc.

4.1.4.3 Fasteners should be indexed with a paint pen, torque seal, or equivalent, in order to detect movement of the fasteners. Straight lines should be made from the center of the fastener head to the component that the fastener connects to.

4.1.4.3 For testing where it is necessary to check the closure gaps, straight lines (horizontal and/or vertical as needed) should be applied to assist in visually evaluating sag during the test (see Figure A17).

4.1.5 Facilities and/or Equipment Preparation. Record all site and instrument calibration information on Appendix A, Data Sheet A1.

4.1.6 Standard Data Preparation. The following procedures provide guidelines for the processing of data, if required.

- GMW15219 Standard Laboratory File Naming and File Extension Naming
- GMW15223 Calculating Coherence
- GMW15232 Generic Data Processing Flowchart with Annotations
- GMW15243 Data Verification
- GMW15244 Energy Editing Method
- GMW15245 Real Time Test Development Correlation Criteria
- GMW15269 Structural Durability Pseudo-Fatigue Analysis

4.2 Conditions.

4.2.1 Environmental Conditions. Unless otherwise specified in this document text or by the requesting engineer, the typical environmental conditions for developing this test are the temperature, humidity, and pressure at the major test facility (3.1.3). Unless otherwise noted, these conditions are typically 15 °C to 32 °C, (60 °F to 95 °F), and atmospheric pressure equivalent to the local humidity and 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.

4.3.1 Load Input Development. Applicable loads data should be processed using the procedures referenced in 4.1.6.

4.3.2 Setup Instructions for Full or Partial Body Structure Durability. See Figure A1 thru Figure A16 for examples of body support setups.

4.3.2.1 Figure A1, Figure A3, Figure A4, Figure A5, and show a body fixtured appropriately for front shock tower or other suspension/powertrain attachment loading. This type of fixturing is for use when only the local area of the attachment is of interest.

4.3.2.1.1 As only the local attachments are of interest the body can be held rigidly at the rockers, cradle mounts, or other areas. See Figure A1, Figure A5, Figure A6, Figure A7, Figure A8, and Figure A9.

4.3.2.1.2 It is important that the interface with the attachment be representative. Often an adapter is made utilizing an actual attaching component, modified to interface with actuator or fixturing. Figure A10 shows an adapter made from a strut to be used for loading a shock tower. Figure A4 shows an attachment where a standard rod end fitting is suitable as an attachment interface between the actuator and mount.

4.3.2.2 Figure A7, Figure A11, and Figure A15 show a typical fixturing appropriate for testing larger areas of the body with respect to global (or almost global) body torsion. Areas often evaluated are shock towers, rear seat diagonals, front of dash, and roof structure. It is critical to position grounding and load application fixtures to produce the correct load paths, deflections, and strains through the area of concern.

4.3.2.2.1 It is important to allow the body to deflect in a manner consistent with the mode you are trying to simulate, while constraining it from moving in other directions. See examples in Figure A7, Figure A11, Figure A13, Figure A14, and Figure A15. It is also important to apply the load in such a way that no bending

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moment, due to deflection in the test object, will occur in the actuator piston. One way to prevent that is to use a ball bearing (pivot bearing) in both ends of the actuator as shown in Figure A6.

4.3.2.2.2 Often pivot bearings are used to allow the body to rotate about a longitudinal axis, while preventing it from translating in fore/aft, lateral, or vertical directions. See Figure A7, Figure A11, Figure A13, Figure A14, Figure A15 and Figure A16. When using bearings it is best to consult Computer Aided Engineering (CAE) models to help locate the bearing along the body's natural axis of rotation.

4.3.2.3 Prepare the hydraulic actuator. For some tests, it may be advantageous to use an actual or fabricated component interface. The test setup should be agreed to prior to test equipment assembly. Reference Figure A10 for an example.

4.3.2.4 Install hydraulic actuator assembly into position as agreed at the correct load vector. Attach firmly to the bedplate.

4.3.3 Test Development. The test development goal is to reproduce the characteristic response in the areas of interest affecting the issue identified in 3.5.4.

4.3.4 Instructions.

4.3.4.1 Operation Instructions.

4.3.4.1.1 Use the appropriate technique to achieve the desired loading or response without introducing undesired loads.

4.3.4.1.2 Conduct the test with the appropriate drive file(s) or the number of test cycles as defined in the Durability Cycle Requirement (3.5.1) or by the requesting engineer.

4.3.4.2 Photograph Test Setup.

4.3.4.2.1 After pre-test assembly, inspections, and preparations are complete, commence testing. Monitor test periodically and look for unusual wear, leaks, abrasions, or equipment malfunctions.

4.3.4.2.2 At each inspection period (per the current lab standard), visually inspect the load interface and the surrounding area. Any cracks or unusual wear should be recorded on the lab data sheet. Reference GMW14048 and any specific inspection instructions/criteria on the Test and Vehicle Review Form or Test Request. The actuator assembly and interface simulation should not be removed, unless absolutely necessary. Repositioning fixture in exactly the same location is difficult, and any difference in location can affect the accuracy of the command signal reproduction.

4.3.4.3 Posttest Sample Inspection.

Note: Every posttest operation/measurement/inspection must typically have a pre-test equivalent to have any meaning or significance. For example a crack detected at end of test means little unless there is pre-test documentation verifying no crack existed prior to start of test, as it cannot be determined when the crack occurred. Inspect the area for cracks, part separation, damaged welds, fastener movement, etc, and note in the final test report.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results. The results should be interpreted with respect to GMW14048, the applicable Vehicle Technical Specification (VTS), SSTS, or Component Technical Specification (CTS) requirements, and any specific instructions or criteria included in the Test and Vehicle Review form or the Test Request.

5.3 Test Documentation. Test documentation/Report Format. The final test report shall be presented in a format consistent with the CG190 GM Evaluation Report Format Template. Damage and findings should be documented in a test report that includes cycle chart and photographs, as well as setup.

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.

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7 Notes

7.1 Glossary.

Actuator: Any device (i.e., Servo-hydraulic actuated cylinder) capable of producing/applying the required loads.

Bell Crank: A lever with two arms that share a fulcrum at the point where they join.

Body Structure: The primary structure of the vehicle which includes the body, any significant structural members that may affect the stiffness of the body structure when the structural component or component interface is being evaluated.

Real-Time Data: Data recorded by either strain-gauged components or onboard transducers while driving actual prototype or production vehicles over known surfaces, shipping the vehicle, or using the vehicle in another manner (e.g., slamming a closure).

Servo-Hydraulic Controller: A hydraulically powered closed-loop feedback and control device that is able to adjust/control the actuator in order to reproduce a predetermined loading or motion.

7.2 Acronyms, Abbreviations, and Symbols.

BIW	Body-In-White
CAE	Computer Aided Engineering
CTS	Component Technical Specification
RLDA	Road Load Data Acquisition
SSTS	Subsystem Technical Specification
VTS	Vehicle Technical Specification

8 Coding System

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

Test to GMW15833

9 Release and Revisions

This standard was originated in March 2008. It was first approved by the Global Body Structures Team in February 2009. It was first published in February 2009.

Issue	Publication Date	Description (Organization)
1	FEB 2009	Initial publication.
2	OCT 2014	5 Year Refresh. (Body – Structural Durability Global Subsystem Leadership Team)

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Data Sheet A1: Instrument Calibration Record

Activity Request Number	Test Name	Sample/Vehicle Number	Engineer	Technician

[illegible]

Author Signature: _____ Date: _____ Phone/Pager: _____

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Note: The photos and examples contained in this document are for illustrative purposes only, and do not necessarily represent the most current practice, designs, configurations, or constructions.



Figure A1: Example Where the Rocker Panels are Clamped Between Two Cross Beams

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