



Wheel Lateral Impact 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. This standard is intended to provide details for determining the ability of passenger car and light duty truck wheels to sustain a lateral curb impact.

1.2 Applicability. This test procedure is applicable for steel and light-alloy wheels intended for normal highway use and temporary use for passenger car vehicles, light duty trucks including dual wheel usages, or multipurpose vehicles.

1.3 Remarks. This standard establishes a uniform testing technique that assesses wheel structural degradation due to lateral impact for the purpose of evaluating wheel design conformance to specifications. The test is based on SAE International recommended practice Wheels-Impact Test Procedure-Road Vehicles, SAE J175, International Organization for Standardization (ISO) recommended practice Road Vehicles-Light Alloy Wheels-Impact Test, ISO 7141, and Japan standard Test for Light-Alloy Disc Wheels, TRIAS 09-J002-001.

2 References

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

2.1 External Standards/Specifications.

ISO 7141 SAE J175 TRIAS 09-J002-001

2.2 GM Standards/Specifications.

GMW16590

2.3 Additional References.

- Component Technical Specifications (CTS)
- GHI Systems, Incorporated, San Pedro, California (www.ghisys.com)
- GM wheel drawings
- National Institute of Standards and Technology (NIST), U.S. Department of Commerce, Gaithersburg, Maryland (www.nist.org)

3 Resources

3.1 Facilities. Roofed facility that ensures striker free fall is unfettered and that the rubber mounts do not deteriorate between calibration events.

3.2 Equipment.

3.2.1 Zyglo or equivalent dye penetrant crack inspection media.

3.2.2 Hand tools, various as required.

3.2.2.1 Torque wrench capable of applying and measuring requested torque values. Torque measurements shall be accurate within $\pm 3 \text{ N}\cdot\text{m}$ ($\pm 2.2 \text{ lb ft}$).

3.2.2.2 Paint pens as needed, refer to 4.1.2.2 for required colors.

3.2.3 Test Machine Requirements. A test machine approved by GM, which shall be constructed per SAE J175.

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3.2.3.1 Path of striker mass is constrained to the plane perpendicular to earth and impact support fixture base plate. Constraining system must not absorb energy during drop or impact of the striker mass.

3.2.3.2 The striker face shall be at least 125 mm (5 in) wide and at least 375 mm (15 in) long as described in SAE J175, figure titled Impact loading test machine. Striker face shall be parallel to the horizontal within ± 0.5 degrees.

3.2.3.3 Impact support fixture shall be at an angle of 13 degrees ± 1 degrees from horizontal. Impact support fixture shall have rubber mounts as described in SAE J175, figure titled Calibration of rubber mounts.

3.2.3.4 A system for adjusting striker mass within $\pm 2\%$ of the required test load value.

3.2.3.5 A system for measuring striker mass velocity, recorded in time (milliseconds).

3.2.3.5.1 The striker mass velocity is described as the time it takes for a 25.46 mm (1.0025 in) gate timing blade to pass through a sensing gate when the blade exits the gate at an approximate height of 2 mm (0.080 in) above the highest point of tire-wheel assembly.

3.2.3.5.2 Gate timing blade and sensing gate shall be calibrated as a unit and have less than $\pm 2\%$ error.

3.2.3.5.3 GM approved velocity monitoring system: VS200 Velocity Monitor and Optical Sensor available through GHI Systems, Incorporated.

3.2.3.6 A system for measuring tire pressure having a minimum accuracy of ± 2 kPa (± 0.5 psi).

3.2.3.7 It is recommended, from a safety aspect, that a system be in place to remotely monitor and relieve tire pressure.

3.2.3.8 Wheel adapters for specified fastener sizes and wheel bolt patterns.

3.2.3.9 Wheel attaching fasteners, as specified.

Note: Fasteners are wheel design dependent.

3.3 Test Vehicle/Test Piece.

3.3.1 Test Wheels. All wheels shall be fully processed, except cast and forged aluminum wheels. All wheels shall be manufactured to minimum stock thickness conditions, unless otherwise stated by the requester.

3.3.1.1 Two (2) wheels are typically required for testing, unless otherwise specified by the requester. One (1) wheel shall be impacted on a spoke and the other at a vent window.

3.3.1.2 Cast, cast flow-formed, forged or forged flow-formed aluminum wheels shall not be clear coated or painted, but shall be otherwise fully processed, including all shot blasting, polishing, paint curing oven exposure or plating.

Note: Wheels shall not be shot blasted if shot blasting is an optional manufacturing process.

3.3.1.3 Cast, cast flow-formed, forged or forged flow-formed aluminum wheels that are flange designed (for clip-on balance weights on the curb side) may require testing for both minimum and maximum material thickness conditions, if specified by the requester. In these cases, there will be four (4) wheels required for testing: two (2) wheels with maximum flange material thickness and two (2) at the minimum flange material thickness.

Note: Requester shall supply rim flange thickness value for each wheel, as required.

3.3.1.4 Cast aluminum wheels shall be fluoroscope evaluated, prior to test. The spoke having the highest fluoroscope value shall be identified with the fluoroscope value using a red paint pen (refer to 4.1.2.2).

3.3.2 Test Tires. Test tires are identified on GM wheel drawings. Otherwise, use a tire with the smallest nominal section width released for the vehicle.

3.3.3 Fastener. Fasteners (identified on GM wheel drawings), or equivalent shall be used.

3.4 Test Time.

Calendar time: 5 days (maximum)

Test time: 6 h

Coordination time: 1 h

3.5 Test Required Information. Test load is stated on the wheel drawing, and is described by SAE as D Striker Mass Value (kilograms) (refer to Appendix B, Section B1 for calculation, if not otherwise specified).

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3.5.1 Drop Height.

3.5.1.1 Drop height is the distance from the bottom of the striker face to the highest point on the wheel rim, and shall be 230 mm (9.0625 in) plus, as needed, the increase in drop height needed to overcome system friction in order to perform a 9.81 m/s² drop.

3.5.1.1.1 Increase drop height accordingly to meet the requirements of a 9.81 m/s² free fall from a starting height of 230 mm (9.0625 in). Determine ideal gate time either by analytical method shown in Appendix C, Section C1 "Determining Ideal Gate Time", or graphically as described in Appendix C (Figures C1 and C2). The ideal gate time value is used to verify that the striker/striker mass unit drops in a frictionless free fall. Allowable gate time variance is 0%, +2%, otherwise stated as; a maximum of 2% slower time value than ideal gate time.

3.6 Personnel/Skills. Test operator shall be qualified on the basis of appropriate education, training, experience, and/or demonstrated skills.

4 Procedure

4.1 Preparation.

4.1.1 Calibration.

4.1.1.1 Impact support fixture shall be calibrated per SAE J175 requirements, as described in SAE J175, Figure 2.

4.1.1.1.1 A test calibration adapter must be located at the mid span of the steel beam (which supports the wheel hub adapter).

4.1.1.1.2 With a 1000 kg (2200 lb) load applied to the calibration adapter, the vertical central deflection of the test fixture shall be 7.5 mm $\pm$ 10% when measured at the center of the beam. System shall be calibrated every six (6) months.

4.1.1.2 The fixed (non-removable) carriage/striker mass should be calibrated to have a single mass value, calibrated once every ten (10) years.

4.1.1.3 The removable mass weights shall be calibrated individually, once every ten (10) years if made from ferrous materials. Otherwise, if mass weights are made from softer materials, such as lead or aluminum, calibrate annually.

Note: There should be a sufficient number of removable weights to obtain the required test load within $\pm$ 2%.

Note: All load cells used to calibrate equipment shall be traceable to the National Institute of Standards and Testing (NIST).

Note: All weights used for calibration shall meet NIST Class F tolerances.

4.1.1.4 The velocity sensor shall be calibrated per the manufacturer's recommended procedure. All other calibration items shall be calibrated at least every six (6) months.

4.1.2 Pretest Inspection.

4.1.2.1 All wheels shall be inspected for cracks prior to test. Observations shall be documented on the test data sheet and wheel (refer to Appendix A, Figure A1).

4.1.2.1.1 Use Zyglo or equivalent dye penetrant crack inspection media.

Note: Non-cast aluminum wheels with apparent cracks are unacceptable for testing unless approved by the requester.

Note: All other wheels (cast aluminum wheels and steel wheels) with apparent cracks are acceptable for testing.

4.1.2.2 Marking Wheel Cracks.

4.1.2.2.1 Use a fine point marker (paint pen) that will not be removed by materials used during subsequent crack inspections.

4.1.2.2.2 Mark ends of crack with small lines.

4.1.2.2.3 Color code crack marks as follows.

4.1.2.2.3.1 Black for pretest inspection of light colored wheels.

4.1.2.2.3.2 Yellow for pretest inspection of dark colored wheels.

4.1.2.2.3.3 Red for end of test inspection and fluoroscope value.

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4.1.2.2.4 Photograph all cracks.

4.1.2.3 Data Sheet Documentation. Record observations on data sheet (refer to Appendix A, Figure A1). Refer to Appendix D, Section D1 and Figure D1, for crack location codes.

4.1.2.3.1 To describe crack location use the valve stem hole as the zero (0) point, and inspect the wheel in a clockwise direction (looking at the curbside of the wheel). Each spoke and wheel bolt hole position is identified by number, with the number one (1) nearest or just clockwise of the valve stem hole and counting upward while traveling in a clockwise direction around the wheel.

4.1.2.3.2 Describe crack direction (radial, circumferential, axial, diagonal, etc.) and length.

4.1.2.3.3 Describe crack area (window, spoke, support rib, weld, drop well, pocket, curb side, backside, etc).

4.1.2.4 On the data sheet shown in Figure A1, include a note documenting the appropriate condition of either the highest fluoroscope level spoke at intended contact area or highest fluoroscope level spoke adjacent to intended contact area.

4.1.2.5 Requester shall review all cracks found during wheel inspection.

4.2 Conditions.

4.2.1 Environmental Conditions. Room temperature: $24^{\circ}\text{C} \pm 14^{\circ}\text{C}$ ($75^{\circ}\text{F} \pm 25^{\circ}\text{F}$).

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 Mount a tire onto a test wheel.

4.3.2 Determine test load value, **D**. Test load value shall be stated on the test request or may be calculated per Appendix B, Section B1.

4.3.3 Adjust striker mass to within $\pm 2\%$ of required **D** test load value.

Note: All removable mass components shall be rigidly attached to striker mass fixture before proceeding.

4.3.4 Raise and secure the striker mass to gain access to the impact support fixture.

4.3.5 Mount appropriate wheel hub adapter to the impact support fixture.

4.3.6 Mount and secure the tire-wheel assembly to a wheel hub adapter.

4.3.6.1 Using a star pattern, tighten wheel fasteners to torque value specified by the requester.

4.3.6.2 Using a star pattern, recheck fastener torque until requested torque values stabilize.

Note: New fasteners are not required for each test. However, the fasteners shall be inspected prior to each test to assure there is no apparent damage.

4.3.7 Lower and secure the striker at approximate 25 mm (1 in) above the tire-wheel assembly.

4.3.8 Move impact support fixture such that the striker face is over the tire and the striker face edge overlaps the rim flange by $25\text{ mm} \pm 1\text{ mm}$ ($1\text{ in} \pm 0.040\text{ in}$).

4.3.9 Rotate wheel to align impact location with the striker and secure wheel hub adapter to the impact support fixture.

4.3.9.1 Specified impact locations for aluminum wheels, unless otherwise stated by the requester.

4.3.9.1.1 Spoke impact. Position spoke with the highest fluoroscope level under striker centerline.

4.3.9.1.2 Vent window impact. Position vent window adjacent to spoke with the highest fluoroscope level under striker centerline.

4.3.9.2 Specified impact locations for steel wheels, unless otherwise stated by the requester.

4.3.9.2.1 Spoke impact. Position first spoke at or just clockwise from the valve stem hole, under striker centerline.

4.3.9.2.2 Vent window impact. Position first vent window at or just clockwise from the valve stem hole under striker centerline.

4.3.10 Set Tire Pressure.

4.3.10.1 Connect machine tire pressure line to tire air valve, as applicable.

4.3.10.2 Inflate tire to pressure specified by requester or $200\text{ kPa} \pm 2\text{ kPa}$ ($29\text{ psi} \pm 0.5\text{ psi}$) if pressure value is not specified.

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4.3.11 Velocity Sensor Setup. For GHI VS200 gate type system with optical sensor, use the following procedure. (Refer to Appendix C, Figure C2.)

4.3.11.1 Install GHI optical gate on a sliding rail parallel to the striker mass path of travel.

4.3.11.2 Attach GHI blade to striker mass so that the blade passes through the gate without interference.

4.3.11.3 Lower the striker face to $2 \text{ mm} \pm 1 \text{ mm}$ ($0.080 \text{ in} \pm 0.040 \text{ in}$) before contact with tire (Z Height).

4.3.11.3.1 Set the gate height so the blade passes through the gate just before the striker face contacts the tire, shown in Appendix C, Figure C2.

4.3.11.3.2 Record on data sheet (refer to Appendix A, Figure A1) the height that the striker face is above the highest part of the rim flange. This numerical value will then be subtracted from the drop height value within the velocity calculation (refer to Appendix C, Section C1).

4.3.11.3.3 Reset the GHI (electric timer) velocity sensor unit.

4.3.11.3.4 Raise gate allowing blade to pass through. Timer should start running.

4.3.11.3.5 Slowly raise gate until timer stops. Secure the sensing gate to rail. The timer will now stop just before striker face contacts tire.

Note: Verify that the GHI velocity sensor timer system is reset.

4.3.11.3.6 Set drop height of striker face to 230 mm (typical) above the highest part of the rim flange, or as determined to meet the requirement of a 9.81 m/s^2 free fall, refer to pictorial shown in Appendix C, Figure C2.

4.3.11.3.6.1 The ideal gate time (t_m) allowed for the 9.81 m/s^2 free fall is calculated per Appendix C, Section C1 "Determining Ideal Gate Time", pictorially described in Appendix C, Figure C2 and tabulated in Appendix C, Figure C1. Additionally, do not raise the striker height so high that the measured gate time is faster than the ideal gate time. However, the measured gate time may be 2% greater than the ideal gate time.

4.3.11.3.6.1.1 Calculate ideal gate time (t_m) shown in Appendix C, Figure C2 or determine (Z) height per setup shown in Appendix C, Figure C2. Then determine the ideal gate time from Appendix C, Figure C1 using (Z).

4.3.12 Striker shall be held in position awaiting release. Striker height shall not drift downward more than 0.5 mm (0.20 in).

4.3.13 Digital photograph of the wheel is no longer required for TRIAS 09-J002-001, and is optional for GMW14910.

Note: Only one picture of test setup is required even when multiple wheels are being tested.

4.3.14 Release striker mass.

4.3.15 Record tire pressure on data sheet (refer to Appendix A, Figure A1) immediately after striker mass stops bouncing. A minor drop in pressure may be expected due to instantaneous unseating of tire bead.

4.3.16 Record time value in milliseconds from GHI velocity sensor timer on the data sheet (refer to Appendix A, Figure A1).

Note: Verify that the striker dropped at 9.81 m/s^2 or as described in 4.3.11.3.6.1. Gate time must fall between the calculated ideal time (refer to Appendix C, Section C1 "Determining Ideal Gate Time") and the maximum limit time (refer to Appendix C, Figure C2).

4.3.17 Wait at least one minute after striker mass stops bouncing, and then record tire pressure on the data sheet (refer to Appendix A, Figure A1).

4.3.18 Raise and secure striker, to gain access to the tire-wheel assembly.

4.3.19 Release all air pressure from tire.

4.3.20 Remove tire-wheel assembly from wheel adapter.

4.3.21 Wheel Inspection (Posttest).

4.3.21.1 Inspect wheels for cracks using Zyglo or equivalent dye penetrant crack inspection media.

4.3.21.2 Identify any cracks using marking method described in 4.1.2.2.

4.3.21.3 Record observations on data sheet (refer to Appendix A, Figure A1), as described in 4.1.2.3.

4.3.22 Repeat 4.3.1 to 4.3.21.3 for remaining test wheels.

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5 Data

5.1 Calculations.

5.1.1 Test Load or Striker Mass. Refer to Appendix B, Section B1.

5.1.2 Ideal Drop Time Calculation. Refer to Appendix C, Section C1 "Determining Ideal Gate Time".

5.1.2.1 Ideal Drop Time and Maximum Limit Time. Refer to Appendix C, Figure C2.

5.2 Interpretation of Results.

5.2.1 The tire-wheel assembly shall not exhibit a total loss of air pressure within 1 minute, after being subjected to the impact.

5.2.1.1 If it is suspected that total air loss resulted from subsequent impacts caused by the mass rebounding or the mass resting on the tire, means should be employed to capture the mass after first impact.

Note: One (1) impact is intended.

5.2.2 No new or propagating crack allowed, except in the area of the rim section contacted by the striker face. See Appendix E, Figures E1 and E2, for photographs of acceptable cracks and Appendix F, Figures F1 through F3, for unacceptable cracks.

Note: Separation of the center member from the rim is unacceptable.

5.2.3 Drop time shall be no greater than 2.0% of the calculated ideal time for the blade to pass to the sensing gate, refer to Appendix C, Section C1.

5.3 Test Documentation. The test results documentation should include the following:

- Test results report (generated by Global Tire-Wheel Test System (GTWTS) if submitting Extensible Markup Language (XML) files)
- Test result data files (XML) format
- Completed datasheets. Refer to Appendix A, Figure A1 for datasheet example.
- Photographs.

Note: For data being loaded into GTWTS, submit electronically the test results data files (XML format) and other supporting files listed in 5.3. GMW16590 defines the electronic file details (e.g., file types, file naming convention, and detailed file formats) for the GTWTS.

Note: This documentation is also used to describe the location of the highest fluoroscope level spoke, as applicable.

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.

Adapter: A removable plate that retains wheel attaching fasteners and attaches to the impact support fixture. Adapters are allowed to have more than one (1) bolt pattern.

Crack: Any discontinuity that can be identified using crack detection methods approved by General Motors.

Gross Axle Mass Rating (GAMR): Is stated within the GM wheel drawing, whereas, $(2 \times W)$ (kg) = (maximum GAMR). Additionally, W = maximum static wheel load rating (kg) as called by SAE (refer to Appendix B, Section B1).

Impact Support Fixture: Fixture used to support adapter plates that support tire-wheel assembly during testing. (**Note:** Impact support fixture shall be at an angle of 13 degrees $\pm$ 1 degree from horizontal.)

New Crack: Any identified new crack after impact.

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Propagating Crack: Any identified crack that has grown in size after impact.

Striker Face: Horizontal surface of striker mass that contacts the tire-wheel assembly.

Striker Mass: Fixture with specific mass (test load) dropped onto a tire-wheel assembly. Any removable mass must be rigidly attached to fixture (refer to Appendix B, Section B1 for calculations).

Vent Window: The region between the wheel spokes.

7.2 Acronyms, Abbreviations, and Symbols.

CTS	Component Technical Specifications
GAMR	Gross Axle Mass Rating
GSSLT	Global Subsystem Leadership Team
GTWTS	Global Tire-Wheel Test System
ISO	International Organization for Standardization
NIST	National Institute of Standards and Testing
SAE	SAE International
TRIAS	Test Requirements and Instructions for Automobile Standards (Japan)
XML	Extensible Markup Language

8 Coding System

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

Test to GMW14910

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