



## Front Knuckle Steering Arm Impact

### 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 test is to provide visual evidence of ductility of the knuckle steering arm when subjected to an impact load condition.

**1.2 Applicability.** This test procedure applies to front knuckles for all passenger cars and light duty trucks.

**1.3 Remarks.** Success criteria will vary from part to part based on the steering arm design. Consult the GM design engineer.

### 2 References

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

#### 2.1 External Standards/Specifications.

None

#### 2.2 GM Standards/Specifications.

None

#### 2.3 Additional References.

CG583 Validation Sign-off Form (ID)

(ID) = This document is limited to internal use within General Motors and shall not be accessed outside this company. Contact the GM Lead Engineer for further instructions.

### 3 Resources

**3.1 Facilities.** The bedplate should be approximately 1.5 m × 1.5 m (5 ft × 5 ft.) or equivalent.

**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** Static impact drop hammer, or equivalent.

**3.2.2 Application for cast iron knuckles only.** Deep freeze (or equivalent) capable of obtaining and maintaining a temperature of -40 °C (-40 °F). Aluminum knuckles may be tested at room temperature.

**3.2.3** Fixturing to secure the knuckle assembly at the bearing attachment, such that the knuckle steering arm boss can be freely impacted by the drop hammer. Fixturing must allow the knuckle steering arm to be impacted in both the **inboard** and **outboard** directions, while using the design intent bearing attachments to ground the knuckle.

**3.2.4 Special tie rod stud.** Cut the ball off of a current production tie rod end stud or fabricate a surrogate stud having the same taper as the released stud. Mark the center of the stud at both ends for use as reference points for determining steering arm deflection at approximately the middle of the boss.

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**3.2.5** Fixturing to support the knuckle while measuring the relation of the steering arm to a reference plane. Refer to Appendix A, Figure A1 for the location of the reference plane.

**3.2.6** Vernier height gauge.

**Note:** All instrumentation is to be calibrated as required; record instrumentation details and date of calibration on data sheet unless the information is otherwise preserved in the testing laboratory records.

**3.3 Test Vehicle/Test Piece.** Sample quantity shall be 12 total: three (3) inboard strikes, three (3) outboard strikes on each hand.

**3.4 Test Time.**

Calendar time: 5 d to 7 d

Test time: 4 h to 6 h

Coordination time: 20 h to 40 h

**3.5 Test Required Information.** Not applicable.

**3.6 Personnel/Skills.** The test technician should be familiar with the test machine and instrumentation required to obtain test data.

## 4 Procedure

### 4.1 Preparation.

**4.1.1** All samples must be magnetic particle (or dye penetrant, in the case of aluminum) inspected prior to conducting the test. If any cracks or indications are found, notify the Design Responsible Engineer (DRE). X-rays of the castings should be taken to document the level of porosity that is being validated.

**4.1.2** Determine the energy to be used for the initial strikes (inboard and outboard are typically different). This energy can be determined from prior tests, a Computer Aided Engineering (CAE) simulation, and/or hand calculation. The goal is to deform the steering arm as much as possible, without fully fracturing it from the knuckle's main body (a hairline crack is acceptable). If the crack opens more than ½ mm, the sample is invalid since the crack opening will exaggerate the plastic deformation being observed.

**4.1.3** Place each test sample on a qualified flat surface (bedplate) and measure and record the location of the steering arm stud centers (both ends), relative to the bearing attachment surface, prior to impact. Calculate the midpoint of the steering arm boss along its centerline. Refer to Appendix A, Figure A1 for the location of the reference plane, and Appendix A, Figures A2 and A3 for the modified stud arrangement.

### 4.2 Conditions.

**4.2.1 Environmental Conditions.** The cast iron knuckle test sample must obtain a stable temperature of  $-40^{\circ}\text{C} \pm 2^{\circ}\text{C}$  for at least 30 minutes prior to impacting the steering arm. The aluminum knuckle test sample may be tested at room temperature.

**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. See CG583 Validation Sign-Off form, including photos and/or layouts of the test setup.

### 4.3 Instructions.

**4.3.1** Arrange and secure the fixturing required to support the knuckle during the impact test. This may include tightening bearing bolts to a bedplate fixture for a Gen3 bearing (see Appendix A, Figure A3), or using a center bolt to clamp the knuckle between two (2) fixture details through the bearing bore for a Gen1 bearing.

**4.3.2** Adjust the fixturing and/or impact hammer such that the impact hammer will strike the middle of the steering arm boss (not the tapered stud). See Appendix A, Figure A2.

**4.3.3** Drop the impact hammer with the correct height and weight using a quick release mechanism. Only one (1) impact per sample is permitted.

**4.3.4** Remove the knuckle test sample from the fixture and visually inspect the sample for fractures. Record any observations noted during the test.

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**4.3.5** Any sample with a crack that has opened more than ½ mm will not be valid, and another sample will be needed to replace it. In this case, adjust the weight and/or height of the hammer and run another sample. Refer to 4.1.2.

**4.3.6** Measure and record the location of the steering arm stud centers (both ends) per 4.1.3.

**4.3.7** Repeat all steps specified in 4.3.1 thru 4.3.5 for each of the following combinations:

**4.3.7.1** Three (3) Left hand/Inboard.

**4.3.7.2** Three (3) Left hand/Outboard.

**4.3.7.3** Three (3) Right hand/Inboard.

**4.3.7.4** Three (3) Right hand/Outboard.

#### **4.4 Posttest Inspection.**

**4.4.1** Mark all cracks found during inspection and photograph one (1) or more representative samples.

**4.4.2** Samples that have results that deviate from the rest shall be subjected to metallurgical examination, which may include chemical composition, hardness, and microstructure.

**4.5 General Information.** A knuckle, as a safety-critical component, needs to show a certain level of plastic deformation prior to fracturing.

## **5 Data**

**5.1 Calculations.** Not applicable.

**5.2 Interpretation of Results.** Not applicable.

#### **5.3 Test Documentation.**

**5.3.1** The test setup and methodology must be reviewed with the GM design engineer. Photographs and/or Computer Aided Design images of the test must be provided.

**5.3.2** Any issues which occur outside of the validation requirements should be documented in an Issue Report.

**5.3.3** The following information should be included in the final evaluation report:

- Sample Model Year/Model/System.
- Energy derivation, including practice sample results.
- Test methodology.
- Any deviations from procedure.
- Photographs of test setup. See Appendix A, Figure A1.
- Photographs of indications, cracks, or anything else of note on tested samples.
- Fixture layout numbers.
- Test instrumentation and calibration information.
- Detailed description of results. See Appendix B, Data Sheet B1.

## **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.**

**Inboard:** The direction of impact described as parallel to the knuckle spindle towards the center of the vehicle.

**Outboard:** The direction of impact described as parallel to the knuckle spindle towards the outside of the vehicle.

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