



Fatigue Test of Drive Axle Shafts and Joints

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. Determination of component durability in the fatigue strength range for quality control of production axle shafts and joints.

1.2 Applicability. This procedure is applicable to all halfshafts for which a rotating torque requirement and/or a load to stroke requirement has been specified in the program specific SSTs. This procedure is applicable to a halfshaft mounted in a bench level test fixture. It is not applicable to the halfshaft installed in the vehicle.

1.3 Remarks. Reliability shall be demonstrated in the following laboratory test to be conducted by a supplier and defines requirements for the performance of halfshafts. It is required that a supplier of halfshafts to General Motors have the ability to run these laboratory tests and that representative halfshafts successfully complete a laboratory validation program approved by the appropriate platform release and validation engineers.

The laboratory tests program must include, but is not limited to, the areas of performance specified in this document. The supplier is expected to demonstrate that their laboratory test meets the durability requirements stated in this document.

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.

- Component Technical Specification (CTS) (for Halfshaft)
- GM1829 Analysis/Development/Validation Plan and Report (ADVP&R)
- Statement of Requirements (SOR)
- Subsystem Technical Specification (SSTs) (for Halfshaft)
- Validation Cross Reference Index (VCRI)

3 Resources

3.1 Facilities.

The test facility shall have a valid International Organization (ISO) certificate, **which is noted in the test report**. A bedplate large enough for securing the test rig and capable of withstanding dynamic loading of the rig/specimen is required.

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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February 2017

Page 1 of 9

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 A hydraulic power system and **rotary fatigue** test machine (i.e., High Angle Rotary Structural Test Machine) that is compatible with the strength of the components being tested. Since the test will be carried out using load control mode, the testing machine must have servo-hydraulic load-monitoring system mounted in series with specimen. The load and displacement must be monitored continuously until the failure occurs.

3.2.2 Hydraulic torsion actuator with Torque (M_t) = 2000 N·m.

3.2.3 Torsional load sensing device (M_t maximum = 2000 Nm).

3.2.4 Torque control unit as a closed control circuit, if possible, with supporting angle control equipment to control men and oscillatory torques.

3.2.5 Cathode ray oscillograph for control and optimization of control behavior.

3.2.6 Preselect cycle counter with automatic shutoff.

3.2.7 One cutoff switch.

3.2.8 Fixtures. See Appendix A, Figures A1, A2, and A3.

3.2.9 Halfshaft rotary fatigue fixture.

Note: It is preferable to test the halfshaft as a complete assembly (including the mating interfaces to the driveline system); however, halfshaft components can be tested as individual pieces.

3.3 Test Vehicle/Test Piece. The test piece shall consist of a complete production halfshaft assembly as would be installed on a production vehicle.

3.3.1 Unless otherwise specified, a minimum of seven (7) samples of halfshafts are to be tested. Data for each sample are to be documented in the test record.

3.3.1.1 Four (4) samples are to be at minimum specified casting hardness, minimum shaft diameter, and minimum spline diameter.

3.3.1.2 Three (3) samples are to be as above except with maximum specified spline diameter.

3.3.2 Interface components (inboard stub shafts; outboard hub and nut) of the halfshaft being tested.

Note: Load to be applied through interfaces simulating vehicle attachment.

3.3.3 Appropriate fasteners, snap rings, seals, o-rings, etc.

3.3.4 Wheel bearings as required, designed for use with the hub being tested.

3.3.5 All halfshafts are to be Magnaflux inspected before and after test.

3.4 Test Time.

Calendar time: 6 days

Test hours: 100 hours

Coordination hours: 32 hours

3.5 Test Required Information. Single-step fatigue test by application of an alternating torque to determine fatigue life in the fatigue strength range.

- Component Technical Specification (CTS) (for Halfshaft)
- GM1829 Analysis/Development/Validation Plan and Report (ADVP&R)
- Statement of Requirements (SOR)
- Subsystem Technical Specification (SSTS) (for Halfshaft)
- Validation Cross Reference Index (VCRI)

Remarks: These are the steps to demonstrate compliance to this specification:

The supplier shall provide a typical S-N curve (plotted to the semi-logarithmic scale) based on the product they are recommending for the application.

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February 2017

Page 2 of 9



Documents

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GM and the supplier will measure halfshaft torsional loads on the appropriate vehicle durability test and/or vehicle off road, abuse load data acquisition.

The measured data is to be reduced by GM and the supplier to find the equivalent sinusoidal load amplitude at 100 cycles (low count cycles) and at the high count cycles, and number of cycles to cause fatigue damage to the halfshaft equivalent to the fatigue damage caused by the vehicle durability schedule. The load and cycles shall be plotted on an S-N diagram to form a "vehicle load data" S-N curve. This is a theoretical curve that represents the minimum S-N curve that the actual parts must meet to be expected to survive vehicle durability based on the life expectancy defined in the SSTs.

The supplier is to conduct fatigue tests at a minimum of two (2) loads:

- The low load test is to be run at a test load where the vehicle load data S-N curve crosses the high count cycle line.
- The high load test is to be run at a test load where the vehicle load data S-N curve crosses the 100 (500 for off road vehicles) or low count cycle line.

3.6 Personnel/Skills. This test requires a minimum of one (1) technician or engineer trained in halfshaft fatigue measurements. The technician should be proficient in operation of the equipment listed in 3.2, and familiar with the general operation of halfshafts.

4 Procedure

4.1 Preparation. Fixturing should be designed and made to mount the test specimen to a bedplate. The axle shaft outputs must be held stationary with fixturing. An input adapter must be fabricated to connect the pinion flange to the input actuator. See Appendix A for example set-up.

Note: Load to be applied through interfaces simulating vehicle attachment.

4.1.1 All samples shall be inspected for geometrical conformance with the appropriate specimen drawing (and weld specification, if applicable). Any non-compliant specimen must be set aside and a compliant specimen be tested in its place.

4.1.2 Check that all parts and fixtures needed are included for the mounting.

4.1.3 Paint critical areas with an appropriate color (e.g., white) to make it easier to find cracks.

4.1.4 Test Stand Review. The test set up and methodology must be reviewed with the GM System Validation Engineer (SVE). The GM SVE may request review by the Design Release Engineer (DRE) and/or the Bill of Material Family Owner (BFO). Photographs and/or computer aided design images of the test must be provided.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

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.

4.2.2.1 Test Torque. The test torque to be applied shall be taken from the SSTs or provided by GM's DRE/Computer Aided Engineering (CAE) Group. Obtain halfshaft Torque Capacity Testing Parameters (see Table 1) from GM CAE (or Program Lead DRE) per virtual Road Load Data Acquisition (vRLDA) or actual Road Load Data Acquisition (RLDA) or CTS/SSTs.

Note: General Motors (and in certain cases, the supplier) will perform RLDA on the appropriate vehicle durability test and/or vehicle abuse test in order to acquire pertinent torsional loads.

The supplier is to conduct fatigue tests at a minimum of two (2) loads:

- The low load test is to be run at a test load where the vehicle load data S-N curve crosses the high count cycle line.
- The high load test is to be run at a test load where the vehicle load data S-N curve crosses the 100 (500 for off road vehicles) or low count cycle line.

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February 2017

Page 3 of 9