GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW15599

Steering Column Intermediate Shaft Stick Slip 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. The purpose of this test is to determine the **stick slip** characteristics of passenger car and light-duty truck collapsible intermediate shafts (I-shafts) when subjected to axial displacement and constant torque. This procedure may be used for development or validation.

This test provides axial displacement in conjunction with a constant torque applied to the intermediate shaft. Results of the test will predict stick slip performance in a worst case scenario (large and or frequent stroking events between steering column and steering gear).

1.2 Applicability. This procedure applies to body on frame and body frame integral vehicles.

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.

Technical Specifications includes the Subsystem Technical Specification (SSTS), which defines the subsystem level testing and reliability requirements of the chassis assembly, and the Component Technical Specification (CTS) which defines the component level testing and reliability requirements of the component.

3 Resources

3.1 Facilities. A bedplate approximately 0.5 m x 2.5 m with hydraulic capacity. The test facilities and equipment shall be in good working order, and all instrumentation shall have a valid calibration label. The bedplate and hydraulic system must be isolated from outside influences that can affect the data collection portion of the test.

This procedure describes the setup for one rig/station capable of evaluating one I-shaft specimen at a time. Multiple stations can be assembled parallel to each other to allow simultaneous testing of I-shaft specimens.

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.

Note: The following list(s) include test rig, fixtures, transducers, instrumentation, and controllers typically used by the General Motors North America (GMNA) Warren Structural Development Laboratory to perform this test. Other equipment may be substituted at the discretion of the local testing facility as long as it provides equivalent accuracy as specified herein or by the requestor. Any setup must be approved by the I-shaft Bill of Material (BOM) family owner.

3.2.1 Hydraulic Actuator. One (1) hydraulic actuator with low friction bearings and seals. The actuator must be capable of providing both high and low frequency small displacement sine wave motions without noise or internal

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friction that could mask the stick-slip response from the I-shaft. An example of an actuator with these characteristics is the Material Test System (MTS) series 242 actuator.

3.2.2 Fixtures. Fixtures necessary to support the intermediate shaft at the actuator end and the reaction end. The fixtures must simulate the interfacing parts of the intermediate shaft. The actual interfacing parts may be used as fixtures.

3.2.3 Angle Stands. Angle stands to support the actuator and I-shaft reaction fixture.

3.2.4 Torque Arm. A torque arm is attached to the actuator shaft to provide constant static torque to the intermediate shaft. The torque arm must be adjustable to provide the specified torque for each test (3.5 and 7 N·m).

3.2.5 Environmental Box. An insulated box is required to contain the desired thermal environment for the thermal portion of the test. This box is required for the duration of the accelerated wear test (4.3.3.2) in order to avoid disturbance of the specimen.

3.2.6 Thermal Source(s). A thermal source must be located near the environmental box. The thermal source shall be capable of providing temperatures specified in 4.3.3.1. A typical method of providing elevated temperatures is to attach an electric heat gun blower on a stand adjacent to the test. An air duct is then used to convey heat to the environmental box. A typical method of providing sub-ambient temperatures is with the use of nitrogen which is dispersed via nozzle into the environmental box. The heat sources shall not be directly applied to the test specimen.

3.2.7 Transducers.

3.2.7.1 Load Cell. One (1) load cell capable of measuring loads in the range of 1.0 N to 500 N.

3.2.7.2 Linear Variable Differential Transformer (LVDT). The hydraulic actuator must be outfitted with an LVDT to allow displacement measurement and control of the actuator. This will also allow displacement limits to be enabled for the safety of personnel and equipment.

3.2.7.3 Thermocouple. A thermocouple must be utilized to provide temperature feedback for the thermal portion of the test.

3.2.8 Instrumentation.

3.2.8.1 Miscellaneous Cabling. Cabling with appropriate end connectors will be required to connect the transducers to the instrumentation and controllers to the hydraulic actuator and instrumentation.

3.2.8.2 Test Site Controller (TSC). The TSC is used to play the specified test profile drive signals out to the test rig during the test. It can also be used to collect responses from the transducers for test monitoring.

3.2.8.3 Servo Hydraulic Controller. The servo controller provides closed loop control to the servo hydraulic loops on the test rig. Test rig drive signals (command) are played into the servo controller from the TSC.

3.2.8.4 Temperature Controller. A thermal source must be controlled to provide the environment required for the thermal portion of the test. The controller must be capable of controlling the thermal source from the output of a thermocouple.

3.2.8.5 Data Acquisition System. A data acquisition system capable of recording a triggered load vs. time response is required to evaluate the stick slip performance of the intermediate shaft. Data shall be collected at the minimum rate of 2048 samples/second. The data acquisition system must be able to supply the displacement and/or load vs. time results in both graphical and numerical formats. Refer to Appendix A, Figure A6 for numeric output requirements.

3.3 Test Vehicle/Test Piece.

3.3.1 Sample quantity of the intermediate shaft as specified by the Design Engineer or CTS. All test material should be certified prior to receipt to confirm that it is representative of design intent.

3.3.2 The intermediate shaft shall be in line with the actuator and extended to match the vehicle design position.

3.3.3 There must be a U-joint at each end of the I-shaft. The intent is to prevent bending loads from being induced into the I-shaft. Vehicle joint angles are not required/acceptable.

3.3.4 If the intermediate shaft is equipped with an isolator, it is necessary to by-pass it by either removing it from the test part or fully grounding it out by clamping or welding. The method used must be approved by the I-shaft Bill of Material (BOM) family owner.

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3.4 Test Time.

Calendar time:	40 to 120 days
Test hours/sample:	240 hours
Coordination hours:	80 to 120 hours

3.5 Test Required Information. The requesting engineer is responsible for providing the CTS which must include the performance objectives (sample size and failure criteria) for development and/or validation tests.

3.6 Personnel/Skills. Not applicable.

4 Procedure

4.1 Preparation.

4.1.1 Secure one angle stand to the bedplate and attach the actuator in the horizontal position.

4.1.2 Support the rod end of the actuator with fixtures necessary to provide vertical and lateral support.

4.1.3 Install the torque arm on the actuator rod followed by the load cell and I-shaft interface fixture.

4.1.4 Secure the remaining angle stand to the bedplate and attach the I-shaft reaction fixture. See Appendix A, Figure A3.

4.1.5 Install the environmental box, see Appendix A, Figure A4.

4.1.6 Install the I-shaft specimen in line with the actuator and with the U-joints positioned at a distance equal to that of the in vehicle installed dimension.

4.1.7 Clamp the torque arm in a horizontal position on the actuator rod and adjust the weight to provide the specified torque to I-shaft. See Appendix A, Figure A5.

4.1.8 Attach the thermocouple directly to the I-shaft outer tube centered at the working location of the I-shaft. Remove any coating material from I-shaft to obtain an accurate temperature reading of the outer metal tube.

4.1.9 Tuning. Optimize the servo loop using a digital oscilloscope. The system must be able to produce a clean sinusoidal waveform that is not disrupted by any internal or outside sources (such as actuator internal friction or electronic signal noise) during the data collection portions of the test.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Durability Test Environmental Conditions. Unless otherwise specified in this procedure's text or by the requesting engineer, the typical environmental conditions for performing this procedure are the temperature, humidity and pressure of the test facility. 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.

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.

4.2.3 Over Stroking. Any time after a test is started; if the specimen is stroked beyond the specified displacement, the test shall be terminated.

4.3 Instructions.

4.3.1 Data Collection Parameters. Unless otherwise specified record the load vs. time response for 7 s to 10 s with a constant amplitude sine wave displacement of ± 0.35 mm at a frequency of 1.0 Hz. Data shall be collected at a rate of 2048 samples/second.

4.3.2 Dry Slider Test. This is a validation test to be performed on parts with no lubrication at the slider interface.

4.3.2.1 Test Parameters.

Waveform	Sine
Frequency	5 Hz
Displacement	± 0.5 mm
Applied Static Torque	7 N·m
Cycles	180 000

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