GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW16318

Hydraulic Steering System Return Hose Pressure Characterization During a Simulated Engine Cold Start Event

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. To measure the hydraulic pressure in the power steering return hose(s) during an engine cold start simulation event.

1.2 Applicability. This procedure is applicable to all vehicles with a Hydraulic Power Steering System.

1.3 Remarks. This test provides information for selection of return hose type and the connection style for securing the return hose to the pipe.

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.

- Lovejoy Incorporated, Downers Grove, Illinois, www.lovejoy-inc.com
- Master Process Document (MPD)
- Meggitt (Endevco) Sensing Systems, Irvine, California, www.endevco.com
- Mityvac of Lincoln Industrial Corporation, St. Louis, Missouri, www.mityvac.com

3 Resources

3.1 Facilities. Cold chamber capable of -40 °C with sufficient electrical power to support electrical motor function and capable of housing the entire power steering system, approximately 2 m × 2 m minimum.

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. Electric motor.

3.2.1.1 Minimum speed shall be the greater of the pump speeds described in 3.5.5 and 3.5.6.

3.2.1.2 Minimum power of the electric motor is 3.7 kW (5 hp).

3.2.2. Angle stands and associated equipment to constrain the test specimen as described in 4.3.2 and 4.3.7.

3.2.3 Endevco Pressure Transducer Model No. 8530B-2KM37 or equivalent. See Figure A1 in Appendix A.

3.2.3.1 Pressure capability: 14 MPa (2000 psig).

3.2.3.2 Sampling frequency: 1000 Hz minimum.

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3.2.4 Pressure transducer pipe adapter(s). Steel adaptors for steel pipe and aluminum adaptors for aluminum pipe are required. See Figure A2 in Appendix A for adapter configuration and dimensional specifications for the specified pressure transducer. Equivalent adaptors are permissible for different transducers.

3.2.5 Thermocouple.

3.2.6 Signal recorder/data collection device.

3.2.7 Appropriate amp/signal conditioner for the pressure transducer or equivalent.

3.2.8 Motor cart/setup, consisting of the motor and switch to run the power steering pump. See Figures A4 thru A7 in Appendix A for examples.

3.2.8.1 Bracket to secure pump to cart at in-car position. See Figures A8 and A9 in Appendix A for examples.

3.2.9 Handheld Mityvac vacuum pump (tool number J35555) or equivalent and bleeder adaptor (tool number J43485) or equivalent.

3.2.10 Rubber isolated motor coupling assembly (Lovejoy Jaw Type or equivalent) with specially prepared coupling hub for adaptation to the pump driveshaft. See Figure A4 in Appendix A for photo of typical coupling.

3.3 Test Vehicle/Test Piece. The following parts shall be included in the preproduction test kits requested by the validation engineer to support this testing or provided by design engineer.

All test material shall be dimensionally certified prior to receipt to confirm that it is representative of design intent.

3.3.1 Power steering pump.

3.3.2 Power steering reservoir(s).

3.3.3 Power steering gear assembly.

3.3.4 Power steering hose assemblies.

3.3.5 Power steering cooler, if applicable.

3.3.6 Any other component in the power steering circuit.

3.3.7 A sufficient quantity of the production intent power steering fluid.

3.4 Test Time.

Calendar time:	6 days
Test hours:	24 hours
Coordination hours:	40 hours

3.5 Test Required Information. The design engineer shall supply:

3.5.1 Layout/math data showing pump to reservoir relative position and pump to steering gear relative position.

3.5.2 Assembly information, such as Master Process Document (MPD) sheets, showing assembly position, sequence, etc.

3.5.3 Hydraulic connections tightening torque.

3.5.4 Hydraulic power steering pump relief pressure.

3.5.5 The pump speed during a cold start, engine light, event.

3.5.6 The minimum pump speed (revolutions/minute), at which the pump's flow control valve is actuated and the pump is in flow control mode.

3.5.7 The volume of fluid produced (liters/minute) while in flow control mode.

3.5.8 The material (steel or aluminum) of the power steering hose assemblies' pipes, to which the pressure transducer ports will be attached.

3.6 Personnel/Skills. One laboratory test technician skilled in the setup, tuning, and use of pressure and temperature measurement equipment and controllers. One test engineer for test planning, data preparation, direction, and incident analysis. One validation engineer to request part kits and track the status of parts from Pre Production Operations (PPO).

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4 Procedure

4.1 Preparation.

4.1.1 Attach the adapter(s) to the pipe(s) of the hose assemblies.

4.1.1.1 Adapter locations on the return hose assembly shall be as close to the hose to pipe connections as possible. Typical adapter locations are approximately 50 mm from the hose connection to prevent heat damage to hose material during soldering or welding process. Typical adapter location must be in a straight section of pipe. See Figure A3 in Appendix A for typical adapter location(s).

4.1.1.2 Adapter location on the pressure hose assembly shall be anywhere it is convenient to attach it. See Figure A3 in Appendix A for typical adapter location.

4.1.2 After adapters are attached to pipes, drill a hole through the wall of the pipe using the adapters as a drill guide. Maximum drill size shall be same as tap drill for adapter. Blow air through the hose assembly during drilling to prevent chips from accumulating in the pipe. The direction of the blown air should be prioritized based on avoiding blowing the chips through tuning devices such as restrictors or through the shortest distance of return hose length possible.

Note: Pipes must be free of contamination prior to installing transducers and running tests to prevent pump damage.

4.1.3 Install specified pressure transducers in adapters.

4.1.4 Drill hole through reservoir cap sufficiently large to allow thermocouple to pass through into reservoir.

4.1.4.1 Install thermocouple through hole in cap and glue in place.

4.2 Conditions.

4.2.1 Environmental Conditions. Test to be run at the following temperatures:

- -40 °C
- -30 °C
- -20 °C
- -10 °C
- 0 °C

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. Test Set Up.

4.3.1 Install steering system to fixtures using nominal torques.

4.3.2 Pump to be mounted to pump cart in vehicle orientation.

4.3.3 Secure steering gear assembly to angle stand assembly.

4.3.4 Pressure and return hose assemblies shall be in approximate vehicle position, taking care not to kink, twist or flatten hoses.

4.3.5 Attach or secure rubber isolated motor coupling to pump shaft.

4.3.6 Set motor speed to the greater of the pump speeds defined in 3.5.5 and 3.5.6, or more. The motor speed must not exceed 2000 rpm.

4.3.7 If there is a remote reservoir, make sure the reservoir is oriented per design intent above the pump.

4.3.8 Fill system with oil and bleed system to remove any air from system using handheld vacuum pump.

4.3.9 Test instrumentation and recording equipment with trial run at room temperature.

4.4 Instructions. Test Execution.

4.4.1 Cold soak test set for 12 h at -40 °C.

4.4.2 Start recording equipment and confirm transducer and thermocouple function.

4.4.3 Start electric motor, run for 5 s and turn motor off.

4.4.4 Turn off recording equipment.

4.4.5 Soak test setup for 2 h at -30 °C and repeat steps 4.4.2 through 4.4.4.

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4.4.6 Soak test setup for 2 h at -20 °C and repeat steps 4.4.2 through 4.4.4.
4.4.7 Soak test setup for 2 h at -10 °C and repeat steps 4.4.2 through 4.4.4.
4.4.8 Soak test setup for 2 h at 0 °C and repeat steps 4.4.2 through 4.4.4.
4.4.9 Collect the following information and record:

- Pump speed
- Pressure
- Temperature

5 Data

5.1 Calculations. Not applicable.
5.2 Interpretation of Results. Not applicable.
5.3 Test Documentation.
5.3.1 Calibration Record Sheet, Data Sheet B1 in Appendix B.
5.3.2 Test Review and Approval Form, Data Sheet B2 in Appendix B.
5.3.3 Photographs of test setup and issue observations.
5.3.4 Test results.
5.3.4.1 Peak pressure of each channel recorded.
5.3.4.2 Pressure vs. Time plot (time histories) of all pressure transducers.
5.3.4.3 Peak Pressure vs. Temperature plot of all pressure transducers.

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.

7 Notes

7.1 Glossary.
7.2 Acronyms, Abbreviations, and Symbols.

BLK	Black
Cal.	Calibration
DIA	Diameter
DIM	Dimension
GRN	Green
GSSLT	Global Subsystem Leadership Team
MAX	Maximum
MPD	Master Process Document
No.	Number
PPO	Pre Production Operations
REF	Reference
Samp.	Sample
THD	Thread
UNF	Unified Fine
Veh.	Vehicle
WHT	White

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8 Coding System

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

Test to GMW16318

9 Release and Revisions

This standard was originated in October 2009. It was first approved by the Steering Global Subsystem Leadership Team (GSSLT) in January 2010. It was first published in January 2010.

Issue	Publication Date	Description (Organization)
1	JAN 2010	Initial publication.
2	JUL 2015	Revised to current template. (Chassis Steering GSSLT)

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