GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW15809

Vehicle Coolant System Evaluation

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 determine if the total coolant flow, flow to the radiator, flow to the heater, and flow balance in engines, meets the design intent under various thermostat opening conditions. To provide additional data for 1D system modeling and the model validation. In particular, the pressure drop vs. flow characteristics for system components is required. To ensure surge tank function under dynamic conditions, such as maximum engine speed. To determine the necessity for a second degassing line.

To determine coolant flow for "Low Temperature Cooling Loops" which can be either dependent or independent cooling circuits. Coolant flow to low temperature radiator, pumps, air separators, liquid cooled charge air cooler, and power electronics.

1.2 Applicability. All liquid cooled circuits.

1.2.1 Conventional engine cooling loop, System 1.

1.2.2 Power Electronics or Energy Storage System (Hybrid) cooling loop. System 2.

1.2.3 Inter-cooler (liquid-to-air charge air cooler (CAC)) cooling loop. System 3.

1.3 Remarks. This is a vehicle coolant flow test procedure used for coolant system development.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW3202 GMW14905

2.3 Additional References.

- CG2287 – Data Sheet
- Service Manual Guide: https://share.gm.com/sites/GWMandDSO/SitePages/Home.aspx

3 Resources

3.1 Facilities.

- Garage with hoist.
- Test track facility.

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. A 1.5 kW "Hartzel" fan (or equivalent) for cooling the vehicle.

3.2.1 Fixturing. Not applicable.

3.2.2 Instrumentation.

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3.2.2.1 Flow meters, sized for appropriate flow rate with minimum pressure drop.

3.2.2.2 Thermocouples and pressure transducers.

3.2.2.3 Glass coolant sight tubes.

3.2.2.4 Data acquisition system.

3.2.3 Coolant Heaters (Optional).

3.3 Test Vehicle/Test Piece. A vehicle built with representative hardware for Systems 1, 2, and 3.

3.4 Test Time.

Calendar time:	15 days
Test hours:	15 hours
Coordination hours:	25 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. A technician skilled in test set up, instrumentation and test operation.

4 Procedure

4.1 Preparation.

4.1.1 Install pressure taps in inlet and outlet ports of all system coolant heat exchangers. Example: radiator, heater core, low temperature radiator (LTR), etc.

4.1.2 Install pressure taps in the inlet and outlet ports of all system pumps including the engine block. Note that in some cases, there will be two measurement locations separated only by a length of hose. Test engineer judgment should be exercised to determine whether two taps are required based on hose length and routing.

4.1.2.1 Other locations depending on complexity of the system and requestor's requirements. For example, additional locations on the block and head may be needed to characterize the pressure drop through the block, head gasket, and head.

4.1.3 Add sight glass tubes to all of the coolant hoses to determine coolant flow direction and level of aeration.

4.1.4 Add thermocouples per the locations defined in Figures B1 thru B4 in Appendix B.

4.1.5 Flow Meters. Install flow meters per the locations defined in Figures B1 thru B4 in Appendix B.

4.1.5.1 Include flow meters in any bypass system, if feasible.

4.1.5.2 Optional flow meters may be installed in any of the coolant paths if required.

4.1.5.3 Avoid sharp bends, abrupt transitions, and flow restrictions in the hoses.

4.1.6 "Hoke" Valve can be installed on the lower radiator hose near radiator outlet port if the radiator does not have a draincock valve.

4.1.7 For System 1. Cycle a production intent thermostat, either mechanically or thermally, from closed to full open five times. This thermostat will be used for the "closed thermostat" tests. Previous experience with some thermostats suggests that the spring load relaxes after several cycles. This is of importance in inlet-side thermostats, where the spring load may be overcome by the hydraulic pressure differential at high engine speeds. As a result, the thermostat is "pushed" open.

4.1.7.1 Using a screw or other means, mechanically fix a second production intent thermostat to its full open position.

4.2 Conditions.

4.2.1 Environmental Conditions. Run at ambient conditions.

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 Fill the system with fluid as specified in the Global Product Description System (GPDS). Be sure to measure the installed volume of coolant.

4.2.4 System Fill.

4.2.4.1 System1. Fill coolant system using Service Fill procedure GMW14905.

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4.2.4.2 System 2. Fill coolant system using Vehicle service fill procedure “Drive Motor Generator Power Inverter Module Cooling System Draining and Filling”. Service procedure Cooling System Draining and Filling can be found in the Service Manual Guide.

4.2.4.3 System 3. Fill coolant system using Vehicle service fill procedure “Inter-Cooler Circuits”. Charge Air Cooler System Draining and Filling can be found under Engine Cooling in the Service Manual Guide.

4.3 Instructions.

4.3.1 System 1 Baseline Coolant System Run.

4.3.1.1 Record system data at pump speeds from 500 rpm to maximum engine speed in 500 rpm ± 20 rpm increments for both fixed wide open thermostat and operating thermostat. Suspend test if pump flow meter or calculated pump flow exhibits a pressure reduction of 10% as engine speed increases. This is an indication that the coolant pump is cavitating. Pump flow may need to be calculated by adding radiator and internal bypass flows.

4.3.1.2 Reduced Coolant Level. Remove 5% of the coolant from the coolant system. (Round off to the nearest 0.1 L). Use the radiator drain, if equipped. If not, remove the coolant from the surge tank.

4.3.1.3 Repeat 4.3.1.1. Note the status of the low coolant level sensor, if equipped.

4.3.1.4 Remove an additional 5% of the coolant from the system. (Round off to the nearest 0.1 L).

4.3.1.5 Repeat 4.3.1.1. Note the status of the low coolant level sensor, if equipped.

4.3.1.6 Continue to remove coolant until system cavitates. Note the critical low coolant level (based on pump cavitation).

4.3.2 System 2 Baseline Coolant System Run.

4.3.2.1 Record system data at pump speeds starting at 10% Pulse Width Modulated (pwm) signal to 100% pwm in steps of 10% ± 2% pwm increments. Suspend test if pump flow exhibits a pressure reduction of 10% as pump motor rpm increases. This is an indication that the coolant pump is cavitating.

4.3.2.1.1 For pump motors that are not controlled by a pwm signal, regulate pump motor voltage starting at 10 V to 14 V in steps of 0.5 V increments.

4.3.2.2 Reduced Coolant Level. Remove 5% of the coolant from the coolant system. (Round off to the nearest 0.1 L). Use the radiator drain, if equipped. If not, remove the coolant from the surge tank.

4.3.2.3 Repeat 4.3.2.1. Note the status of the low coolant level sensor, if equipped.

4.3.2.4 Remove an additional 5% of the coolant from the system. (Round off to the nearest 0.1 L).

4.3.2.5 Repeat 4.3.2.1. Note the status of the low coolant level sensor, if equipped.

4.3.2.6 Continue to remove coolant until system cavitates. Note the critical low coolant level.

4.3.3 System 3 Baseline Coolant System Run.

4.3.3.1 Record system data at pump speeds starting at 10% pwm signal to 100% pwm in steps of 10% ± 2% pwm increments. Suspend test if pump flow exhibits a pressure reduction of 10% as pump motor rpm increases. This is an indication that the coolant pump is cavitating.

4.3.3.1.1 For pump motors that are not controlled by a pwm signal, regulate pump motor voltage starting at 10 V to 14 V in steps of 0.5 V increments.

4.3.3.2 Reduced Coolant Level. Remove 5% of the coolant from the coolant system. (Round off to the nearest 0.1 L). Use the radiator drain, if equipped. If not, remove the coolant from the surge tank.

4.3.3.3 Repeat 4.3.3.1. Note the status of the low coolant level sensor, if equipped.

4.3.3.4 Remove an additional 5% of the coolant from the system. (Round off to the nearest 0.1 L).

4.3.3.5 Repeat 4.3.3.1. Note the status of the low coolant level sensor, if equipped.

4.3.3.6 Continue to remove coolant until system cavitates. Note the critical low coolant level.

4.4 Service Fill Deaeration. Conduct Service Fill Procedure per cooling system requirements.

4.5 Coolant Level Sensor Function (if equipped).

4.5.1 Install operating thermostat.

4.5.2 Completely deaerate (pack) the coolant system.

4.5.3 Fill coolant system to the “cold fill” service level.

4.5.4 Verify that the low coolant sensor operates correctly.

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