GM	WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW17663

Coolant Control Valve

1 Introduction

This document is intended to relate the general level of required content for all Coolant control Valves provide the basis for technical communication and provide a reference for design and document change. The Coolant Control Valve is expected to perform without any failures in all applications.

The responsible Engineers/suppliers may suggest adding additional requirements to this document if they found additional elements are needed to insure the coolant valve will perform as expected, and in a safe and predictable manner.

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. This specification defines the:

a. Design Verification (DV), Production Validation (PV) and In-Process (IP) tests required for Coolant Control Valves that are installed in the high or low temperature Coolant Loops of a GM vehicle.

b. Minimum requirements for coolant control valves.

1.2 Applicability. This standard applies to all global vehicle applications, which include Hybrid, Non- Hybrid, Fuel Cell and Electric Vehicles.

1.3 Remarks. The coolant valve is a functional component designed to regulate, direct, and transfer coolant. More specifically, the role of the coolant control valve is to optimally direct thermal energy to the intended destination.

2 References

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

2.1 External Standards/Specifications.

ASTM D1384	IPC610E	SAE J1726
ASTM D2570	SAE J814	

2.2 GM Standards/Specifications.

GMW3059	GMW3600	GMW14322	GMW15758
GMW3097	GMW3660	GMW14386	GMW15786
GMW3103	GMW8758	GMW14387	GMW15920
GMW3116	GMW14079	GMW14573	GMW16449
GMW3172	GMW14156 (ID)	GMW14671	GMW17144
GMW3191	GMW14157 (ID)	GMW15725	GMW17388

Note: (ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References.

- CG3039, Validation Cross Reference Index (VCRI). (Analysis/Development/Validation Plan and Report (ADVPR) template.)

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- Design Review Based on Test Results (DRBTR).
- GM Part Number 12378255.
- SOR Appendix B.
- SOR Appendix C2.
- SOR Appendix G2.
- SOR Appendix G3.

2.3.1 Standard Titles.

ASTM D1384	Standard Test Method for Corrosion Test for Engine Coolants in Glassware
ASTM D2570	Standard Test Methods for Evaluating Water-Resistive Barrier (WRB) Coatings Used under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage
IPC610E	Acceptability of Electronic Assemblies
SAE J814	Engine Coolants
CG3039	Analysis/Development/Validation Plan and Report
GMW3059	Restricted and Reportable Substances for Parts
GMW3097	General Specification for Electrical/Electronic Components and Subsystems, Electromagnetic Compatibility
GMW3103	Electromagnetic Compatibility (EMC) Component Test
GMW3116	Recyclability/Recoverability
GMW3172	General Specification for Electrical/Electronic Components – Environmental/Durability
GMW3191	Connector Test and Validation Specification
GMW3600	Generic Supplier Analysis/Development/Validation Process Tasks and Deliverables
GMW3660	GM Commodity Validation Signoff Form
GMW8758	Calibrated Accelerated Life Testing (CALT)
GMW14079	Hose Connections
GMW14156	Test Reliability Requirements Guidelines
GMW14157	Statistical Confidence Level for Reliability Validation Testing
GMW14386	Free Acceleration Evaluation Procedure
GMW14387	Electrically Powered Components, Sound Power Evaluation
GMW14573	Global Performance Requirements for Labels
GMW14671	Organic Coating Performance for Under hood and Underbody Components
GMW15725	Performance Requirements for Engine Compartment Plastic Parts
GMW15758	Analysis Development Validation (ADV) Process Development and Validation Terminology
GMW15786	A/C Refrigerant Fitting Shipping Cap Specification
GMW17144	Global Metric Coolant Connections
GMW17388	Software Validation and Verification Process Tasks and Deliverables

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3 Requirements

3.1 System/Subsystem/Component/Part Definition.

The valve should have a single inlet port with discrete outlet ports. The valve shall be configured to allow full, discrete (100%) flow to each outlet and should smoothly blend flow in-between these discrete positions. The coolant valve shall be capable of operation in 50% dexcool® solution.

3.1.1 Appearance.

3.1.1.1 Cosmetic Quality.

a. No visible blemishes may be present on the outside of the part. In addition, none of the defective points may be > 1 cm^2.

b. The above-mentioned requirements (item a) shall be monitored by means of visual check and borderline sample (for purpose of comparison).

c. No sharp edges, flash, or parting lines shall be present unless approved.

d. Deviations to be approved by GM Engineering.

3.1.1.2 Port Labeling.

a. Valve ports shall be numerically (V number) labeled sequentially starting with the Inlet port (Inlet = V1).

b. Label must be permanent.

c. Label type (embossed, etched, etc.), size, and location to be approved by GM Engineering.

3.1.1.3 Part Labeling.

a. Part shall have a label located on the valve body.

b. The label shall not be on the bracket.

c. Label location to be approved by GM Engineering.

d. Label must contain the GM part number, a serialized date code, a time code, and a lot number.

e. The label shall be compliant with GMW14573.

3.1.2 Content. Not applicable.

3.1.2.1 Physical Content. Not applicable.

3.1.2.2 Functional Content. Not applicable.

3.1.3 Ambient Environment.

a. In non-operational soak conditions (shipping and storage), the valve shall not have external coolant leakage or permanent loss of function after being subjected to temperatures between (-51 and 150) °C.

3.1.4 Interfaces.

3.1.4.1 Hose Connections.

a. GM Conventional tube end form will be required for all connections.

b. Parts shall be designed with seamless joints.

c. There shall be no parting lines or flash in the hose connection sealing areas unless approved by GM Engineering.

d. Hose connections shall be verified to GMW17144 (molded fitting type - Joint D or C).

3.1.4.2 Electrical Connections.

a. The electrical connection shall be compliant to GMW3191.

3.1.4.3 Mechanical Connections.

a. The valve shall be mounted to the vehicle bracket by at least two points (preferably on opposite sides of the center of mass).

b. The bracket, isolators (if used), and valve, as a system, must have a natural frequency of > 45 Hz.

c. Isolation of the valve from the vehicle shall be reviewed and approved by the GM Noise Vibration Handling (NVH) Engineer.

3.1.5 Usage Definition. Not applicable.

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3.2 Product Characteristics.

a. Variables and conditions to be recorded on the Component Data Standard (CDS) template shall be approved by the GM Analysis Engineer (template provided by GM Analysis Engineer). Performance capability bandwidth (not just nominal values) of the manufacturing population shall be provided.

b. Other product characteristics to be recorded on the CDS are as follows:

- Pressure Drop (refer to 4.3.10).
- Calibration Table (refer to 3.2.1.2.5.1).
- Current to Move (Maximum In-rush Current, Average Current while Moving, Maximum Stall Current).

3.2.1 Performance Requirements.

3.2.1.1 Electrical.

In addition to the following requirements, the circuit board of the Coolant Control Valve shall be compliant to IPC610E Class 2.

3.2.1.1.1 GMW3172 Coding.

a. When testing per GMW3172, the following loadings shall apply:
   - Electrical Loads – C.
   - Mechanical Loads – G.
   - Operating Temperature – G.
   - Climatic Loads – C.
   - Chemical Loads – E.
   - Dust and Water Protection - IP6K9K, IP6K8.
   - Mounting Location - Engine Compartment: On engine (heavy-duty trucks application).

b. Exact test plan to be approved with the GM GMW3172 Electrical Environmental Engineer.

c. Post-test Functional Check (reference: GMW3172) must be successful after all tests in GMW3172. Following this test, the coolant valve may not show any defects and must fulfill all requirements of GMW17663.

3.2.1.1.1.1 Humidity Requirements.

a. The valve shall operate in a relative humidity range of (0 - 100)% per GMW3172.

3.2.1.1.1.2 Dust/Water/Seal Requirements.

a. The valve shall operate in a dusty environment and be robust to splash and submersion per GMW3172.

3.2.1.1.1.3 Resistance to Chemicals (External).

a. The valve assembly shall meet GMW15725 (for plastic) and GMW14671 (for E-Coat) or judged to be acceptable by GM Material and Validation Engineering.

b. The valve shall meet resistance to chemicals requirements (as defined by GMW16449) for chemicals typically encountered in an exterior/underhood environment, as defined by GMW3172.

3.2.1.1.1.4 Drop Test.

a. The coolant valve shall meet requirements of crush (elbow) and assembly drops at sub-assembly supplier or vehicle assembly plant per GMW3172.

3.2.1.1.1.5 Vibration Test.

Vibration test loading requirements per GMW3172. Valve specific boundary conditions are as follows:

a. The coolant valve, and all components it supports, shall be mounted to the vehicle mounting structure, using the production intent isolators.

b. All coolant hoses shall be attached and retained simulating vehicle position.

c. The valve shall be charged with the correct fluid and statically pressurized with compressed air to 100 kPag (kPa gauge).

d. All pressures within valve shall be monitored with gages to record any pressure decay.

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3.2.1.1.1.6 Voltage Requirements.

a. The valve shall operate without damage or performance degradation when subjected to the electrical loading code defined in 3.2.1.1.1.

3.2.1.1.1.7 Electromagnetic Compatibility (EMC).

a. This coolant control valve shall be compliant with the requirements of GMW3097 and GMW3103. The exact test plan is to be approved by the GM EMC Electrical Environmental Engineer.

Note: For solenoid-type valves:

a. The only section of the GMW3097 specification that applies for the solenoid valve design is Section 3.5.1 of GMW3097, Conducted Emissions (CE), Transients.

b. If the coolant solenoid valve should ever be used in an application involving continuous switching of the solenoid at a frequency of 10 Hz or greater (e.g., using Pulse Wide Modulation (PWM), etc.), then Section 3.3 of GMW3097 Radiated Emissions (RE) and Conducted Emissions (CE) also may apply. The purpose of these tests is to evaluate the risk of vehicle-level radio interference. In general, these tests would not apply to the solenoid valve as a single component, but rather to the electronic device controlling the continuous switching of the valve (i.e., Engine Control Module (ECM), Accessory Power Module (APM), etc.) Any RE or CE issues would generally be resolved through the design of the electronic controller, not the solenoid valve. The solenoid design should never include a capacitor, as this could exacerbate the RE or CE emissions associated with the valve operation if a PWM control system is used.

3.2.1.1.1.8 GMW3172 Test Temperature Definition.

The coolant valve shall function in the following conditions, without: setting a vehicle diagnostic code, external coolant leakage, and/or loss of function.

a. Operational Ambient: Refer to 3.2.1.1.1 of GMW17663.

b. Coolant: The Coolant Control Valve shall have an operational capability of being exposed to coolant at temperatures of (-37 to 124) °C Continuous, 135 °C Excursion (non-operational soak temp).

3.2.1.1.2 Strength of Ports.

Refer to Section 4.9 of GMW14322 Strength of Ports requirements and tests.

The fastening and ports shall be strong enough to withstand an effort of 150 N in direction of ports. The fastening shall be strong enough to withstand an effort of 75 N in any other possible direction.

3.2.1.1.3 Current Draw.

a. The valve energy efficiency shall be approved by GM Release Engineer or Bill of Materials (BOM) Family Owner (BFO).

b. The valve shall not under defined operating conditions cause a vehicle fuse failure.

3.2.1.1.3.1 Current Draw – Validation Test – Acceptance Criteria.

a. The current draw of the coolant valve shall always be ≤ 0.9 A (including but not limited to in-rush and stall). For non-solenoid valves, the current draw of the coolant valve shall be ≤ 0.250 A on average while moving (not including in-rush current).

b. Post-test functional check (reference: GMW3172) must be successful. The coolant valve may not show any defects and must fulfill all requirements of this specification.

3.2.1.1.4 Performance/Onboard Diagnostic (OBD).

Refer to GMW17388 for software validation requirements.

3.2.1.1.4.1 Performance/OBD (Solenoid type) – Validation Test – Acceptance Criteria.

When tested according to 4.3.6 of GMW17663, the valve response time must be < 150 ms. Response time is the total time from command of current application at start position to final desired valve position.

Note: Response time can degrade to 250 ms for end of life and low temperature conditions (below -30 °C) as noted.

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3.2.1.1.4.2 Performance/OBD (Variable Position type).

Drive the valve from port to port within the range of (2 to 10) s in all temperatures/voltages (as defined in GMW3172) with 50% dexcool® Coolant Mixture, for both directions.

a. Must have feedback through the entire length of valve travel.
b. The feedback must be accurate to the variation specified in 3.2.1.2.5, under all operating voltage and temperature requirements.
c. A valid analog feedback signal must always be between 10% and 90% the reference voltage. Exceeding these limits will be considered a failure.
d. A valid PWM drive signal shall operate between 10% and 90% frequency. Exceeding these limits will be considered a failure.
e. Components/Valve Board and Assembly must comply and be approved by GM OBD Representative.

3.2.1.1.4.2.1 Performance/OBD (Variable Position type) – Linear Interconnect Network (LIN) Command and Feedback.

a. The valve complying with GMW17663 shall be controlled by Local Interconnect Network (LIN) software and shall provide feedback. See SOR Appendix C2 for the specification.

3.2.1.2 Mechanical.

3.2.1.2.1 Operating Frequency/Duration.

a. Refer to 4.3.7 and Appendix A – Component Lifecycle Test.

3.2.1.2.1.1 Operating Frequency/Duration – Validation Test – Acceptance Criteria.

a. Setting a diagnostic fault code during the test constitutes a failure.
b. All parts must pass the End of Life (EOL) leakage requirement.
c. Post-test Functional Check (reference: GMW3172) must be successful.
d. The coolant valve may not show any defects and must fulfill all requirements of GMW17663.

3.2.1.2.2 External Leakage.

a. The coolant valve and assembled connections shall be tight and leak free.
b. No visible deformation may occur after test.
c. Coolant valves shall be 100% pneumatic leak tested before shipping from the plant.
d. This test shall be performed before any other EOL performance tests.

3.2.1.2.2.1 External Leakage – Validation Test – Acceptance Criteria.

a. No > 4 cm^3/minute of air may leak.
b. Post-test Functional Check (reference: GMW3172) must be successful. The coolant valve may not show any defects and must fulfill all requirements of GMW17663.

3.2.1.2.3 Internal Leakage (Port to Port).

a. This function is one of the primary functions of the valve. Elimination of internal leakage is the goal.
b. The coolant valve and assembled coolant connections shall be tight and leak free. For verification the coolant valve shall be capable of operation in 50% dexcool® Solution at conditions as defined in Table 2 in 4.3.9.

3.2.1.2.3.1 Internal Leakage (Port to Port) – Validation Test – Acceptance Criteria.

a. Criteria are within Table 2 in 4.3.9 post-test.
b. Functional Check (reference: GMW3172) must be successful.
c. The coolant valve may not show any defects and must fulfill all requirements of GMW17663.

3.2.1.2.4 Pressure Drop.

a. This function is one of the primary functions of the valve. Minimization of pressure drop is the goal.
b. The valve shall not be a significant restriction to the overall system. Component restriction shall be approved by GM Release Engineer or BFO.

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