



Thermal Bypass Valve Validation Test

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. This specification defines the Design Validation (DV), Product Validation (PV), and Post Validation Audit (PVA) requirements for a mechanical Thermal Bypass Valve (TBV).

1.2 Applicability. This specification defines the minimum requirements for Thermal Bypass Valves in passenger car transmission oil cooler systems. This specification applies to all global vehicles.

1.3 Remarks. Not applicable.

2 References

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

2.1 External Standards/Specifications.

ASTM B221 SAE J1344

2.2 GM Standards/Specifications.

9986333	GMW8758	GMW15272	GMW16449
GMW3059	GMW14156 (ID)	GMW15724	
GMW3172	GMW14157 (ID)	GMW15758	
GMW3600	GMW14872	GMW15920	

(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.

- CG2997 Analysis Development Validation (ADV) Test Plan (ADVPR template).
- SOR Appendix B, C2, G, G2, and/or G3.

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The Thermal Bypass Valve regulates oil flow to the remote located cooler in order to control the operating temperature of the transmission. In a cold state, a thermally actuated valve contained inside the bypass housing will allow the oil to short-circuit the Transmission Oil Cooler (TOC). In a predetermined hot state, the valve closes off the bypass and forces all the oil to go through the TOC which, in turn, will regulate the oil temperature of the transmission.

3.1.1 Appearance. Not applicable.

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. The TBV potentially could be located under the hood of a vehicle. The TBV may be exposed to temperatures from (-40 to 150) °C and subject to salt mist and water splash.

3.1.4 Interfaces. Approved GM quick connect fittings and/or directly to steel or aluminum tubes.

3.1.5 Usage Definition. The TBV will be located in the underbody and will be exposed to fluids in GMW16449 (see Appendix A - "Fluid Applicability Per Vehicle Location" table in GMW16449).

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3.2 Product Characteristics.

3.2.1 Performance Requirements. Test fluid used during each test shall be 9986333 (ATF-212B) transmission fluids or a program specific fluid as specified by GM Engineering in the Component Technical Specification (CTS) provided. Ultraviolet dye shall be added to the test fluid prior to testing. All pipe connections on the TBV must be approved by GM Engineering and meet requirements of GMW15724.

3.2.1.1 Fixed-Value Performance Testing Requirements. The following tests (excluding Cleanliness Test and Burst Test) shall be conducted both before and after the tests in 3.2.1.2 Endurance Testing Requirements. In pre-tests, the TBVs shall meet the requirements for each test as described in the procedures and the CTS. In post-tests, the TBVs still must meet the requirements for each test as described in the procedures and the CTS, and shall not have degraded in performance by > 5% from the initial pre-test measurement.

3.2.1.1.1 Pressure Drop Tests. The TBV shall have a maximum pressure drop of 50 kPa when oil at 5 °C below the start to open temperature is flowed at 11 L/minute through the device (4.3.2). The TBV shall have a maximum pressure drop of 25 kPa when oil at Full Open (FO) + 10 °C is flowed at 11 L/minute through the valve (4.3.2).

3.2.1.1.1.1 System Pressure Drop. The maximum system pressure drop is 600 kPa. TBV shall be able to work with 600 kPa of pressure delta between cooler outlet and cooler inlet ports.

3.2.1.1.2 Leakage Test.

3.2.1.1.2.1 Internal Leakage. The TBV internal leakage past the sealing feature shall not exceed 0.3 L/minute with fluid flowing at 12 L/minute at 1000 kPa and the following valve positions: Full Open (FO) with fluid temperature at FO + 10 °C and Full Closed (FC) with fluid temperature at FC - 10 °C when tested (4.3.3.1). Full Open (FO) and Full Closed (FC) requirements shall be defined as according to the CTS.

3.2.1.1.2.1.1 Internal Leakage (In-process Check). The TBV internal leakage past the sealing feature shall not exceed 0.05 L/minute when tested (4.3.3.1.1).

3.2.1.1.2.2 External Leakage. No external leakage of oil is permissible from the TBV assembly including crimped/quick connect pipe interfaces when tested (4.3.3.2). (Refer to Table 3).

3.2.1.1.2.2.1 External Leakage (In-process Check). The leakage shall not exceed 200 L/minute when tested (4.3.3.2.1).

3.2.1.1.3 Hysteresis Test. The TBV must exhibit the hysteresis response defined in the CTS document ("Thermal Bypass Requirement" section) when tested (4.3.4).

3.2.1.1.4 Response Time Test. The FC - 10 °C position to FO + 10 ° position shall be < 45 s when tested (4.3.6) Thermal Durability Test.

3.2.1.1.5 Cleanliness Test. The total weight of contaminants shall not exceed 0.5 mg and all dimensions of any piece of contaminant cannot exceed 0.5 mm when tested (4.3.1).

3.2.1.1.6 Burst Test. Minimum burst strength shall be no less than 6895 kPa when tested (4.3.5).

3.2.1.1.7 TBV Drop Test. The samples tested shall meet the requirements of all endurance and performance tests when tested (4.3.11). Each sample will then be tested in an endurance test leg shown in CG2997.

3.2.1.1.8 TBV Assembly Drop Test. The samples tested shall meet the requirements of all endurance and performance tests when tested (4.3.12). Each sample will then be tested in an endurance test leg shown in CG2997.

3.2.1.1.9 High Temperature Aging Test. The TBV shall meet the pressure drop requirements (4.3.2), internal leakage requirements (4.3.3.1), external leakage requirements (4.3.3.2), hysteresis requirements (4.3.4), and vibration requirements (4.3.10) after completion of high temperature aging test (4.3.8).

3.2.1.1.10 Corrosion Test. The valve assembly shall meet the Underbody Cosmetic and Functional corrosion requirements for Class 1/2 Regional Corrosion, per GMW15272. The valve shall meet Underhood Cosmetic Corrosion requirements per GMW15272 (see Appendix A – "Cosmetic Corrosion Resistance Requirements" table in GMW15272), and GMW14872 (see Appendix A – "Mass Loss Targets (3.18 mm thick coupons) - Cosmetic and Functional" table in GMW14872) Underhood All Splash, Method 1/2 cosmetic and functional corrosion requirements, columns B and E. The valve assembly shall meet "Thermal Soak Addition" deviation in GMW14872.

3.2.1.2 Endurance Testing Requirements. These requirements are subject to sample size and reliability requirements (3.2.3.2).

3.2.1.2.1 Thermal Durability Test. The TBV shall meet the pressure drop requirements (4.3.2), internal leakage requirements (4.3.3.1), external leakage requirements (4.3.3.2), and hysteresis requirements (4.3.4) after testing per 4.3.6 and meeting the Reliability requirements (3.2.3.2).

3.2.1.2.2 Thermal and Pressure Cycle Test. The TBV shall meet the pressure drop requirements (4.3.2), internal leakage requirements (4.3.3.1), external leakage requirements (4.3.3.2), and hysteresis requirements (4.3.4) after testing per 4.3.7 and meeting the Reliability requirements (3.2.3.2).

3.2.1.2.3 Vibration Test. The TBV shall meet the pressure drops requirement (4.3.2), internal leakage requirements (4.3.3.1), external leakage requirements (4.3.3.2), and hysteresis requirements (4.3.4) after completion of vibration test (4.3.10). Mount TBV (GMW3172), truck duration, transmission mounted. Multiple lives are not required for this test. The hours defined by GMW3172 already includes multiple lives.

3.2.2 Physical Characteristics. Not applicable.

3.2.2.1 Dimensions and Capacity. Not applicable.

3.2.2.2 Mass Properties. Not applicable.

3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point. This specification, as written, provides a test exposure representing a Reliability Evaluation Point (REP) of 15 years of corrosion and 240 000 km (150 000 mi) of severe customer usage at the vehicle level.

3.2.3.2 Reliability Requirements. This specification, as written, supports the demonstration of the required reliability of 99% or greater at a 50% confidence (R99C50), at the REP for the TBV. The supplier shall utilize "vehicle equivalent" laboratory test setups to simulate "in vehicle" orientations. If the orientation may be different from one vehicle to another, use the orientation which will provide the worst-case loads for all physical level reliability demonstration testing.

The reliability demonstration is provided by the Design Validation (DV) Endurance Tests. In contrast to DV, the endurance tests specified for Product Validation (PV) are intended to confirm conformance to the reliability demonstrated during DV. See 4.1.5 of this GMW16580 for endurance test specification.

Test to Failure is always the preferred method. Failure is defined as, but not limited to, the loss of function, unacceptable performance degradation and non-conformance of the component as stated in this specification.

Note: The required number of test samples may be negotiable if it is not practical to run (i.e., 23 samples). Negotiation of sample size should consider test equipment limitations, test sample physical size, test duration, etc. However, reduction of the sample size may require inclusion/use of longer test durations or other test methods, such as Highly Accelerated Stress Screening (HASS), Highly Accelerated Stress Testing (HAST), Calibrated Accelerated Life Testing (CALT), Highly Accelerated Life Testing (HALT), etc. Weibull slope values available from previous failure testing may be considered as a way to reduce the sample size and/or test duration. For details refer to GMW14156 and GMW14157.

3.2.3.3 Accelerated Test Methods. GM encourages the use of appropriate accelerated test methods, wherever possible; for example, the use of accelerated stress testing to reduce test time (GMW8758).

Note: GM Validation Engineering shall review and approve reliability demonstration test plans prior to the supplier submitting the Analysis Development Validation (ADV) Test Plan, CG2997 form, for approval (CG2997 is located in the Statement of Requirements (SOR), Appendix G).

3.2.4 Serviceability. Not applicable.

3.2.5 User System/Subsystem/Component/Part Interface. Not applicable.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines.

3.3.1.1 Material Guidelines. Not applicable.

3.3.1.2 Processes Guidelines. Not applicable.

3.3.1.3 Parts Guidelines. Not applicable.

3.3.1.4 Recycling. Materials shall be recyclable per SAE J1344.

3.3.2 Design Guidelines and Constraints. Not applicable.

3.3.3 Identification and Marking. Materials must be labeled with the GM part number, date code and tool/cavity number in a visible location.

3.3.4 Workmanship. Not applicable.

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3.3.5 Interchangeability. Not applicable.

3.3.6 Packaging. Not applicable.

3.4 Documentation. All test samples must be qualified dimensionally. All data points must be reported. For samples destructively tested, mode of failure must be reported and include digital photographs of failure mode. All test specimens must be retained by the supplier for a minimum of one year and be available for review by GM Engineering, if requested. Test Procedures referencing specific minimum test values must be met by the -3 sigma limit of the sample population tested. For PV testing, documentation shall be provided as required by the normal Production Part Approval Process (PPAP).

3.5 Support of System/Subsystem/Component/Part After Sale. Not applicable.

3.6 System/Subsystem/Component/Part Operator Training. Not applicable.

3.7 System/Subsystem/Component/Part Characteristics.

3.7.1 System/Subsystem/Component/Part Definition.

4 Validation

4.1 General.

4.1.1 Validation Phase Definitions. Reference GMW15758 (ADV Process Development and Validation Terminology) for the definitions of Design Validation, Product Validation, and Post Validation Audit.

4.1.2 Test Samples. Reference GMW15758 for explanations of how parts for Design Validation, Product Validation, and Post Validation Audit shall be produced and selected.

4.1.3 Test Equipment Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

4.1.3.1 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this specification shall be determined correctly with respect to its physical definition. When test facilities or test equipment are changed between DV and PV testing, GM Component Validation Engineer approval is required.

4.1.4 Performance Test Requirements. These are tests designed to demonstrate the performance of the component, but not necessarily the reliability.

4.1.5 Endurance Test Requirements. These tests are designed to demonstrate the component reliability. Endurance testing may be conducted using either Test to Failure (4.1.5.1) or Success Testing (4.1.5.2). Test to Failure (TTF) is always the preferred method.

4.1.5.1 Test to Failure. Failure is defined as, but not limited to the loss of function, unacceptable performance degradation, and nonconformance of the component as stated in this specification. Use of Weibull analysis is required to determine the reliability.

Note: The required number of test samples may be negotiable (considering test equipment limitations, test sample physical size, test duration, etc.) Weibull slope values available from previous failure testing may be considered as a way to reduce the sample size and/or test duration. Reduction of sample size shall not cause demonstration of the reliability requirement to be unfulfilled. In no case shall the sample size be less than four (4). In no case shall the Weibull slope be > 4.0 (even with previous failure data).

Note:

- If any failure occurs in the 1st life of customer usage, stop the entire test. Do a Design Review Based on Test Results (DRBTR) and perform root cause analysis. If, and as determined, redesign the part or product and repeat testing from the beginning.
- Upon failure after the 1st life, plot Weibull slope and calculate reliability demonstrated.
- If no failures by the completion of required reliability demonstration, remove half of the samples from test stand and do the functional tests followed by DRBTR.
- Continue test to failure with the remaining samples (consider using stepped stress methods to induce failure) and do the functional tests followed by DRBTR to analyze failed samples.

4.1.5.2 Success Testing. Refer to Table 1 for success test.

Table 1: Number of Samples Required for Endurance Tests

Minimum Sample Size Required			
Reliability Requirement	Quantity of REPs (lives)	Slope (beta)	Success Testing (samples)
R99C50	2.0	2.5	12

Note: The slope values listed may be reduced by the GM Validation Engineer for new design or new suppliers.

Note:

- If any failure occurs in the 1st life of customer usage, stop the entire test. Do a Design Review Based on Test Results (DRBTR), perform root cause analysis. If, and as determined, redesign the part or product and start testing all over again.
- Upon failure after the 1st life, plot Weibull slope and calculate reliability demonstrated.

4.2 Validation Cross Reference Index.

4.2.1 Analysis/Development/Validation Plan and Report (ADVPR). The ADVPR template is CG2997. This document contains all component requirements, associated test procedures, test flows, and the quantity of parts to be tested at DV, PV, and Post Validation Audit (PVA) phases. This document is to be completed by the supplier and approved by the appropriate heat exchanger GM Design Release Engineer and GM Component Validation Engineer. Exceptions and or clarifications may be in SOR Appendix C2, G2, and/or G3, and should be comprehended in the final approved ADVPR.

4.2.2 Test and Results Approvals. Both test plans, and test results shall be approved as noted in the following.

4.2.2.1 DV Approval. Approval shall be provided by the appropriate GM Component Validation Engineer.

4.2.2.2 PV Approval. Approval shall be provided by the appropriate GM Component Validation Engineer.

4.2.2.3 PVA Approval. Test results are self-certified by the supplier. Results shall be available for audit by the GM Component Validation Engineer, GM Design Release Engineer, or the GM Supplier Quality Engineer.

4.2.2.3.1 Alternative Compliance. Supplier may request an exemption from Post Validation Testing, provided supplier can demonstrate that sufficient process controls are in place so as to make testing unnecessary. The approvals required are to be provided by the GM Validation Engineer, GM Supplier Quality Engineer and GM Bill of Materials (BOM) Family Owner (BFO).

4.2.2.3.2 Lot Retention. In the case of a Post Validation Audit test result not meeting requirement, the affected production lot shall be retained by the supplier until Root Cause Analysis is complete. The supplier shall then decide the disposition of the affected production lot. The supplier has three options for this retained lot; it shall be either:

- Scrapped.
- Corrected and certified (which may mean lot testing the revised part again) based on the root cause analysis.
- Shipped without correction if deemed to be acceptable based upon the root cause analysis.

In any event, GM Supplier Quality Engineering shall be notified whenever any of the preceding options is exercised. GM Supplier Quality Engineering approval is required for Option c. Lot acceptance test procedure is defined in Appendix B of the SOR documents.

4.2.3 Documentation.

Documentation shall be provided as required by the normal Production Parts Approval Process (PPAP) process. Refer to GMW3600 and SOR Appendix G2. Documents shall be managed according to GMW15920.

4.3 Supporting Paragraphs.

4.3.1 Cleanliness Test.

- Obtain the TBV immediately after final assembly or from proper packaging according to the CTS so that no containments will interfere with the internal passages.
- Obtain and clean a flask.
- Obtain a new, unused piece of filter paper of a maximum of 20 µm from a sealed container.
- Place the filter paper on a cleaned plastic petri dish to measure the weight of the filter paper and dish together.

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