



Plastic Plumbing for Water/Coolant Application - Low Temperature Coolant Circuits Assemblies Validation

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) and Product Validation (PV) requirements for Plastic Coolant Plumbing Assemblies on Low Temperature Coolant Circuits external to Rechargeable Energy Storage System (RESS)

1.2 Applicability. This test is applicable to all thermoplastic glycol/water cooling lines for low temperature circuits such as external battery cooling lines, drive unit cooling lines, etc.

1.3 Remarks. The thermoplastic low-temperature lines (material and joints) shall pass GMW18152 to support the diverse packaging and processing requirements.

2 References

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

2.1 External Standards/Specifications.

ISO 17025

2.2 GM Standards/Specifications.

GMW3059	GMW3420	GMW14872	GMW15760
GMW3116	GMW14573	GMW15272	GMW15920
GMW3221	GMW14797	GMW15758	GMW18152

2.3 Additional References.

- GM Part Number 9986100 dexcool® Premix
- GM1829 Analysis/Development/Validation Plan and Report (ADVP&R)
- Statement of Requirements (SOR) Appendix B
- Subsystem Technical Specification (SSTS)
- Vehicle Technical Specification (VTS)
- Verband der Automobileindustrie (VDA) (German Association of the Automotive Industry) information can be found at www.vda.de/en.html

3 Requirements

3.1 System/Subsystem/Component/Part Definition. Not applicable.

3.2 Facilities. As required to perform the test as described on this document.

3.2.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label. Test facilities certification per ISO 17025.

3.2.2 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.

3.3 Requirements on Test Specimens. Reference GMW3221. Unless otherwise specified, the shape and size of test pieces shall be in accordance with the relevant test method. The minimum number of samples (hose assemblies) per test is defined in Table 1 (see 4.3.1). Samples are finished parts or to be taken from finished parts. Where the dimensions on the finished parts do not allow preparing of test pieces, tests are to be performed on material from the same production batch. For testing of a hose construction to the following performance properties of Table 1 of this specification, each type of quick connector, inline, T connector or Y connector used in a design released to this specification must be incorporated into the samples tested.

3.4 Reliability.

3.4.1 Reliability Evaluation Point (REP). This specification provides a test exposure representing a REP required by GM.

3.4.2 Reliability Requirements. This specification supports the demonstration of the required Reliability performance of 99% or greater at a 50% Confidence level (R99C50), at the REP for the coolant pipe joints. 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 caseloads for all physical level reliability demonstration testing.

The reliability demonstration is provided by the DV Endurance Tests specified in Table 2 (see 4.3.1.3).

Note: 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.

3.4.3 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.

Note: The required number of test samples may be negotiable if it is not practical to run, for example, 23 samples. Negotiation of sample size shall consider test equipment limitations, physical size of test samples, 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.

Note: GM Validation Engineering shall review and accept reliability demonstration test plans prior to the supplier submitting the Analysis Development Validation (ADV) Test Plan for approval.

3.5 Serviceability. Not applicable.

3.6 Identification and Marking. All assemblies must be labeled with the GM part number, date code and tool/cavity number in a visible location. All labels shall conform to GMW14573. Printing shall conform to GMW14797.

3.7 Recycling. Materials shall be recyclable per GMW3116. Attempts shall be made to minimize the variety of materials used, to make recycling more viable.

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

3.9 Equipment.

3.9.1 Instrumentation. As required to make sure the test is performed following the parameters as described on this document.

3.9.2 Test Equipment.

3.9.2.1 Fixturing. The fixtures shall not impact the performance of the part on the test.

3.9.2.2 Test Piece. Test material include all Tube and attachments as required to simulate in-vehicle installation.

3.10 Test Vehicle/Test Piece. Test material include all hose assembly and attachments as required to simulate in-vehicle installation.

3.11 Test Time. Time depends on the number of samples tested. The following are estimates.

Calendar time:	30 d
Test time/Long Lead Test:	20 d

3.12 Test Required Information. The performance measurements and durability test results shall be summarized and reported to GM on the supplier form GM1829 for the component or components being tested. Full test reports shall be available for viewing by GM personnel per GMW15920. If there is a breakage, leak or condition out of the acceptance criteria on test, GM must be informed within 24 h.

As a preparation for all testing, supplier shall bend the hose 180 degrees on the convoluted portion and fix it on that position for 1 h at standard ambient temperature, then take the part back to its original position to start the test. If the hose assembly has more than one (1) portion of convolutes, the bend should be made only on one (1) portion, select the bend with the biggest angle; Figure 1 shows an example.

Figure 1: Bend Hose 180 degrees



3.12.1 Burst Test.

3.12.1.1 Procedure.

- Mount the mating interfaces (e.g., Verband der Automobileindustrie (VDA) spigot, hose barb, etc.) in a test chamber.
- Install the assembly being tested. All ends of the pipe shall be attached to the test chamber and sealed.
- As a testing fluid, either coolant or air can be used. The test equipment shall be capable of supplying sufficient pressure until burst.
- Completely fill the pipe test sample with testing fluid.
- Maintain test chamber ambient temperature at Maximum Excursion Temperature $\pm 2^\circ\text{C}$ for 4 h. Use 60°C for hose construction Type A per GMW18152. For Hose construction Type B and Type C per GMW18152, use VTS Maximum Excursion Temperature.
- Increase pressure at a rate of $20\text{ kPa/s} \pm 5\text{ kPa/s}$ until either burst or leakage occurs. A diagram of pressure vs. time must be recorded on the chart of the software of the equipment.

3.12.1.2 Requirements: The minimum burst pressure shall be at least two (2) times $\pm 5\text{ kPa}$ the maximum continuous system working pressure per SSTS/VTS (SOR Appendix B). Burst pressure and failure mode shall be documented in supplier document (supplier-owned form/format).

3.12.2 Dimensional Analysis.

3.12.2.1 Before the following test, 3.12.3 to 3.12.6, a dimensional analysis is required on each sample being tested as well as the spigots used for the testing.

3.12.2.2 For the case of Pressure Vibration Temperature (PVT) per 3.12.6, additional dimensional analysis is required for the position of the pipe on the chamber.

3.12.2.3 The dimension analysis must be delivered as part of the test report and shall include at least the following characteristics:

3.12.2.3.1 Spigots of the Interfaces in the Chamber. Dimensions shown on the respective drawing. Report required for parts to be used on DV and PV.

3.12.2.3.2 Intermediate Connections. Dimensions shown on the respective drawing. Dimensions to be taken before the subcomponents are assembled. Report required for DV parts only.

3.12.2.4 Assemblies. Report at least the following dimensions on samples to be tested for DV and PV:

- Hose Inner Diameter (ID) and Outside Diameter (OD)
- Minimum and Maximum diameter on convoluted portions on external surface only (peaks and valleys)
- Routing profile

3.12.3 Vacuum Collapse Test.

3.12.3.1 Procedure. All the hoses shall be exposed to a vacuum pressure of 2 kPa (Absolute Pressure) for 30 s.

3.12.3.2 Requirement. The test can be considered as passed under any of the following circumstances:

- a. The minimum OD shall decrease by no more than 20% during application of vacuum pressure.
- b. There is no indication of delamination between plastic layers.
- c. No permanent deformation of the hose ID after application of vacuum pressure.
- d. No bulge or crack effects of hose outer surface.
 - After completion of vacuum pressure, conduct leak test per 3.12.4.

3.12.4 Leak Test.

3.12.4.1 Procedure.

- a. Mount the complete assembly on a bench using interfaces/spigots made of either aluminum or thermoplastic with a geometry that meets VDA standards. Use aluminum if the interface on the vehicle is metal, use thermoplastic if the interface in the vehicle is plastic.
- b. Connect the assembly to a pressure decay system and apply an internal pressure equal to 1.20 times $\pm$ 5 kPa maximum continuous system working pressure per SSTs/VTs, hold this pressure for 5 minutes. If no pressure value is specified, consider 200 kPa.
- c. Make sure the temperature is stabilized at 23 °C.

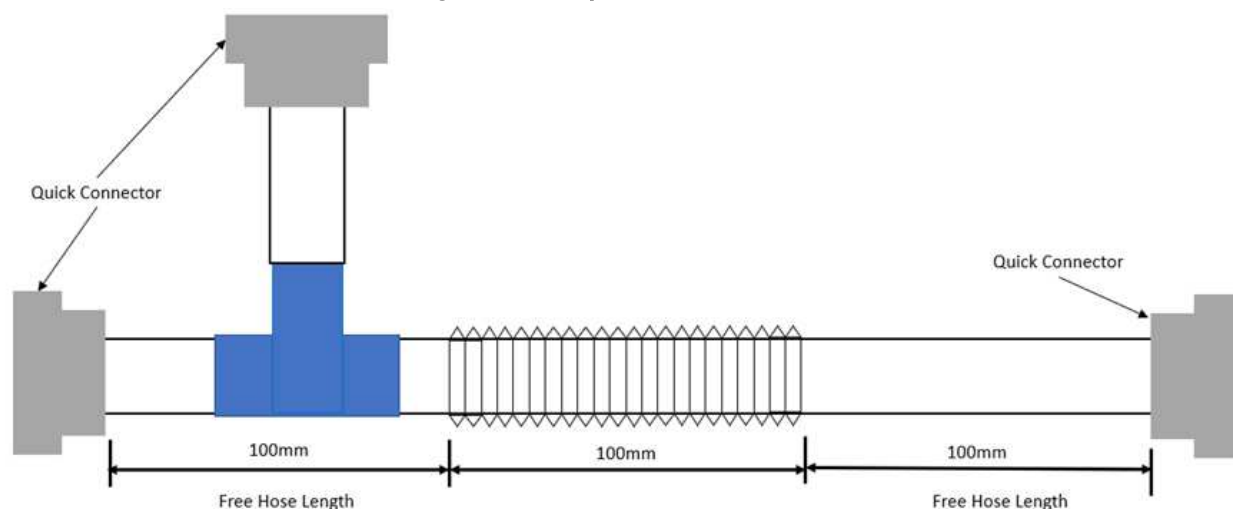
3.12.4.2 Requirement. No reduction of internal pressure which could indicate leaks.

3.12.5 Cold Leak Test.

3.12.5.1 Procedure.

- a. Place the assembly on a bench using interfaces/spigots made of either aluminum or thermoplastic with a geometry that meets VDA standards. Use aluminum if the interface on the vehicle is metal, use thermoplastic if the interface in the vehicle is plastic.
- b. If the assembly includes mid connections or plumbing branches, make sure the branch is included and tested with its corresponding spigot as shown in Figure 2.
- c. Follow the procedure as indicated on GMW18152.

Figure 2: Setup for Cold Leak Test



3.12.5.2 Requirements. No stains that could indicate leaks. Inspection using Ultraviolet (UV) light equipment is recommended.

3.12.6 Pressure Vibration Temperature (PVT).

3.12.6.1 Procedure. This test applies only for the parts subjected to relative movement between the interfacing components.

3.12.6.1.1 Procedure. Prior to testing, visually inspect all hoses for evidence of bloom, cuts/damage or residual oils or other residue from the manufacturing process and capture findings.

- Samples for this test shall be the same samples used for tests on sections 3.12.2 to 3.12.5 (Appendix A, Figures A1, A2, A3 and A4 include graphical representations of the profile, pressure signal and coolant flow).

3.12.6.1.2 Segment 1. Raise chamber temperature linearly at a range of 1.5 °C/minute up to 90 °C for Type A, 120 °C for Type B and 130 °C for Type C or maximum temperature per SSTS/VTs and stabilize for 540 minutes while keeping the following conditions:

- Coolant heater: ON. See **Note 1** following 3.12.6.1.6
- System Pressure: ON (Maximum Flow Rate 26 L/minute). See **Note 2** following 3.12.6.1.6
- Coolant pump: ON
- Motion: ON, for definition of motion vector, see Appendix B in this document.
- Coolant Flow: 26 L/minute

3.12.6.1.3 Segment 2. Increase coolant temperature at a rate of approximately 1 °C/minute until the fluid reaches the extreme temperature set by SSTS/VTs, or 75 °C for Type A, 125 °C for Type B and 135 °C for Type C. Keep chamber at 90 °C for Type A, 120 °C for Type B and 130 °C for Type C or maximum temperature per SSTS/VTs and finish segment under the following conditions:

- System Pressure: ON (Maximum Flow Rate 26 L/minute). See **Note 2**
- Coolant pump: ON
- Motion: ON, for definition of motion vector, see Appendix B in this document.
- Coolant Flow: 26 L/m

3.12.6.1.4 Segment 3. Reduce chamber temperature until it reaches -40 °C keeping the next conditions:

- System Pressure: OFF
- Coolant pump: OFF
- Coolant heater: OFF
- Motion: OFF