



Validation Testing for Water/Coolant Joints

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), Production Validation (PV) and Steady State Part Monitoring (SSPM) requirements for coolant hose interfaces, including mid-assembly connections (T joint, Y joint, etc.) The designs validated under this specification may or may not be included in GMW17144, which is the global metric coolant connection standard for hoses and fittings. GM Engineering may require any connection not defined in GMW17144 be subjected to this specification, prior to acceptance. The supplier shall work with the GM Design Responsible Engineer (DRE) to comprehend this requirement.

1.2 Applicability. This specification and the test described applies for all the connections used on coolant applications, this includes but is not limited to, hose and clamps, hose and quick connectors and/or hose with overmold features. This procedure must be executed regardless of the type of interface used in the assembly.

1.3 Remarks. None.

2 References

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

2.1 External Standards/Specifications.

ASTM A254 SAE J1344

2.2 GM Standards/Specifications.

GMW3059	GMW14329	GMW15184	GMW15920
GMW3116	GMW14573	GMW15272	GMW17144
GMW3286	GMW14785	GMW15758	
GMW3420	GMW14872	GMW15760	

2.3 Additional References.

- 9985809, Dexcool® Extended Life Engine Coolant.
- Instron Testing Systems available at www.instron.us/en-us/products/testing-systems.

3 Requirements

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

3.2 Product Characteristics. All crimps, over-molds (plastic molded rings acting as crimps), and non-standard clamp joints shall be described as coupled assemblies, for the remainder of this document.

3.2.1 Performance Requirements.

3.2.1.1 Fixed-Value Performance Testing Requirements. GM Engineering to agree to samples before testing begins. For sample requirements and quantities, see 3.8.

3.2.1.2 Endurance Testing Requirements. GM Engineering to agree to samples before testing should begin. For sample requirements and quantities, see 3.8.

3.2.1.2.1 Pressure/Vibration/Temperature (PVT) Test. Samples must meet the acceptance requirements of GMW14785. Samples must meet the acceptance requirements of the Cold Leak Test (see Table 4, 4.3.1.1), following test completion. For sample quantity guidelines, see 3.8.

3.2.1.2.2 Pressure/Temperature Test. Assemblies shall be tested per Table 6, 4.3.2.2 - Pressure/Temperature Test, no leakage is allowed during the test procedure. Assemblies must pass the requirements of the Cold Leak Test (see Table 4, 4.3.1.1), following test completion.

3.2.1.2.3 Coolant Circulating Test. Assemblies shall be tested per Table 6, 4.3.2.3 - Coolant Circulating Test. Assemblies must pass the requirements of the Leak and Blow off Test (Table 4, 4.3.1.2), following test completion.

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) required by GM.

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 coolant hose assembly. 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 1.

Note: Test to Failure (TTF) is always the preferred method. 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.

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.

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.

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.

3.2.4 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.

3.3.1.3.1 Coupling Design. The coupling shall be designed and manufactured (for example, over-molded, inserted, swaged, or crimped) so that no internal tube abrasions, cuts or flaws shall result under any condition or combination of assembly component dimensioning or tolerances allowed by supplier production specifications, or under any condition of rubber hose compression allowed by supplier production specifications.

3.3.1.3.2 Sharp Corners. Sharp corners are not permitted where the coupling contacts the tube in order to prevent cutting of the hose when the hose assembly is subjected to internal pressure.

3.3.1.3.3 Tube Insert. The tube insert must not extend past the end of the crimp shell after crimping, and the end of the tube insert must have a radius and be manufactured to eliminate burrs or sharp edges which might cause hose damage under conditions of assembly vibration or pressure impulse.

3.3.1.3.4 Damage. Damage to hose rubber or reinforcement generated by the coupling of the hose is not permissible under any possible production manufacturing conditions or supplier production tolerance stack-up, including variations in hose compression concentricity.

3.3.1.3.5 Tube Collapse. Metal tube insert collapse during crimping is not permissible, except when this collapse is limited, predictable, controllable, and does not increase the potential for assembly leakage or other malfunction. Approval is required from the GM Global Heating, Ventilation, Air Conditioning, Powertrain Cooling (HVACPTC) Engineer.

3.3.1.3.6 Design Restrictions. Grooves, upsets, or serrations are not permitted on the tube stem Outside Diameter (OD), or on the crimp shell Inside Diameter (ID), except that these grooves, upsets, or serrations do not cause hose cutting or other damage under any condition or combination of assembly component dimensioning or tolerance allowed by supplier production specifications, or under any condition of rubber hose compression allowed by the supplier production specifications.

3.3.1.3.7 Skiving, Adhesives. Skiving of the hose is not permissible. Use of adhesives in the joint is not permissible.

3.3.1.4 Recycling. Materials shall be recyclable per GMW3116. Attempts shall be made to minimize the variety of materials used, to make recycling more viable. See also 3.3.3.1.

3.3.2 Design Guidelines and Constraints.

3.3.3 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.

3.3.3.1 All plastic parts shall be identified for recycling per SAE J1344.

3.3.4 Workmanship. Not applicable.

3.3.5 Interchangeability. Not applicable.

3.3.6 Packaging. Not applicable.

3.4 Documentation. See GMW15920.

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. Not applicable.

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

3.8 Testing Requirements.

3.8.1 DV Phase.

Table 1: DV/PV Test Table

Reference	Test	Number of Samples for Couplings ^{Note 1}	Number of Samples for Quick-Connect	Test Type
Table 4, 4.3.1.1	Cold Leak	24	12	Performance
Table 4, 4.3.1.2	Leak and Blow off	24 ^{Note 2}	12 ^{Note 2}	Performance
Table 4, 4.3.1.3	Blow off After Heat Aging	24	12	Performance
Table 4, 4.3.1.4	Vacuum	24	12	Performance
Table 4, 4.3.1.5	Insertion Force	Not applicable	12	Performance
Table 4, 4.3.1.5	Cleanliness Test	6 ^{Note 4}	6	Performance
Table 4, 4.3.1.7	Cyclical Corrosion	24 ^{Note 3}	12	Performance
Table 4, 4.3.1.8	Salt Spray	24 ^{Note 3}	12	Performance
Table 4, 4.3.1.9	Maximum Crimp Compression Condition	16	Not applicable	Performance

Reference	Test	Number of Samples for Couplings ^{Note 1}	Number of Samples for Quick-Connect	Test Type
Table 4, 4.3.1.10	Minimum Crimp Compression Condition	16	Not applicable	Performance
Table 4, 4.3.1.11	Error-Proofing Pull-Tab Test	Not applicable	12	Performance
Table 4, 4.3.1.12	Anti-Rotation Torque Test	Not applicable	12	Performance
Table 6, 4.3.2.1	Pressure/Vibration/Temperature	24	12	Endurance
Table 6, 4.3.2.2	Pressure/Temperature	24	12	Endurance
Table 6, 4.3.2.3	Coolant Circulating	24	12	Endurance

Note 1: This quantity may change depending on the type of coupling (see 3.8.1.1 thru 3.8.1.1.2.2).

Note 2: Execution of procedure Table 4, 4.3.1.2 to set pressure for leak is required to certify assemblies/joints prior the start of endurance testing included in the Table 6.

Note 3: This testing not required in PV as long as material is identical to material used in DV testing.

Note 4: This testing is required just for vehicle electric applications unless specified by GM DRE.

3.8.1.1 Test Samples. Sample or assembly is used to describe the component to be tested which shall include the production design intent component, if production intent connection fitting is not available, samples can be machined using vehicular design parameters. This is subject to approval by GM DRE and GM Validation Engineer.

3.8.1.1.1 For DV. Design representative test samples may be produced from prototype tooling or from equivalent production tooling, but must represent design intent, including design tolerances and material variation within specification. DV testing can be completed using entire assemblies (representative hose routing at vehicle position with all additional components installed) or with the definition of connection coupons with a free hose length of 250 mm as minimum, prior GM DRE and GM Validation Engineer approval.

3.8.1.1.2 For PV. Production test samples must be produced using production representative equipment including the effects of manufacturing variation, full assemblies have to be tested for Performance and Endurance testing with the number of samples defined on Table 1, if due hardware problems, such as the size of the full assembly relative to the size of the test chamber or test equipment capabilities, the definition of connection coupons is possible just if the parts come from production representative equipment with a free hose length of 250 mm prior GM DRE and GM Validation Engineer approval. Sample selection of components to be utilized for the purpose of PV reliability requirements demonstration shall be in concurrence with the guidelines set forth in GMW15760.

3.8.1.1.2.1 Coupled Assemblies. For crimped hoses: Twelve hose assemblies crimped at nominal hose compression and twelve at minimum hose compression shall be tested. This may mean more than 24 samples for the DV tests, and would require the Analysis, Development and Validation Performance Review (ADVPR) to reflect this sample increase. A minimum of two samples per parameter configuration is required. For over-mold designs the supplier must choose samples representing the full extent of the design parameters, as well as proposed production parameters. For clamp interfaces, the supplier must demonstrate compliance of the minimum clamping force per GMW15184 on the test subjects. This may mean more than 24 samples for the DV tests, and would require the ADVPR to reflect this sample increase. A minimum of two samples per parameter configuration is required. For the minimum sample size refer to Table 1.

3.8.1.1.2.2 Quick-Connect Assemblies. Twelve assemblies at maximum dimension tolerance (largest female connection features, smallest male spigot features) shall be tested per Table 1. GM Engineering to agree to samples before testing begins. The exception will be for test Table 4, 4.3.1.5 Insertion Force, where the assemblies shall be at minimum dimension tolerance (smallest female connection features, largest male spigot features).

3.8.1.2 Fixed-Value Performance Testing. Hose assemblies shall be tested for conformance per Table 1.

3.8.1.2.1 Crimp Compression. Test samples throughout this specification will be referred to as minimum hose compression, nominal hose compression or maximum hose compression samples. The requirements for these conditions are described in Appendix A. If not specified, the test samples shall be of nominal hose compression.

3.8.1.3 Endurance Testing. Hose assemblies shall be tested for endurance per Table 1.

3.8.1.4 Design Level Requirements. Not applicable.

3.8.1.5 Approval Requirements. Approval shall be provided by the GM DRE and the GM Validation Engineer.

Note: DV and PV approval will require the information in 3.8.1.5.1 thru 3.8.1.5.6 to be submitted.

3.8.1.5.1 Drawings and Unigraphics (UG) math data showing the design, dimensions and tolerances for all components of the assembly including allowed eccentricity in the hose, tube insert, and coupling OD. In addition, the range of the all-hose compression possible under each condition of dimensional tolerance stack-up shall be provided.

3.8.1.5.2 The submission of sectioned coupling samples to demonstrate that all the construction requirements have been met.

3.8.1.5.3 A detailed description of the statistical process control procedures for the coupling diameter dimensions and the hose compression range. Include a sample of Statistical Process Control (SPC) data once available.

3.8.1.5.4 The value for hose compression necessary to induce (referred to Hose Compression to Damage):

- Hose rubber damage (any layer).
- Hose reinforcement damage.

3.8.1.5.5 Data presented in both tabular and graph form, showing values of hose compression (calculated using both linear and area methods) vs. Blow off performance (Table 4, 4.3.1.4), and fitting insert collapse. The dimensions of the crimped assembly components for each data point must be listed, as well as the resultant hose compression, refer to Appendix A, Table A1 for calculations.

3.8.1.5.6 Copies of the test fixture parameter data, confirming pressure and temperature regimens imposed on the samples during test.

Note: Values of hose compression must be reported both in terms of linear compression and area compression. See Appendix B, Table B1 for the formula for each calculation.

3.8.1.6 Documentation. All test samples must be qualified dimensionally. All data points must be reported. For samples destructively tested, mode of failure must be reported. Failure mode(s) must be recorded with digital photograph and supplied to GM Engineering upon request. All test specimens must be retained by the supplier for 1 year and be available for review by the GM Global HVACPTC Engineer, upon request. Test procedures referencing specific minimum test values, must be met by the -3 Sigma limit of the sample population tested.

Note: Approval shall be provided by the GM DRE and the GM Validation Engineer. For DV approval requires the information in 3.8.1.7 be submitted.

3.8.1.7 DV/PV Engineering Approval Factors. Engineering source approvals generated through testing to prove compliance to this specification are specific for combinations of the following:

- Size of hose and coupling components.
- Hose material and construction, including supplier.
- Coupling design.
- Tube; insert material, plating, finish and hardness.
- Coupling shell material, plating, finish and hardness.
- Supplier specifications, manufacturing procedures and supplier (both hose and assembly) manufacturing sites.

Note: Testing of one construction of assembly can result in engineering source approvals for two crimp designs or materials by placing each design or material variant on one end of the assembly.

3.8.2 Steady State Part Monitoring (GMW15758).

3.8.2.1 Test Samples. Test samples shall be made using production intent process/techniques/parameters for tube extrusion and the assembly of any additional hardware such as quick connectors. Connection coupons shall be made to leave a free tube length of 250 mm, endurance testing can be completed by using straight tube sections between connections.

3.8.2.1.1 Test to Failure (TTF). If the decision is made to define tests that are run to failure, the number of samples shall be defined as required to achieve R99C50 and use Weibull analysis to determine slope. This shall be decided in agreement with GM DRE and GM Validation Engineer by exposing the samples to procedures listed in Table 6.