GM	WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW16295

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 regiments 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.

Note:

- If any failure occurs in the first life of customer usage, stop the entire test. Do a Design Review Based upon Test Results (DRBTR). Perform root cause analysis. If and as determined, redesign the part/product and start testing all over again.
- First life/customer usage shall be normal stress, 2nd and 3rd life can be accelerated and/or Step Stress.
- Upon failure, plot Weibull slope and calculate reliability demonstrated.
- If no failures by the end of the 3rd life, remove ½ of the samples from test stand and do the functional tests followed by a DRBTR.

Continue test to failure with the other remaining samples using steps of stress method to induce failure and do the functional tests followed by a DRBTR to analyze failed samples.

3.8.2.1.2 Success Testing. If the decision is made to define tests that are run for a finite number of cycles by exposing the samples to procedures described in Table 6, the number of samples shall be defined as required to achieve R99C50 with a minimum of eight samples, using a Weibull slope of 2, see Table 2.

Table 2: Example of Number of Samples Required for Endurance Testing Tests (Based on Weibull Slope of 2)

Reliability Requirements	Success Test	Minimum Sample Size Required	
		Test to Failure (TTF)	Success Testing
		Sample Size	Sample Size
R99C50	Not applicable	See 3.8.2.1	
R99C50	2.1 Customer Usage Lives		16 Samples (No Failures)
R99C50	2.4 Customer Usage Lives		12 Samples (No Failures)
R99C50	2.9 Customer Usage Lives		8 Samples (No Failures)

Note: One (1) life of customer usage is defined as ten (10) cycles of endurance testing for Table 6, 4.3.2.1, PVT test.

3.8.2.2 Testing Requirements. Hose assemblies shall be tested for conformance with references in Table 3. The supplier must get GM Supplier Quality Engineer buy-in defining test frequency to prove capability. It is required for any new production to start with a minimum test per Table 4, 4.3.1.2 completed weekly, and test per Table 4, 4.3.1.4 completed monthly.

3.8.2.3 Approval. Tests are self-approved by the supplier, subject to audit by GM Supplier Quality Engineering.

3.8.2.4 Lot Retention. In the case of a Steady State Part Monitoring (SSPM) 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:

a. Scrapped, or
b. Corrected and certified (which may mean lot testing the revised parts again) based on the root cause analysis, or
c. 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 three lot retention options is exercised.

3.8.2.5 Documentation. Records shall be maintained at the manufacturing facility per the GM Production Part Approval Process (PPAP) process.

3.8.2.6 Alternative Compliance. Supplier may request an exemption from SSPM testing, provided it can be demonstrated that sufficient process controls are in place so as to make testing unnecessary. The approval is to be provided by either GM Supplier Quality Engineering or the GM DRE.

Table 3: Steady State Part Monitoring (SSPM) Test Table

Reference	Test	Number of Samples
Table 4, 4.3.1.2	Leak and Blow off	Per GMW15760
Table 4, 4.3.1.4	Vacuum	Per GMW15760

4 Validation

4.1 General.

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

4.1.2 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.

4.2 Validation Cross Reference Index (VCRI). See the Statement of Requirements (SOR) or contact GM Engineering on how to get the latest version of this ADVPR. The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement and the test battery included on the VCRI template.

4.3 Supporting Paragraphs. Test procedures.

4.3.1 Fixed-Value Performance Testing Procedures. See Table 4 for 4.3.1.1 thru 4.3.1.12.

Table 4: Performance Testing Procedures and Details

Property	Test Procedure	Unit	Value
4.3.1.1 Cold Leak Test.			
All coolant joints regardless connection type or interface	Fill the coupled hose assembly with 50% Ethylene Glycol: 50% water solution making sure it is colored. Wrap clean white cloth or paper towel around each joint of the assembly and secure to the assembly (a tie strap is recommended). Place the assembly in an environmental chamber oriented so that each joint is completely wet at all times during the test. It is recommended the coolant reservoir used is located higher vertically than the assemblies to ensure the joints are kept wet. Subject assemblies to -30 °C ± 2 °C and stabilize for 2 h then pressurize the assembly to 280 kPa. Hold the pressure and chamber temperature for 20 minutes. Reduce the pressure to 0 kPa ± 5 kPa, remove the assembly from the environmental chamber and allow to warm at room temperature for 2 h.	N/A	No stains that could indicate leaks. Inspection using Ultraviolet (UV) light equipment is recommended for leak inspection.

4.3.1.2 Leak and Blow off Test.			
All coolant joints regardless connection type or interface	Subject the assembly to internal pressure using water at a rate of 20 kPa/s until it reaches the values included in the row labeled as “Pressure for Leak” in Table 5, hold this pressure for 180 s. Continue increasing the pressure until the hose disconnects from the connection fitting. The final Blow off pressure must comply with the values in the row labeled as “Blow off pressure” in Table 5. **Note 1:** If lubricant is used to aid during hose installation, it must be any of the lubricants approved by GM. Let the assemblies dry for 20 minutes after lubricant application before conduct 4.3.1.2 Leak and Blow off Test. GM Approved assembly aid lubricants shall be provided by GM DRE. **Note 2:** Production assemblies containing mechanical or electronic trigger methods shall be removed from the assembly and replaced with a straight short pipe length clamped in place. **Note 3:** Pressure decay or other leak testing methods may be substituted for the air under water method when equivalence is proven and engineering approval is granted by GM Validation Engineer	kPa	No leaks at “Pressure for Leak” on Table 5 Minimum Blow off pressure as specified in Table 5
4.3.1.3 Blow off After Heat Aging.			
All coolant joints regardless connection type or interface	Subject the assembly to internal pressure using water. Test sample shall be oven aged for 168 h at 150 °C. Assembly, including each hose (if multiple hoses in the assembly) of the test sample will be flexed immediately upon return to room temperature (24 °C ± 2 °C) then conduct procedure described in 4.3.1.2 Leak and Blow off Test.	kPa	Minimum Blow off pressure as specified in Table 5
4.3.1.4 Vacuum Test.			
Hose assembly	At 24 °C ± 2 °C, evacuate the hose and tube assembly until the internal pressure of the assembly is stabilized at c-1.0 bar (gage) hold for 40 s and then increase the pressure linearly at a rate of 20 kPa/s until reaching 200 kPa ± 5 kPa, hold this pressure for 120 s, then conduct procedure described in 4.3.1.2 Leak and Blow off test to set assembly “Pressure for Leak” per values shown in Table 5.	kPa	No leaks at “Pressure for Leak” on Table 5

4.3.1.5 Insertion Force Test.			
Quick Connectors joints	Position the connector in a compression force tester (Instron or equivalent) with a simulated tube end, starting entry into the connector. The simulated tube end must be equivalent in dimensioning to the production intent tube end. Additionally, the dimensions of the tube end must be the maximum values allowed by the tolerance of the tube end. Apply an increasing compression load at approximately 50 mm/minute along the connector centerline until the simulated tube end has seated behind the retainer ears, usually signaled by an audible click and a corresponding drop in compression load. The compression load before seating shall be on a permanent recording. **Note:** Utilization of assembly aid lubricants is not allowed for this test	N	≤ 45 N for HTR applications ≤ 88 N for RAD applications per GM Manufacturing requirement
4.3.1.6 Cleanliness Test.			
For entire assemblies	Visually inspect the hose assembly for evidence of corrosion of internal and external metal surfaces. Quantify internal foreign substances and internal corrosion of the metal components of the assembly using ASTM A254.	g/m2	No greater than 0.25 g/m2 of internal surface area of contaminants is permitted
4.3.1.7 Cyclical Corrosion Test.			
Assemblies with metal pipes Metallic brackets for underhood or underbody applications	-Assemblies with metallic pipes: Test to GMW14872, UB, All, 4 SP, Method 1/2, Exposure A (cosmetic) and E (functional), Option 4 Thermal Soak addition: 117 °C ± 2 °C for 2 h per cycle **to validate underbody applications.** Test to GMW14872, UH, All, 4 SP, Method 1/2, Exposure B (cosmetic) and E (functional), Option 4 Thermal Soak addition: 117 °C ± 2 °C for 2 h per cycle **to validate underhood applications.** -Metallic brackets: Test to GMW14872, UB, All, 4 SP, Method 1/2, Exposure A and E, Option 4 **to validate underbody applications.** Test to GMW14872, UH, All, 4 SP, Method 1/2, Exposure B and E, Option 4 **to validate underhood applications.** **Note:** For metallic parts without coating (aluminum pipes for brackets), skip 4.3.1.8 and just execute GMW14872 according to the vehicle application listed in 4.3.1.7.	kPa	Assemblies with metal pipes: To evaluate functional corrosion: no leaks at “Pressure for Leak” on Table 5 after Exposure E. To evaluate cosmetic corrosion, refer to GMW15272 For metallic brackets: To evaluate cosmetic corrosion, refer to GMW15272 Functional Corrosion resistance: Depending on the corrosion mechanism(s) involved, end-of-test checks for function may not be sufficient to validate 15 year field performance. At a minimum, no metal loss (loose/flaking corrosion product or noticeable pitting of the substrate after media blasting the corroded area)

			is permitted on any components at end-of-test. If any metal loss is observed, additional analysis will be required, and must be conducted with the assistance of GM Corrosion and/or Materials Engineering. Refer to Appendix A, Table A2 for the mass loss targets included in GMW14872, Appendix A.
4.3.1.8 Salt Spray Test.			
Assemblies with metallic components elements	Six hose assembly samples at nominal hose compression are to be tested. Subject the assembly to 168 h salt spray per GMW3286. **Note:** Applicable just for metallic parts made of steel with coating (not aluminum parts).	N/A	Not exhibit evidence of any red rust on ferrous parts
4.3.1.9 Maximum Crimp Compression Condition.			
Joints with crimps	Sixteen coupled hose assembly samples must be prepared with maximum hose compression as defined in Appendix A, Table A2.	N/A	No hose rubber or reinforcement damage generated by the crimping operation. No leaks at “Pressure for Leak” on Table 5. No stains that could indicate leaks. Inspection using UV light equipment is recommended for leak inspection.
	Eight samples shall be disassembled and examined for hose tube, cover, and reinforcement damage. Supplier evaluation of these parts, and the parts themselves, must be returned to the GM Global HVACPTC Engineer issuing the approval for evaluation. The remaining eight samples must be exposed to 4.3.1.1 Cold Leak Test and 4.3.1.2 Leak and Blow off Test to set “Pressure for Leak”.	kPa	
4.3.1.10 Minimum Crimp Compression Condition.			
Joints with crimps	Sixteen coupled hose assembly samples must be prepared with minimum hose compression as defined in Appendix A, Table A1.	N/A	No hose rubber or reinforcement damage generated by the crimping operation. No leaks at “Pressure for Leak” on Table 5.
	Eight samples shall be disassembled and examined for hose tube, cover, and reinforcement damage. Supplier evaluation of these parts, and the parts themselves, must be returned to the GM Global HVACPTC Engineer issuing the approval for evaluation. The remaining eight samples must be exposed to 4.3.1.2 Leak and Blow off Test to set “Pressure for Leak”.	kPa	

4.3.1.11 Error-Proofing Pull-Tab Test.			
Joints with error proofing tabs	Partial Assembly. Partially assemble the connector onto a mating end form with the seal engaged, but without engaging the latching mechanism. Using a tensile force tester (Instron or equivalent) measure the force required to remove the error-proofing tab. Use a 20 mm diameter pin to actuate the pull-tab.	N	Partial Assembly: 12 N
	Complete Assembly. Completely assemble the connector onto a mating end form. Using a tensile force tester (Instron or equivalent) measure the force required to remove the error-proofing tab. Use a 20 mm diameter pin to actuate the pull-tab.		Fully assembled: ≤ 2.5 N
4.3.1.12 Anti-Rotation Feature Torque Resistance.			
Joints with anti-rotation features	Completely assemble the quick-connector onto a mating end form. At a rate of 1 Nm/s, apply a torque to the quick-connect fitting, up to a maximum torque equivalent to 20% the mating fitting seal diameter. For example, if the sealing diameter is 20 mm, the maximum applied torque shall be 4 Nm.	N/A	There shall be no loss of the anti-rotation feature

Note: HTR = Heater, g/m^2 = grams per meter squared, kPa = kilopascal(s), N = Newton(s), N/A = Not applicable, RAD = Radiator.

Table 5: Leak and Blow off Pressure per Hose Application

Application	Pressure for Leak	Blow off Pressure
Hoses with ID < 12 mm	160 kPa ± 7 kPa	> 300 kPa ± 7 kPa
Hoses with ID ≥ 12 mm	1.2X maximum vehicle working pressure	> 2X maximum vehicle working pressure

4.3.2 Endurance Testing Procedures. See Table 6 for 4.3.2.1 thru 4.3.2.3.

Table 6: Endurance Testing Procedures and Details

Property	Test Procedure	Unit	Value
4.3.2.1 Pressure/Vibration/Temperature (PVT) Test.			
All coolant joints exposed to relative movement	Test assemblies shall be tested per GMW14785. After test completion, remove the assembly from the cabinet and allow it to return to room temperature. Subject the assembly to the Table 4, 4.3.1.1 Cold Leak Test. Total test time depends on the number of samples test facility can run at one time. **Note:** Before test starts, subject assemblies (or coupons) to Table 4, 4.3.1.2 to certify that parts are free of leaks.	N/A	See GMW14785

4.3.2.2 Pressure/Temperature Test.			
All coolant joints regardless connection type or interface	Place the assembly in an environmental chamber and attach one end to a reservoir filled with a 50% ± 5% (9985809): 50% ± 5% water solution. Allow the assembly to fill with the engine coolant per GMW3420 (9985809) water solution and bleed off any air, plugging all assembly outlets other than the pressurized outlet after the air is completely bled. The reservoir must have temperature and pressure control to affect the conditions of the hose appropriately. **Subject the assembly to 180 cycles per Table 7.** **Note 1:** After 100 cycles, remove the assembly from the chamber and allow it to return to room temperature for 2 h. Subject the assembly to Table 4, 4.3.1.1 Cold Leak Test and return the samples to the chamber to complete the 80 remaining cycles. All the samples must complete 180 cycles, no test completion if assembly is removed from the chamber at the 100th cycle, exposed to a Cold Leak Test and not returned to the chamber. **Note 2:** After 180 cycles, remove coupons from the thermal chamber and allow them to warm at ambient temperature (24 °C ± 2 °C) for 2 h then expose coupons to Table 4, 4.3.1.2 to set pressure for leak. **No Cold Leak Test after completion of 180th cycle is required**.	N/A	Cold Leak Test criteria at 100th cycle Must be no indication of leaks at the end of the 180th cycle
4.3.2.3 Coolant Circulation Test.			
All coolant joints regardless connection type or interface	Per GMW14329, Coolant Circulation. Within 24 h after test subject the assembly to the Table 4, 4.3.1.1 Cold Leak Test. Test runs approximately 22 days. Total test time depends on the number of samples the test facility can run at one time, for details about increased sample size, refer to 3.8.2.1.	N/A	No leakage in pipes, quick connectors, or hose coupling interfaces. No stains that could indicate leaks. Inspection using UV light equipment is recommended for leak inspection.

Table 7: Pressure/Temperature Test Cycle

Internal Pressure	Temperature	Hold Time	Maximum Transition Time Note 1
Increase to 140 kPa ± 5 kPa	110 °C ± 2 °C	1 h	1.5 h
Decrease to 60 kPa ± 5 kPa	-40 °C ± 2 °C	8 h	1.5 h
Increase to 200 kPa ± 5 kPa	125 °C ± 2 °C	0.5 h	1.5 h
Decrease to 0 kPa ± 5 kPa	-20 °C ± 2 °C	2 h	1.5 h

Note 1: Maximum transition time could be reduced based on thermal chamber capabilities, if such is the case, the new timing must be communicated to GM Validation Engineer.

4.4 Safety. This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

4.5 Deviations from this Standard. Deviations from the requirements of this standard shall have been agreed upon by the responsible GM DRE and Validation Engineer. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.6 Additional Requirements. Any change to the component or material, i.e., design, function, properties, manufacturing process and/or location of any change or modification to the product/process, and manufacture requires a new release of the product. This includes the changes in sub-supplier chains that Tier-1 supplier has. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification of the production product/process and to apply for a new release. If not otherwise agreed to, the entire DV/PV test schedule shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM Supplier Quality Engineer and the supplier.

4.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM department prior to the start of delivery of production level components or materials.

5 Provisions for Shipping.

Not applicable.

6 Notes

6.1 Glossary.

R99C50: Reliability of 99% or greater at a 50% Confidence.

Test to Failure (TTF): Is defined as, but not limited to, the loss of function, unacceptable performance degradation and nonconformance of the component as stated in this specification.

6.2 Acronyms, Abbreviations, and Symbols.

ADV	Analysis Development Validation
ADVPR	Analysis, Development and Validation Performance Review
CALT	Calibrated Accelerated Life Testing
Cpk	Process Capability Index
DRBTR	Design Review Based upon Test Results
DRE	Design Responsible Engineer
DV	Design Validation
g/m^2	grams per meter squared
GSSLT	Global Subsystem Leadership Team
HALT	Highly Accelerated Life Testing
HASS	Highly Accelerated Stress Screening
HAST	Highly Accelerated Stress Testing
HTR	Heater
HVAC	Heating, Ventilation and Air Conditioning
HVACPTC	Heating, Ventilation, Air Conditioning Powertrain Cooling
ID	Inside Diameter
IMDS	International Material Data System
kPa	Kilopascal(s)
N	Newton(s)

N/A	Not applicable
OD	Outside Diameter
PPAP	Production Part Approval Process
PV	Production Validation
PVT	Pressure/Vibration/Temperature
RAD	Radiator
REP	Reliability Evaluation Point
SOR	Statement of Requirements
SPC	Statistical Process Control
SSPM	Steady State Part Monitoring
TTF	Test to Failure
UG	Unigraphics
VCRI	Validation Cross Reference Index

7 Additional Paragraphs

7.1 All materials supplied to this standard must comply with GMW3059, **Restricted and Reportable Substances**, including the requirement to submit a full material composition disclosure to GM via the International Material Data System (IMDS).

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

GMW16295

9 Release and Revisions

This standard was originated in September 2009. It was first approved by HVAC and Powertrain Cooling in April 2010. It was first published in April 2010.

Issue	Publication Date	Description (Organization)
1	APR 2010	Initial publication.
2	MAY 2010	Table 1: 1st seven section numbers corrected and note 1 updated from 4.3.8 to 4.3.7. Table A1: For DV test only, line item 3.2.1.1.8 removed. (HVAC and Powertrain Cooling)
3	FEB 2013	Revise GMW to include Blow-Off After Heat Aging. Restructure GMW to streamline. (Fluid Handling (Hoses, Lines and Fittings) GSSLT)
4	NOV 2015	Updated Reliability Evaluation Point to 15 years. (HVAC - Coolant Plumbing Coolant Hoses)
5	MAR 2019	Revised to current template. GMW content revised: Elimination of Tensile test, communization of Leak and Blow off test in just one test and update acceptance criteria per hose size, acceptance criteria based on vehicle parameters, update on Cold Leak test procedure, change format into table for Performance and Endurance Testing, updates to Cyclical corrosion test procedure and acceptance criteria, specification of Salt Spray test for steel coated parts, addition of Note 2 to Pressure/Temperature test. (HVAC - Thermal Fluid Management GSSLT)

Appendix A

Test samples throughout this specification will be referred to as minimum hose compression, nominal hose compression or maximum hose compression samples. A1.1 thru A1.3 describe the requirements for these conditions. If not specified, the test samples shall be of nominal hose compression.

A1.1 Minimum Crimp Compression Condition. Test samples referred to in this specification, as minimum hose compression samples shall adhere to the requirements in Table A1.

Table A1: Minimum Crimp Compression Requirements

Type	Requirement
Hose Wall	Minimum wall thickness (as determined by the 3 Sigma value of the hose manufacturer)
Crimp/Swage OD	Maximum crimp/swage OD (3 Sigma value of the assembly manufacturer)
Tube Insert OD	Minimum tube insert OD (3 Sigma value of the metal insert manufacturer)
Ferrule Wall	Minimum ferrule wall thickness (3 Sigma value of the ferrule manufacturer)

Note: Assemblies manufactured as described in Table A1, but with the substitution of nominally dimensioned tube insert OD and nominally dimensioned ferrule wall thickness components, may be used for evaluation with the submittal of SPC data confirming minimal tolerances and acceptable Process Capability Index (Cpk) values for these dimensions. The acceptability of nominal insert OD and ferrule wall thickness dimension for this testing must be reviewed beforehand and approved by the GM Global HVACPTC Engineer issuing the approval. If the use of nominal insert OD and ferrule wall thickness dimensions for the testing is found to be acceptable, the crimp OD must be adjusted to result in a value of minimum hose compression which would have resulted if minimum ferrule wall thickness and minimum tube insert OD had been used in the preparation of samples.

A1.2 Nominal Hose Compression Condition. Test samples referred to as "nominal hose compression samples" shall consist of components manufactured to nominal dimensions and crimped to a mean specification value of crimp/swage OD.

A1.3 Maximum Crimp Compression Condition. Test samples referred to in this specification, as maximum hose compression samples shall adhere to the requirements in Table A2.

Table A2: Maximum Crimp Compression Requirements

Type	Requirement
Hose Wall	Maximum wall thickness (as determined by the 3 Sigma value of the hose manufacturer)
Crimp/Swage OD	Minimum crimp/swage OD (3 Sigma value of the assembly manufacturer)
Tube Insert OD	Maximum tube insert OD (3 Sigma value of the metal insert manufacturer)
Ferrule Wall	Maximum ferrule wall thickness (3 Sigma value of the ferrule manufacturer)

Note: Assemblies manufactured as described in Table A2, but with the substitution of nominally dimensioned tube insert OD and nominally dimensioned ferrule wall thickness components, may be used for evaluation with the submittal of SPC data confirming minimal tolerances and acceptable Cpk values for these dimensions. The acceptability of nominal insert OD and ferrule wall thickness dimension for this testing must be reviewed beforehand and approved by the GM Global HVACPTC Engineer issuing the approval. If the use of nominal insert OD and ferrule wall thickness dimensions for the testing is found to be acceptable, the crimp OD must be adjusted to result in a value of maximum hose compression which would have resulted if maximum ferrule wall thickness and maximum tube insert OD had been used in the preparation of samples.

Appendix B

Table B1: Hose Compression Calculations

Linear Compression:

Linear Hose Wall Compression = $[(T_o - T_f)/T_o] \times 100\%$

Where:

T_o = Initial hose wall thickness (prior to crimping)

T_f = Final hose wall thickness (after crimping)

Area Compression:

Area Hose Wall Compression = $(1 - ([R^2_{OD\text{-}F} - R^2_{ID\text{-}F}]/[R^2_{OD\text{-}1} - R^2_{ID\text{-}I}])) \times 100\%$

Where:

$R_{ID\text{-}I}$ = Initial ID radius of the hose (prior to crimping)

$R_{OD\text{-}1}$ = Initial OD radius of the hose (prior to crimping)

$R_{ID\text{-}F}$ = Final ID radius of the hose (after crimping)

$R_{OD\text{-}F}$ = Final OD radius of the hose (after crimping)