Transmission and Engine Oil Cooler Plumbing System

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. The specification describes the quality, reliability, durability and performance requirements for Transmission Oil Cooler (TOC) and Engine Oil Cooler (EOC) plumbing systems for use in GM vehicles. All requirements of this specification shall be met in order to demonstrate design and production validation, as well as in process compliance.

1.2 Applicability. This standard covers qualification tests for plumbing systems used with cooling line oils designated as Type E (Engine oils) and Type T (Transmission oils) used in automotive applications (as detailed in 4.1.1.4.1, Table 1).

1.3 Remarks. None.

2 References

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

2.1 External Standards/Specifications.

ASTM D380	DIN EN 754	SAE J1344	SAE J1739

2.2 GM Standards/Specifications.

GMW3059	GMW15272	GMW16171	GMW17010
GMW14327	GMW15608	GMW16304	GMW17136
GMW14872	GMW15964	GMW16444	GMW17332

2.3 Additional References.

- GM Production Part Approval Process (PPAP) (ID)
- GM1738 Packaging and Identification Requirements for Production Parts (ID)
- GM1820 Pre-Prototype and Prototype Sample Approval (ID)
- Standard Engine Oil, SAE 5W-30
- Statement of Requirement (SOR)

(ID) = This document is limited to internal use within General Motors and shall not be accessed outside this company. Contact the GM Lead Engineer for further instructions.

3 Requirements

3.1 System/Subsystem/Component/Part Definition.

3.1.1 Appearance.

3.1.1.1 Finish. Appearance and finish of parts shall be free of weld and/or braze splatter, flash, ridges, roughness and of tool lubricants and other contamination.

3.1.2 Content. Not applicable.

3.1.3 Ambient Environment. The hose and coupling shall be capable of withstanding temperature variations from -40 °C to +150 °C with an excursion temperature exposure of +165 °C and severe exposure to a corrosive environment. Excursion temperature exposure is a peak.

3.1.4 Interfaces. Not applicable.

3.1.5 Usage Definition. The transmission or engine oil cooler line will be exposed to underhood (UH) and underbody (UB) environments. Hose material and tubing must be compatible with DEXRON® VI (GMW16444) and other GM Specific Program approved transmission fluids, GM and SAE International standard engine oils (e.g., SAE 5W-30), and any other under-hood fluid (windshield washer fluid, brake fluid, etc.) Transmission or Engine Fluid shall be approved by Validation Engineer and Design Responsible Engineer (DRE) before Analysis/Development/Validation Plan and Report (ADVP&R) submission.

3.2 Product Characteristics.

3.2.1 Performance Requirements. Not applicable.

3.2.2 Physical Characteristics. Not applicable.

3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point (REP). The REP shall be one (1) life of severe customer usage at the vehicle level.

3.2.3.2 Reliability Requirements. Components must demonstrate the required reliability of 99% at a 50% confidence (R99C50) and slope of 2, at the REP for the TOC line or EOC line. Reliability evaluation profiles shall be consistent with the customer usage profile and environmental exposure at the REP as specified in the ambient environment and usage sections of this technical specification. Test to failure methodology is preferred.

3.2.4 Serviceability. Refer to 4.3.4.

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.

3.3.1.1.1 Hose. Hoses shall per GMW16304 and GMW16171.

3.3.1.1.2 Tube. Tube shall be in accordance with aluminum tubing 3003 H14 or 3003 H14 per DIN EN 754.

3.3.1.1.3 Connectors. Connector designs shall be at the discretion of the supplier but subject to the performance guidelines contained in this specification.

3.3.1.1.4 Hose to tube Couplings. Coupling designs shall be at the discretion of the supplier but subject to the performance guidelines contained in this specification.

3.3.1.1.5 Hose to Tube Couplings. Use validation requirements per GMW15964.

3.3.1.1.6 Shipping Caps or Covers. All hose assemblies shall have shipping caps or shipping bags, as specified by GM. Shipping caps must remain firmly in place until it is removed just prior to assembly of the oil line fitting on the subassembly or the vehicle. This includes all conditions it may experience during production processing, packing, shipping, unpacking, and queuing at the component and/or vehicle assembly plant. During removal, there must be no degradation of features as represented by the detail drawings. This would include but not be limited to, dislodging of the sealing mechanism (if required) and/or damage to the threads or sealing areas. The shipping caps must conform to the following requirements:

- Installation force not to exceed 54 n (12.0 lb).
- Removal force must be no greater than 54 n (12.0 lb).
- Seal washers, or other seals must not move or come off the fitting at the time of shipping cap removal when recommended removal techniques are followed.

3.3.1.1.7 Protection Sleeves. The protection sleeves material and performance requirements for expandable braided flexible sleeves, heat shrinkable woven sleeves and self-closing sleeves for abrasion resistant shall be per GMW14327. The cross-linked flexible polyolefin heat shrinkable sleeve shall be per GMW17136. The thermal resistant sleeves shall be per GMW15608.

3.3.2 Identification and Marking. All assemblies must show identification of supplier. All plastic parts shall be identified for recycling per SAE J1344.

3.4 Documentation.

3.4.1 Failure Mode and Effects Analysis (FMEA) (SAE J1739). Design and process FMEA shall be submitted to the GM Release Engineer on request and shall be maintained as part of the vendor records of the Design Validation (DV) and Product Validation (PV). The FMEAs shall be updated each time a change occurs.

4 Validation

4.1 General. The requirements shall be satisfied as partial fulfillment of the requirements for prototype and production submission. In addition, plumbing systems must perform satisfactorily in vehicle system validation.

4.1.1 Design Validation (DV). Design Validation is defined as the set of requirements to be used to validate a new design. New design is defined as a design using different materials, processes or dimensions that, in the GM Release Engineer's opinion, is a departure from previous practice. This new design need not be manufactured from production tools and processes but should be representative from a design function standpoint. Submission of test results should be done through both a Design Validation Plan and Report (DVP&R) or through the GM1820 process for pre-prototype material approval. The ADVP&R template to be used for validation will be defined in the Validation Cross Reference Index (VCRI) in the Statement of Requirements (SOR) Appendix. See Validation Engineer if there are any questions related to the ADVP&R plan.

4.1.1.1 Hose to Tube Couplings. Use Validation Requirements per GMW15964.

4.1.1.2 Tube to Tube/Tube to Cooler/Tube to Transmission/Engine Connections.

4.1.1.2.1 Test Sample Construction. Unless otherwise specified by the responsible GM Release Engineer, test samples shall be built as follows:

4.1.1.2.1.1 Vibration Test, Pressure, Displacement and Temperature (PDT), and Heat Aging Tests.

4.1.1.2.1.2 PDT and Heat Aging tests connector samples should be tested with a coupled hose assembly having a straight hose length of 500 mm ± 5 mm (19.7 in ± 0.196 in) and a straight tube length of 100 mm ± 5 mm (3.94 in ± 0.196 in).

4.1.1.2.1.3 Vibration test samples shall be built according to the production released math data.

4.1.1.2.2 All Other Tests.

4.1.1.2.2.1 Connector samples should be tested with a 300 mm ± 10 mm (11.8 in ± 0.394 in) long straight tube assembly.

4.1.1.3 All DV tests require twelve samples. Half of all samples for each test must be supplied at minimum clearance condition and half must be supplied at maximum clearance condition. Maximum clearance condition shall reflect maximum allowed clearance between the male and female portions of the connector. If a seal is used, it shall have the minimum allowed compression or interference. Minimum clearance condition shall reflect the minimum allowed clearance between the male and female portions of the connector. If a seal is used, it shall have the maximum allowed compression or interference. The male and female portions of the connector may be manufactured (within production representative methods) to compensate for the worst case condition produced by the various components. Design tolerance stack information must be provided to confirm each component's dimensions with regard to the appropriate material condition. Additionally, each specimen must be serialized and accompanied by corresponding serialized data showing it conforms to its material condition.

4.1.1.3.1 Reporting Additional to Test Requirements. Additional to the specific individual test reporting requirements, during all DV testing it shall be reported any leak in the samples independently if the test is evaluating a specific joint or its focused in a different part of the design. For this reason, all the features of the samples or assemblies shall be Design representatives.

4.1.1.4 Tensile Strength. This test is intended to ensure that the joint retention structure will withstand a given threshold tensile force. Ten (10) tube and connector assemblies shall be tested.

4.1.1.4.1 Acceptance Determination. The load at failure either by separation of the specimen from the end fittings or by ruptures of the hose structure shall be no less than those in Table 1 when tested per 4.3.1.

Table 1: Acceptable Minimum Load by Type

Type	Test Temperature	Minimum Load Acceptance
All Types	Ambient Room Temperature	2220 N
All Types	150 °C (302 °F)	1000 N

4.1.1.5 Burst Strength.

4.1.1.5.1 Acceptance Determination. Minimum burst strength shall be no < 6895 kPa when tested per 4.3.2.

4.1.1.6 Insertion Force. This test is intended to ensure that assembly effort to make the joint does not exceed manufacturing guidelines (validation of quick connect joints).

4.1.1.6.1 Acceptance Determination. The compression load required to secure the joint must not exceed 66.75 N. Refer to 4.3.3.1.

4.1.1.7 Serviceability.

4.1.1.7.1 Each specimen must not leak when subjected to the Leak Test (4.3.10) prior to this test. In between each and after a total of ten (10) service procedures have been performed on the specimens, the specimens must pass the requirements of the Leak Test (4.3.10). Additionally, after the 10^{th} service procedure, the joint must pass the requirements for Burst Strength (4.3.2). Refer to 4.3.4.1.

4.1.1.8 Heat Aging. This test in intended to verify the capability of the joint's elastomeric components to perform in a high ambient temperature environment. Six (6) samples shall be tested.

4.1.1.8.1 The hose and/or quick connect seal shall show no signs of external or internal cracks, charring or disintegration and must not leak when subjected to the Leak Test (4.3.10) both before and after heat aging. Refer to 4.3.5.1.

4.1.1.9 Vibration. Six (6) samples, (three (3) minimum material condition and three (3) maximum material condition), shall be mounted in the test fixture such that the vibration shall be imparted to the assembly through the hose end, and six (6), (three (3) minimum material condition and three (3) maximum material condition), samples shall be mounted such that the vibration shall be imparted through the tube end.

4.1.1.9.1 Vibration test for DV can be performed by one of the following methods:

4.1.1.9.1.1 Computer Aided Engineering (CAE) analysis when supplier joints have being qualified by the corresponding GM CAE Team and a satisfactory correlation has being achieved. Supplier joints designs shall be identified with the supplier Design Number and corresponding release level, all the joints in the assembly shall be qualified to be able to validate the complete assembly under this procedure. This method shall be agreed by the following GM team: Validation Technical Integration Engineer (TIE), Bill Of Materials (BOM) Family Owner (BFO), DRE, CAE Global Simulation Owner (GSO) and CAE Engineer.

4.1.1.9.1.2 Physical Testing. Six (6) samples, (three (3) minimum material condition and three (3) maximum material condition), shall be mounted in the test fixture such that the vibration shall be imparted to the assembly through the hose end, and six (6), (three (3) minimum material condition and three (3) maximum material condition), samples shall be mounted such that the vibration shall be imparted through the tube end.

4.1.1.9.2 Acceptance Determination. There shall be no evidence of damage to the assembly or components, also no evidence of leakage prior to or at the completion of the vibration test.

4.1.1.10 Corrosion. No corrosion test required for DV.

4.1.1.11 Pressure and Temperature Cycling.

4.1.1.11.1 Test Specimens. Twelve (12) hose assemblies shall be tested.

4.1.1.11.2 Acceptance Criteria. There shall be no evidence of leakage when tested per 4.3.10.

4.1.1.12 Pressure, Displacement and Temperature (PDT).

4.1.1.12.1 Test Specimens. Twelve (12) hose assemblies shall be tested.

4.1.1.12.2 Acceptance Criteria. There shall be no evidence of leakage when tested per 4.3.10.

4.1.2 Production Validation (PV). Production Validation is defined as the set of requirements to be used to validate new production parts. A part is considered new when either a dimensional, material or process change

has been made and, in the GM Release Engineer's opinion, the change affect the design function. Test parts must be manufactured from production tools and processes and selected at random. Submission of test results should be done through a standard Production Part Approval Process (PPAP).

4.1.2.1 Hose to Tube Couplings. Use Validation Requirements in GMW15964.

4.1.2.2 Tube to Tube or Tube to Cooler/Transmission/Engine Connections.

4.1.2.2.1 Test Sample Construction. Unless otherwise specified by the responsible GM Release Engineer, test samples shall be built as follows.

4.1.2.2.1.1 Pressure, Displacement and Temperature (PDT) Test.

4.1.2.2.1.1.1 Connector samples should be submitted as part of a coupled hose assembly having a hose length of 500 mm ± 10 mm (19.7 in ± 0.394 in) and a straight tube length of 100 mm ± 10 mm (3.94 in ± 0.394 in).

4.1.2.2.1.2 All Other Tests.

4.1.2.2.1.2.1 Connector samples should be submitted as part of a production assembly. This assembly may be modified to permit installation in a test chamber.

4.1.2.2.1.2.2 Reporting Additional to Test Requirements. Additional to the specific individual test reporting requirements, during all PV testing it shall be reported any leak in the samples independently if the test is evaluating a specific joint or its focused in a different part of the design. For this reason, all the features of the samples or assemblies shall be Production representatives.

4.1.2.3 Tensile Strength.

4.1.2.3.1 Test Specimens. Ten (10) tube and connector assemblies shall be tested.

4.1.2.3.2 Acceptance Determination. The load at failure either by separation of the specimen from the end fittings or by ruptures of the hose structure shall be no less than those in Table 1 when tested per 4.3.1.

4.1.2.4 Heat Aging. This test is intended to verify the capability of the joint's elastomeric components to perform in a high ambient temperature environment.

4.1.2.4.1 Test Specimens. Six (6) samples shall be tested.

4.1.2.4.2 Acceptance Criteria. The hose and/or quick connect seal shall show no signs of external or internal cracks, charring or disintegration and must not leak when subjected to the Leak Test (4.3.10) both before and after heat aging. Refer to 4.3.5.

4.1.2.5 Pressure Temperature Cycling Test.

4.1.2.5.1 Test Specimens. Twelve (12) hose assemblies shall be tested.

4.1.2.5.2 Acceptance Criteria. There shall be no evidence of leakage when tested per 4.3.10.

4.1.2.6 Pressure, Displacement and Temperature (PDT) Test.

4.1.2.6.1 Test Specimens. Twelve (12) hose assemblies shall be tested.

4.1.2.6.2 Acceptance Criteria. There shall be no evidence of leakage when tested per 4.3.10. Test samples should be inspected for leaks at least every 4 h.

4.1.2.7 Vibration. Six (6) samples, (three (3) minimum material condition and three (3) maximum material condition), shall be mounted in the test fixture such that the vibration shall be imparted to the assembly through the hose end, and six (6), (three (3) minimum material condition and three (3) maximum material condition), samples shall be mounted such that the vibration shall be imparted through the tube end.

4.1.2.7.1 Acceptance Determination. There shall be no evidence of leakage prior to or at the completion of the vibration test.

4.1.2.8 Corrosion. The test is intended to ensure the corrosion resistance capability of the components of the joint per 4.3.6.

4.1.2.8.1 Corrosion for Assemblies

4.1.2.8.1.1 Acceptance Determination. Both before and after being subjected to the corrosion procedures required in 4.3.6, the joint must pass the Leak Test (4.3.10) and Burst Strength (4.3.2).

4.1.2.8.2 Corrosion for Metal Brackets.

4.1.2.8.2.1 Cosmetic: Shall be evaluated per GMW15272.

4.1.2.8.2.2 Functional: 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 GMW14872, Appendix A, Table A2 for the mass loss targets.

4.1.3 Revalidation Requirements. Any change in design, material or processing from that previously approved for production, requires prior approval and revalidation as determined by the GM Release Engineer. Carry-over designs may be revalidated for subsequent model year production using the results of the tests from previous production.

4.2 Validation Cross Reference Index (VCRI). These requirements are to be run on production parts randomly pulled from normal production runs. The intent is to ensure that the source maintains adequate control of production parts. It is the source's responsibility to maintain records for a period of 3 years, indicating that the process is in control and stable for these criteria. For purposes of this document, control is defined as meeting a process capability index (CPK) level of 1.33. Any deviation from these limits must be identified with a five (5) phase corrective action plan. The corrective action plan shall be provided to the GM Supplier Quality organization for review and concurrence.

4.2.1 Monthly In-Process Test Requirements. Test six (6) assemblies per month or production run, whichever is more frequent, in accordance with these requirements: Cleanliness (4.2.2), Tensile Strength (4.3.1) (Quick Connect Fittings only), Burst Strength (4.3.2.1), Insertion Force (4.3.3) and Leak Test (4.3.10).

4.2.2 Cleanliness. This test is intended to ensure that component parts are not introducing an undue amount of foreign substance to the system under evaluation.

4.2.2.1 Test Method. Visually inspect the components for evidence of internal free water and corrosion of internal and external metal surfaces. In addition, conduct a solvent analysis to determine the presence of foreign material in the part. A solvent that will not degrade the part shall be chosen. Initially, to evaluate the cleanliness of the solvent being used for this test, run a blank containing the solvent equivalent to the amount held in the component to evaluated, through a fritted crucible. The solvent shall not contain more than 0.0004 g of contaminant. Dispose of the solvent in an approved reclamation system as necessary at the completion of the test. Next, bend the hose and joint assembly in a u-shape and fill with purified solvent. Agitate the assembly and pour the solvent into a clean beaker, cover and place in a desiccator. After 15 minutes, collect insoluble contaminates by filtering the liquid through a 60 mesh screen (240 µm hole size), and then through a 30 mL fritted glass grade fine filtering crucible of known weight. Place crucible in a desiccator at room temperature for 1 h. Record the weight of the contaminants.

4.2.2.2 Acceptance Criteria. There shall be no evidence of internal or external corrosion of the metal components. In addition, no foreign material shall be collected on the 60 mesh screen and not more than 0.26 g/m^2 of contaminants from the interior surface shall be collected on the crucible.

4.2.2.3 Corrective Action. Joint assemblies not conforming to any of the requirements listed in 4.1.1 are to be analyzed to determine the cause of nonconformance and corrective action to be taken.

4.2.2.3.1 If the supplier can demonstrate a correlation between component dimensions that are under statistical process control and performance on an in-process test, the requirements for that in–process test may be waived. This decision shall be made by the appropriate GM Design Engineering Department.

4.2.3 Yearly In-Process Test Requirements. Test six (6) assemblies once per year in accordance with the requirements in Pressure/Displacement/Temperature Testing (4.3.8).

4.2.3.1 Acceptance Criteria test results must be forwarded to the GM BFO.

4.3 Supporting Paragraphs. Test Procedures.

4.3.1 Tensile Strength.

4.3.1.1 Test Procedure. Position preassembled specimen in a tensile load measuring device (Instron or equivalent). Apply an increasing tensile load of approximately 25 mm/minute along the connector/tube-endform axial centerline until failure of any system component occurs. The maximum tensile load at which yield is reached in any component of the joint must be recorded as the tensile strength. For the tensile testing at 150 °C ambient, the hose must be soaked for at least 1 h before performing the tensile test.

4.3.2 Burst Strength.

4.3.2.1 Test Procedure. The burst test shall be per ASTM D380.

4.3.3 Insertion Force.

4.3.3.1 Test Procedure. Position the connector specimen and tube-endform specimen in a compression force tester (Instron or equivalent), starting entry of the tube-endform into the connector. Apply an increasing compression load at approximately 50 mm/minute along the connector/tube-endform centerline until the tube-endform has seated to the connector's retaining feature as evidence by its operator verification. A corresponding drop in compression load should be recorded at this time as well. The highest compression load observed before seating occurred must be recorded as the insertion force.

4.3.4 Serviceability.

4.3.4.1 Test Procedure. Assemble the samples. Tube-nut joints must be torqued to the highest value of the torque specification to start and then to the lowest value of the torque specification for each subsequent reassembly. Subject each specimen to the Leak Test (4.3.10) on each assembly before the first servicing procedure. Completely dismantle and reassemble each joint, as it is intended to be serviced, a total of ten (10) times. For each service of the joints, reassemble the mating parts at each joint such that joints are oriented the same relative to each other. No replacement of any component is permissible during the servicing procedure unless otherwise specified by the responsible GM Release Engineer. Perform the Leak Test (4.3.10).

4.3.5 Heat Aging.

4.3.5.1 Test Procedure. Specimens shall be capped and filled with appropriate fluid (either transmission oil or engine oil) for testing. Subject each specimen to the Leak Test (4.3.10) before and after the heat aging procedure. After the initial leak test for hose clamp joints, coil the specimens around a mandrel having a diameter eight (8) times the nominal outside diameter of the hose. For quick connects, fully assemble the joint specimens. Place the assemblies in an air oven at 125 °C for an additional 200 h. Remove the assemblies from the oven and allow assemblies to cool to room temperature. Perform five (5) service procedures on the joints per the Serviceability procedure in 4.3.4. Perform the Leak Test (4.3.10) after each individual joint reassembly. Reconnect all joints and replace in the air oven at 125 °C for an additional 200 h. Remove the assemblies from the oven and allow assemblies to cool to room temperature. Subject the hose clamp or quick connect specimens to another Leak Test. For the hose clamps specimens, cut the hose longitudinally and examine for both internal and external cracks, charring and disintegration. For the quick connects, disassemble and reassemble the joints and perform a final Leak Test.

4.3.6 Corrosion.

4.3.6.1 Corrosion for Assemblies Test Procedure. Twelve (12) samples shall be tested. The Leak Test (4.3.10) must be performed on each specimen before and after the corrosion test. Perform corrosion test on line assembly specimens per GMW14872, UB, All, 4 SP, Method 1/2, Exposure A (cosmetic) and E (functional), Option 4, Thermal Soak addition: 121 °C ± 2 °C for 2 h per cycle to validate UB applications. Or Test to GMW14872, UH, All, 4 SP, Method 1/2, Exposure B (cosmetic) and E (functional), Option 4, Thermal Soak addition: 121 °C ± 2 °C for 2 h per cycle to validate UH applications. After completing this procedure, six (6) specimens; (three (3) maximum material conditions and three (3) minimum material conditions), must be tensile tested per 4.3.1 for ambient, with the acceptance determination remaining the same. Additionally, six (6) specimens; (three (3) maximum material conditions, three (3) minimum material conditions), must be evaluated for disassembly effort. After activating the release feature of the joints using any necessary specified tool, separation must not require any undo effort as compared to one not subjected to the corrosion test again evaluated using 4.3.3 but with an acceptance determination load of 111.3 N maximum. Then run Burst Strength (4.3.2). Metal brackets part of the assembly or release separately shall be tested per 4.3.6.2.

4.3.6.2 Corrosion for Metal Brackets. For brackets to be released as part of the line or loose parts, test to GMW14872, UB, All, 4 SP, Method 1/2, Exposure A and E, Option 4 to validate UB applications. Alternately, test to GMW14872, UH, All, 4 SP, Method 1/2, Exposure B and E, Option 4 to validate UH applications.

4.3.7 Vibration.

4.3.7.1 The test assemblies shall be mounted in the test fixture such that the vibration shall be imparted to the assemblies through a rigid connection made to the body of the connector.

4.3.7.2 Test Procedure. Subject the hose and coupling assembly to the Leak Test (4.3.10) prior to and at the completion of this vibration test. Test specimens shall be tested per GMW17010 (vibration for Engine mounted

parts) if program specific Road Load Data inputs are not available. DRE/Subsystem Validation Engineer shall evaluate the specific GMW17010 vibration profile.

4.3.8 Pressure/Displacement/Temperature Testing.

4.3.8.1 These tests shall be run sequentially using the same test samples. These samples shall remain in the same test fixture for a minimum of four (4) cycles.

4.3.8.2 Measurement Parameters. Each of the quantities must be measured throughout the test at the following locations:

- Test fluid temperature on the manifold supplying the samples.
- Test fluid pressure on return line from manifold receiving fluid from the samples.
- Environment temperatures: Top of environmental chamber flow rate at test fluid supply line.

4.3.8.3 Leak Detection. Dye sensitive to ultraviolet (black) light must be added to the test fluid supply. Once every test cycle when the temperature is at ambient, the samples must be inspected using an ultraviolet (UV) light.

4.3.8.4 Heat Aging. Place the test samples in test fixture, fill with test fluid and heat the assembly at 149 °C for 16 h per cycle with no flow.

4.3.8.5 Pump Capacity.

4.3.8.5.1 The pump flow rate must be a minimum of 5.7 L/minute per sample at 0 kPa. Minimum relief pressure of pump shall be not < 1200 kPa

4.3.8.6 Thermal Cycling Test.

- Fluid flow temperature 149 °C.
- Fluid flow pressure 1140 kPa.
- Environment temperature (hot/cold chamber) cycle from -40 °C to +149 °C. See Appendix A, Figure A1.
- **Test fluid:**
  - **TOC Systems:** DEXRON® VI Automatic Transmission Fluid (ATF) (GMW16444).
  - **EOC Systems:** Engine Oil (GMW17332).

Note: Transmission or Engine Fluid shall be approved by Validation Engineer and DRE before ADVP&R submission.

4.3.8.7 Accelerated Pressure Impulse Test.

- Fluid flow temperature 149 °C.
- Fluid flow pressure 1140 kPa, three (3) cycles/minute. See Appendix A, Figure A2.
- Environment temperature (hot/cold chamber) cycle time (24 h per thermal cycle) 16 h at 149 °C, 8 h at 20 °C, perform one (1) cycle. See Appendix A, Figure A3.

4.3.8.8 Manifold Relative Displacement. Each end of the moving manifold must trace out an ellipse tangent to the surfaces of the box defined in Table 2 (see also Appendix A, Figure A4). The manifold must remain parallel to the bottom of the chamber throughout the test. The ellipse should be covered 30 times each minute. Alternate requirements for the frequency, amplitude and the direction of the motion may be specified for the part number tested, at the discretion of the GM Release Engineer.

Table 2: Direction from In-Car Position

Up	Down	Fore	Aft	Left	Right
mm	mm	mm	mm	mm	mm
33.0	33.0	25.4	25.4	22.9	22.9
± 1.3	± 1.3	± 1.3	± 1.3	± 1.3	± 1.3

Note: mm = millimeter(s).

4.3.8.9 Hot Oil Recirculation Test.

- Fluid flow temperature (see Appendix A, Figure A3).
- Fluid flow pressure 345 kPa.
- Ambient temperature 20 °C.
- Test time 42 h.
- **Test fluid:**
  - **TOC Systems:** DEXRON® VI ATF (GMW16444) and other GM Specific Program approved transmission fluids.
  - **EOC Systems:** Engine Oil (GMW17332).

Note: Transmission or Engine Fluid shall be approved by Validation Engineer and DRE before ADVP&R submission.

4.3.8.10 Burst Strength Requirements. The minimum burst strength of the hose assembly while the fluid in the samples is maintained at 149 °C. The burst test shall be per ASTM D380 and minimum burst strength shall be no < 5800 kPa as post test results.

4.3.8.11 Tensile Strength Requirements. Apply a tensile load causing elongation at the rate of 25 mm/minute. This load is to be applied long the centerline of the hose. A permanent recording of elongation vs. time should be made. Acceptance requirements can be based on the load causing failure due to separation at the fittings or by rupture of the hose structure which should not occur at < 450 N. Two (2) samples of each part number shall be tested.

4.3.8.12 A continuous record of the fluid temperature, fluid pressure and environment temperature must be maintained. Samples should be inspected for leaks at least every 4 h.

4.3.9 Pressure Temperature Cycling Test.

4.3.9.1 Install assemblies on manifold and test for air leaks per 4.3.10.

4.3.9.2 Fill reservoir and hose assemblies per GMW16444 for TOC systems and GMW17332 for EOC systems. Add a dye sensitive to ultraviolet light at a maximum concentration of 1%. Bleed air from manifold, attach air supply to reservoir.

4.3.9.3 Raise chamber and fluid temperature to 150 °C while maintaining 140 kPa pressure on the reservoir. Determination of fluid temperature must be made so that the reading obtained is representative of the fluid contained in the assembly. Maintain temperature for 60 minutes. Fluid temperature, system pressure and chamber temperature must be recorded continuously, and these recordings must be included in the test report for review.

4.3.9.4 Reduce chamber and fluid temperature to -40 °C. Determination of fluid temperature must be made so that the reading obtained is representative of the fluid contained in the assembly. Once this temperature has been reached, raise the pressure to 2070 kPa and hold for 15.5 s. Reduce pressure to 140 kPa. Repeat three (3) times per minute for 60 minutes while maintaining temperature at -40 °C.

4.3.9.5 Repeat 4.3.9.3 and 4.3.9.4 to a total of 15 times.

4.3.9.6 Inspection. Inspections per these procedures must be conducted every 30 minutes. Inspect all joints with an ultraviolet light for evidence of leakage and record all leaks per the following rating system:

- **N** = No evidence of leakage.
- **L** = Damp surface.
- **M** = Drops visibly forming.
- **H** = Drops visibly falling.

Inspect all joints for movement of hose out of the crimped joint. Record any movement in millimeters (mm).

4.3.10 Leak Test. This test in intended to discover any fluid leakage which may not become evident during the tests listed in the Test Application (4.3.10.2).

4.3.10.1 Test Fluid. This test must be run with air or dry nitrogen.

4.3.10.2 Test Application. This test is to be performed before and after these tests as part of each tests' Acceptance Criteria.

- 4.3.4 Serviceability.
- 4.3.5 Heat Aging.
- 4.3.6 Corrosion.
- 4.3.7 Vibration.
- 4.3.8 Pressure/Displacement/Temperature.

4.3.10.3 Test Procedure. Keep the joint assembly specimens secured together when removing specimens from a previous test to perform the Leak Test. Install each specimen to the feed and return of the compressed gas supply. Completely submerge the assembly in water, including the compressed gas supply joints.

Pressurize the system to 1725 kPa by increasing the pressure from ambient at a rate of about 300 kPa/s. Hold the pressure at 1725 kPa for 5 minutes to ensure that an apparent leak is continuous and not the short term escaping of air trapped outside the seal but within the connector assembly.

4.3.10.4 Acceptance Determination. Assembly must hold compressed gas pressurized at 1725 kPa for 5 minutes without any visual indication of bubbles which could be considered a leak. Test samples should be inspected for leaks at least every 4 h.

5 Provisions for Shipping

5.1 Packaging. All assemblies shall be packed to provide adequate protection from damage or contamination during handling, packing, shipping and storage. Refer to GM1738 for details.

6 Notes

6.1 Glossary.

4 sp: Four (4) salt sprays, per GMW14872.

Design Validation (DV): Design Validation is defined as the set of requirements to be used to validate a new design. See also 4.1.1.

Fritted Crucible: Fritted glass is finely porous glass through which gas or liquid may pass. A fritted filter is often part of a glassware item, so fritted glass funnels and fritted glass crucibles are available.

New Design: New Design is defined as a design using different materials, processes or dimensions that, in the GM Release Engineer's judgment, is a departure from previous practice.

Production Validation (PV): Production Validation is defined as the set of requirements to be used to validate new production parts. See also 4.1.2.

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

6.2 Acronyms, Abbreviations, and Symbols.

ADVP&R	Analysis/Development/Validation Plan and Report
ATF	Automatic Transmission Fluid
BFO	Bill of Materials (BOM) Family Owner
BOM	Bill of Materials
CAE	Computer Aided Engineering
CPK	Process Capability Index
DRE	Design Responsible Engineer
DV	Design Validation
DVP&R	Design Validation Plan and Report
EOC	Engine Oil Cooler
FMEA	Failure Mode and Effects Analysis
GSO	Global Simulation Owner
GSSLT	Global Subsystem Leadership Team
H	Drops Visibly Falling

HVAC	Heating, Ventilation, Air Conditioning
IMDS	International Material Data System
L	Damp Surface
M	Drops Visibly Forming
mm	millimeter(s)
N	No Evidence or Leakage
PDT	Pressure, Displacement and Temperature
PPAP	Production Part Approval Process
PV	Product Validation
REP	Reliability Evaluation Point
SOR	Statements of Requirements
TIE	Technical Integration Engineer
TOC	Transmission Oil Cooler
UB	Underbody
UH	Underhood
UV	Ultraviolet
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:

GMW15724

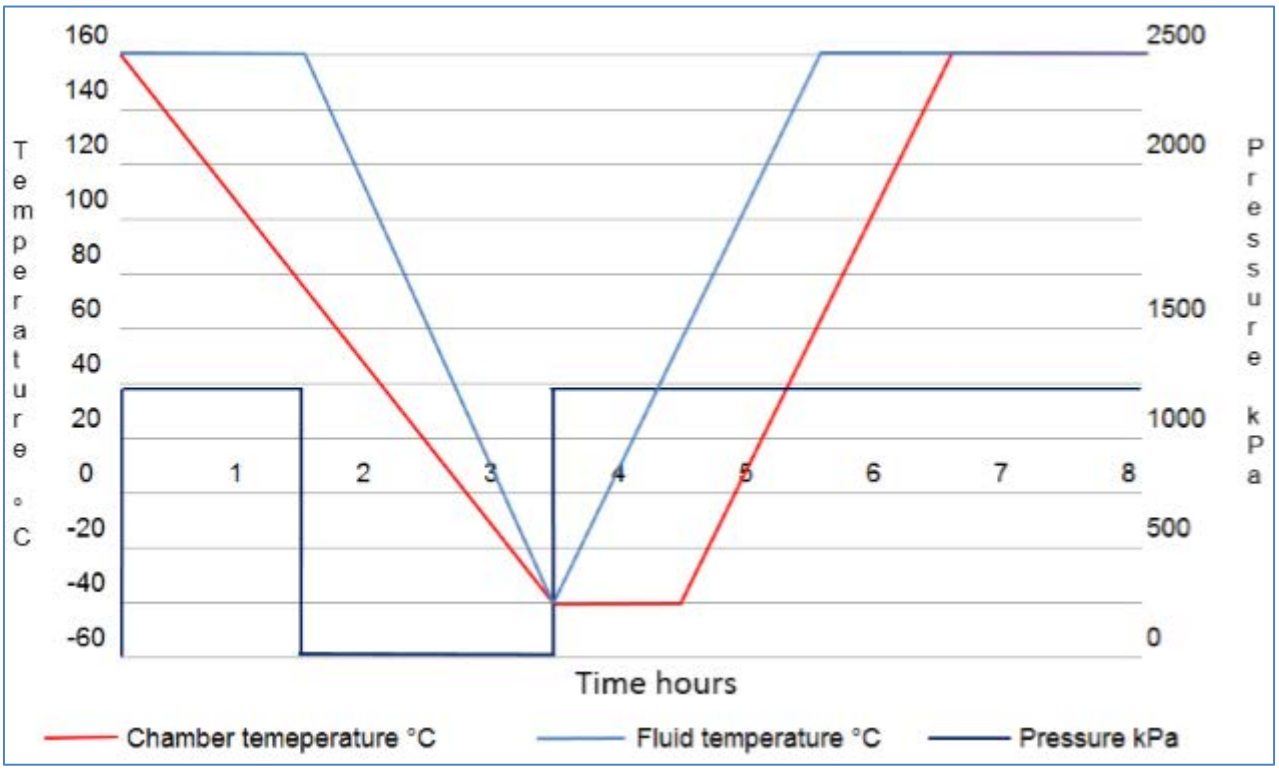
9 Release and Revisions

This standard was originated in October 2007. It was first approved by HVAC and Powertrain Cooling in May 2008. It was first published in May 2008.

Issue	Publication Date	Description (Organization)
1	MAY 2008	Initial publication.
2	SEP 2012	Updated. (HVAC and Powertrain Cooling GSSLT)
3	SEP 2015	Update specification to refer to GMW17010 for vibration testing. Increased system pressure, update REP. vibration and corrosion are Production Validation (PV) added. (HVAC - Fluid and Plumbing GSSLT)
4	AUG 2019	Update requirement for bracket corrosion. (HVAC - Chassis Propulsion Integration and Thermal Systems)

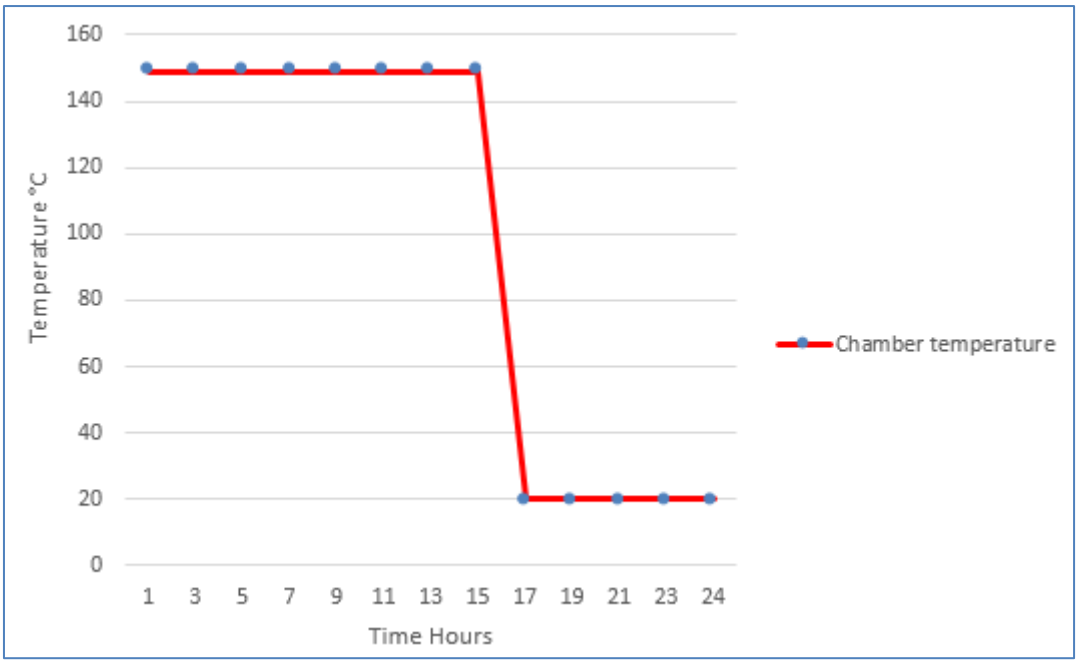
Appendix A

Figure A1: Thermal Cycling



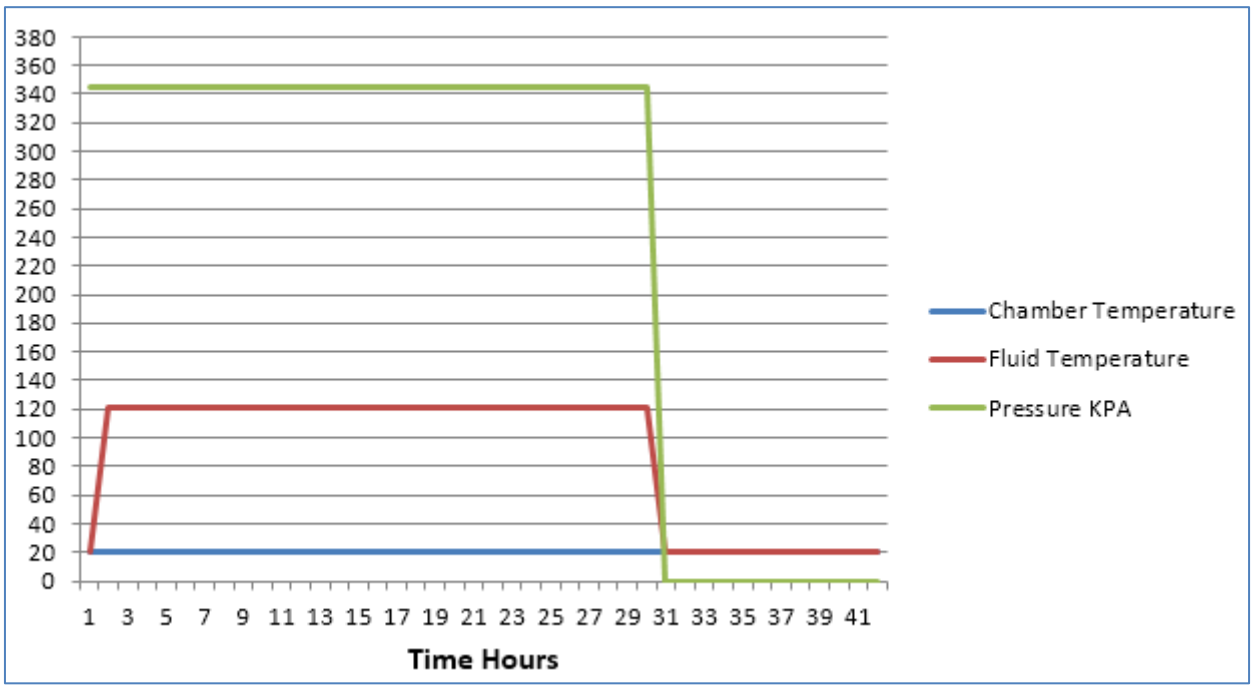
Notes:
The oil temperature is 149 °C. Flow for 1.5 h at 1140 kPa then shut off for 2 h.
During the 3.5 h, the chamber temperature is ramped from 149 °C to -40 °C.
At the start of -40 °C, turn sump oil heater to 149 °C and maintain pressure at 1140 kPa.
The -40 °C chamber temperature is maintained for 1 h, then ramped to 149 °C during 2 h.
Then flow oil for rest of test at a steady 1140 kPa.

Figure A2: Accelerated Pressure Cycling and Manifold Relative Displacement Test



Notes:
Manifold displacement will be run simultaneously with Accelerated Pressure Impulse Test.
Fluid temperature at 149 °C, three (3) cycles per minute, 5 s at 0 kPa, 15 s at 1140kPa.

Figure A3: Hot Oil Recirculation Test



Note: Fluid Flow Pressure at 345 kPa.

Figure A4: Manifold Displacement Test