



Qualifying Transmission and Engine Oil Hose Coupling Assemblies

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 describes the quality, reliability, durability, and performance requirements for Transmission Oil Cooler (TOC) and Engine Oil Cooler (EOC) hose coupling 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. GMW15964 is the only document for transmission and engine oil line coupling qualification.

1.2 Applicability. This standard covers qualification tests for two hose coupling systems used with cooling line oils designated as Type E; Engine oils and Type T; Transmission oils used in automotive applications.

1.3 Remarks.

1.3.1 Classification.

- **Type E:** Medium temperature engine lubricating oil hose.
- **Type T:** Medium temperature transmission lubricating oil hose.

2 References

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

2.1 External Standards/Specifications.

ASTM D380 SAE J1344

2.2 GM Standards/Specifications.

GMW3059	GMW14156 (ID)	GMW15724	GMW16171
GMW3116	GMW14157 (ID)	GMW15758	GMW16444
GMW8758	GMW14573	GMW15760	GMW17010

Note: (ID) = This standard is limited to internal distribution within General Motors and shall not be distributed outside this company. Contact the GM Lead Engineer for further instructions.

2.3 Additional References.

- Analysis/Development/Validation Plan and Report (ADVP&R) plan.
- Statement of Requirements (SOR) Appendix.
- Validation Cross Reference Index (VCRI).
- Vehicle Technical Specification (VTS).

3 Requirements

3.1 System/Subsystem/Component/Part Definition.

3.1.1 Appearance. Not applicable.

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3.1.2 Content.

3.1.2.1 Physical Content.

3.1.2.1.1 Material Identification. To properly define the performance requirements for the assembly, the performance specification number is to be followed by a (e.g., GMW15964, Type T is for medium temperature transmission lubricating oil hose or Type E is for medium temperature engine lubricating oil hose). Refer to GMW16171 for material Construction Letter and Category Type descriptions.

3.1.2.1.2 Coupling Construction.

3.1.2.1.2.1 Coupling Design. The coupling shall be designed, inserted, and swaged or crimped so that no internal hose abrasions, cuts, flaws or damage of any kind shall result under any condition or combination of assembly component dimensioning or tolerance allowed by supplier production specifications, or under any condition of hose compression allowed by supplier production specifications.

3.1.2.1.2.2 Sharp Corners. Sharp corners shall be avoided where the coupling contacts the hose to prevent cutting of the hose when subjected to internal pressure.

3.1.2.1.2.3 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 to eliminate burrs or sharp edges which might cause hose damage under conditions of assembly vibration or pressure impulse.

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

3.1.2.1.2.5 Tube Collapse. 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.

3.1.2.1.2.6 Skiving. Skiving of the hose is not permissible.

3.1.2.1.2.7 Flow Requirements. The coupling shall be designed for low flow restriction.

3.1.2.1.2.8 Coupling Identification. The coupling shall be stamped with the date of manufacture (month and year) and the manufacturer's identification.

3.1.2.2 Functional 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 (-40 °F to 300 °F), with an excursion temperature exposure of 165 °C (329 °F), 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 under-hood and underbody environments. Hose material and tubing must be compatible with DEXRON® - VI (GMW16444), DEXRON® HTP, and other GM Specific Program approved transmission fluids, GM and SAE International (SAE) standard engine oils (e.g., SAE 5W30), and any other under-hood fluid (windshield washer fluid, brake fluid, etc.) Transmission or engine fluid shall be approved by Validation Engineer and Design Release Engineer (DRE) before Analysis/Development/Validation Plan and Report submission.

3.2 Product Characteristics.

3.2.1 Performance Requirements. Not applicable.

3.2.1.1 Fixed-Value Performance Testing Requirements. See 3.8.1.2.

3.2.1.2 Endurance Testing Requirements. See 3.8.1.3.

3.2.2 Physical Characteristics. Transmission oil line and engine oil line can be built to several tube dimensions. Typical tube dimensions are 9.525 mm (³/₈ in), 12.7 mm (¹/₂ in), 15.875 mm (⁵/₈ in), and 19.05 mm (³/₄ in).

3.2.2.1 Dimensions and Capacity. Not applicable.

3.2.2.2 Mass Properties. Refer to Vehicle Technical Specification (VTS) for program requirements.

3.2.3 Reliability.

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

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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 transmission oil cooler line or engine oil cooler line. The supplier shall utilize "vehicle equivalent" laboratory test setups to simulate "in vehicle" orientations. If the orientation may be different from vehicle to vehicle, use the orientation which will provide the worst case loads, for all physical level reliability demonstration testing. Refer to GMW14156 Test Reliability Requirements Guidelines, and GMW14157 Statistical Confidence Level for Reliability Validation Testing.

The reliability demonstration is provided by the Design Validation (DV) Endurance tests specified in 3.8.1.3, in contrast to Design Validation (DV) the Endurance tests specified for Product Validation (PV) in 3.8.2.3, are intended to confirm conformance to the reliability demonstrated during DV.

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.

Test to Failure. A Weibull Plot of the "Nominal and Minimum" crimp assemblies test data will demonstrate that R99C50 of the hose crimp population. Weibull chart shall show three plot lines; one of the "Minimum" crimp assemblies, one of the "Nominal" crimp assemblies, and plot line of the "Minimum" and "Nominal" crimp assemblies combined. The data shall be submitted in tabular format by assembly with the following information: Assembly Inner Diameter (ID), measured linear and area compression of each joint, rating at each inspection interval per Appendix D. A Weibull graph will be plotted based on the test data.

For "Success" Testing. Use Table 5 to determine sample size and number of Pressure and Temperature Cycles to meet R99C50 requirements.

Note: The required number of test samples may be negotiable if it is not practical to run, for example, 69 samples. The negotiation of sample size should 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 Test (HAST), Calibrated Accelerated Life Test (CALT), Highly Accelerated Life Test (HALT), etc. Weibull slope values available from previous failure testing may be considered as a way to reduce the sample size and/or test duration. (For detail refer to GMW14156 Test Reliability Requirements Guidelines, and GMW14157 Statistical Confidence Level for Reliability Validation Testing.)

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 (reference GMW8758 Calibrated Accelerated Life Testing). 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. For Assembly of Test, the test samples of coupled hoses submitted for test to the specification shall have an exposed hose length of 500 mm $\pm$ 10 mm and a maximum tube length from coupling to nut of 100 mm $\pm$ 10 mm. Each sample must be tagged with the following information.

- Hose Coupling Assembly Manufacturer
- GM Material Specification Number (GMXXXXM or GMWXXXXX)
- Hose Type (E or T); and Date

The submission of assemblies to the releasing division for testing to generate an Engineering Source Approval may be waived upon the decision regarding acceptability of vendor supplied data for this approval. Assemblies manufactured for testing to the requirements for maximum hose compression samples shall be manufactured per the dimensional tolerance defined in Appendix C for the maximum crimp compression condition. Assemblies manufactured for testing to the requirements for minimum hose compression samples shall be manufactured with minimum wall thickness (as determined by the 3 sigma value of the hose manufacturer, not the dimensions allowed per the hose specification), maximum crimp/swage Outside Diameter (OD) (3 sigma value of the assembly manufacturer), minimum tube insert OD (3 sigma value of the tube insert manufacturer), and minimum ferrule wall (3 sigma value of the ferrule manufacturer). Assemblies as manufactured per 3.3.1.1, but with the

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substitution of nominally dimensioned tube insert OD and nominally dimensioned ferrule wall thickness components may be used for this evaluation with the submittal of Statistical Process Control (SPC) data containing minimal tolerances and acceptable C_p values for these dimensions. The acceptability of nominal insert OD and ferrule wall thickness dimensions for this testing must be reviewed beforehand and approved by the GM Materials Engineer issuing the approval. Assemblies manufactured for testing to the requirements for nominal hose compression shall be manufactured as close as possible to mean production values for dimensioning and other assembly properties. For these samples, values of hose compression under the crimp must be within $\pm 2\%$ of the production mean value.

3.3.1.1.1 Test Conditions. All temperatures shall be held to $\pm 2^\circ\text{C}$ and all pressures to $+34.5/-0.0$ kPa unless otherwise noted. Tests or portions of tests in which the test temperature is not specified shall be conducted at ambient temperature. Ambient temperature is defined as $23^\circ\text{C} \pm 2^\circ\text{C}$.

3.3.1.1.2 Engineering Source Approval Requirements. Approval for hose (Types E and T) will require the following information to be submitted to the GM Materials Engineer:

3.3.1.1.2.1 Blue prints 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.

3.3.1.1.2.2 The submission of sectioned coupling samples to demonstrate that all of the material guidelines per 3.3.1.1 have been met.

3.3.1.1.2.3 A description of the statistical process control procedures for the control of coupling diameter dimensions and the hose compression range.

3.3.1.1.2.4 The value for hose compression necessary to induce:

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

3.3.1.1.2.5 Data presented in both tabular and graph form, showing values of hose compression (calculated using both linear and area methods) vs. Tensile Test performance (4.3.4), Burst Test Performance (4.3.2), and Fitting Insert Collapse. The dimensions of the crimped assembly components for each data point need to be listed, as well as the resultant hose compression.

3.3.1.1.2.6 Copies of test fixture traces, confirming pressure and temperature profiles imposed on the samples during test.

Note: Values of hose compression must be reported both in terms of linear compression and area compression Appendix C for the formula for each calculation.

3.3.1.1.3 Engineering Approval Factors. Engineering Source Approvals generated through testing to prove compliance to this specification are specific for combinations of the following factors:

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

Testing of one construction of assembly can result in Engineering Source Approvals for two crimp designs or materials by placing a different design or material variant on each end of the assembly.

3.3.1.2 Processes Guidelines. Not applicable.

3.3.1.3 Parts Guidelines. Not applicable.

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

3.3.2 Design Guidelines and Constraints. All tube/hose assemblies manufactured for testing to this specification for Engineering Source Approval purposes shall be completely representative of production level materials, components, processes and tooling.

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The exceptions are those assemblies needing to be specially manufactured under extremes of dimensions and/or tolerancing to meet the test requirements of the specification. Any exceptions to this requirement, or to any criteria referenced in this document (GMW15964), must be reviewed beforehand and approved by the GM Materials Engineer issuing the approval.

3.3.2.1 Engineering Source Approval Testing of Minimum and Maximum Dimensioned Hoses/Components. All testing conducted on assemblies and hoses manufactured with minimum and maximum dimensions are to be conducted one time only for the initial Engineering Source Approval.

3.3.2.2 Coupling Assembly Required Tests. All test samples must be qualified dimensionally. All data points must be reported. For samples destructively tested, mode of failure must be reported. All test specimens must be retained by the supplier for a minimum period of one (1) year and supplied to the GM Materials Engineer for review if requested. Test procedures referencing specific minimum test values that must be met, must be met by the -3 sigma limit of the sample population tested.

3.3.2.3 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.

3.3.3 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. 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. Not applicable.

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 (GMW15758, 3.2.1 Design Validation). The performance measurements and durability test results shall be summarized and reported to GM on the supplier Analysis/Development/Validation Plan and Report (ADVP&R) plan for the component or components being tested. Full test reports will be available for viewing by GM personnel by request. Sample sizes will be defined in the Validation Cross Reference Index (VCRI) in the Statement of Requirements (SOR) Appendix.

3.8.1.1 Test Samples. 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 the materials specification. The exceptions are those assemblies needing to be specially manufactured under extremes of dimensions and/or tolerances to meet the test requirements of the specification. Any exceptions to this requirement must be reviewed beforehand and approved by the GM Thermal Engineer issuing the approval.

3.8.1.2 Fixed-Value Performance Testing. The following fixed-value performance tests must be run. These are tests designed to demonstrate the performance of the component but not necessarily the reliability.

3.8.1.2.1 Cleanliness. Hose and coupling assemblies shall be tested per 4.3.1.

3.8.1.2.1.1 Acceptance Determination. There shall be no internal free water present in the hose assemblies and no corrosion of either internal or external metal surfaces. In addition, no foreign material shall be collected on the 60-mesh screen and not more than 0.26 g/m² of internal surface shall be collected on the crucible (after drying in a desiccator at 65 °C for 1.5 h).

3.8.1.2.2 Burst Test. Hose and coupling assemblies shall be tested per 4.3.2.

3.8.1.2.2.1 Acceptance Determination. Minimum burst strength shall be no less 6895 kPa.

3.8.1.2.3 Leak. Hose and coupling assemblies shall be tested per 4.3.3.

3.8.1.2.3.1 Acceptance Determination. There shall be no indication of air leakage at the coupling or in the hose member when the assembly is subjected to the specified air pressure for Types E and T hose while under water.

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With engineering approval, an equivalent pressure decay leak test procedure or mass flow leak test procedure may be substituted for the air under water procedure.

3.8.1.2.4 Tensile Strength. Hose and coupling assemblies shall be tested per 4.3.4.

3.8.1.2.4.1 Acceptance Determination. The load at failure either by separation of the specimen from the end fittings or by rupture of the hose structure shall be no less than those in Table 1.

Table 1: Acceptable Minimum Load by Type

Type	Test Temperature	Minimum Load Acceptance
E	Ambient Room Temperature	2220 N
E	93.5 °C	1000 N
T	Ambient Room Temperature	890 N
T	150 °C	500 N

3.8.1.2.5 Heat Aging. Hose and coupling assemblies shall be tested per 4.3.5. The ends shall be uncapped for testing.

3.8.1.2.5.1 Acceptance Determination. The hose shall show no signs of external or internal cracks, charring, or disintegration and shall not leak when subjected to the Leak Test.

3.8.1.2.6 Over-Crimp to 3 sigma Limits. Hose and coupling assemblies shall be tested per 4.3.6.

3.8.1.2.6.1 Acceptance Determination. No hose rubber or reinforcement damage generated by the crimping operation is permissible in these samples.

3.8.1.2.7 Over-Crimp to Damage. Hose and coupling assemblies shall be tested per 4.3.7.

3.8.1.2.7.1 Acceptance Determination. Signs of damage to the cover, tube and/or reinforcement shall be evidence that the over-crimp limit has been exceeded.

3.8.1.2.8 Cyclical Corrosion Test. Twelve (12) samples shall be tested per 4.3.8.

3.8.1.2.8.1 Acceptance Determination. Upon completion of cosmetic requirements, sample must show no greater than 5% base metal corrosion. Upon completion of Exposure E, assembly must meet all of the requirements of the Leak Test (4.3.3) and the Burst Test (4.3.2).

3.8.1.3 Endurance Testing. The following endurance tests must be run.

Endurance test requirements are designed to demonstrate the component reliability. Some examples are fatigue, creep, pressure/vibration/temperature cycling, etc. Endurance testing may be conducted using either Test to Failure, or "Success" testing.

3.8.1.3.1 Pressure Cycling. Hose and coupling assemblies shall be tested per 4.3.9. Subject the specimens to the Leak Test per 4.3.3 prior to and at the conclusion of the Pressure Cycle Test. Subject the specimens to 150 000 cycles of hydrostatic pressure at the specified temperature and pressure. The pressure shall be applied quickly by means of a quick opening solenoid valve at a rate of 25 cycles to 35 cycles per minute. The pressure medium shall be as shown in Table 2.

Table 2: Pressure Cycling Test Parameters

Suffix	Temperature (°C)	Pressure Test (kPa)	Fluid
Types E	150	700	Defined by Engine Option Code
Types T	150	1140	Defined by Transmission Option Code

3.8.1.3.1.1 Acceptance Determination. The assemblies shall show no signs of hydraulic leaks during the pressure cycling test or pneumatic leaks prior to or at the completion of the cycle test.

3.8.1.3.2 Temperature Cycling. Hose and coupling assemblies shall be tested per 4.3.10 (see Table 3).

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