

PROCEDURE FOR QUALIFYING HOSE COUPLING ASSEMBLIES

GM9058P

1 SCOPE. This specification covers qualification tests for 5 types of coupled hose assemblies as follows: fuels (gasoline, gasohol, diesel fuel) designated as Type A; low temperature lubricating oils designated as Type B; liquid propane fuels designated as Type C; medium temperature engine lubricating oils (GM6260M) designated as Type E; and medium temperature transmission lubricating oils (GM6260M) designated as Type T for use in automotive applications.

TYPE A – Liquid Fuels (gasoline, gasohol, diesel fuel) hose

TYPE B – GM6197M Low temperature lubricating oil hose

TYPE C – Liquid propane fuel hose

TYPE E – GM6260M Medium temperature engine lubricating oil hose

TYPE T – GM6260M Medium temperature transmission lubricating oil hose

1.1 RESTRICTED AND REPORTABLE CHEMICALS (GM1000M). All materials supplied to this specification must comply with the requirements listed in GM1000M, "Restricted and Reportable Chemicals."

2 REFERENCED STANDARDS.

GM1000M	GM6197M	9985687
GM4298P	GM6260M	9985912
GM6163M	GM9060P	ASTM D380

3 HOSE CONSTRUCTION.

3.1 The hose must meet the applicable hose specification as called out on the hose drawing. Quick-connectors incorporated into assemblies released to the GM9058P specification must meet the requirements of GM9060P.

3.2 COUPLING CONSTRUCTION.

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

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

3.2.3 The tube insert must not extend past the end of the crimp shell after crimping, and the end of the tube insert must be radiused to eliminate burrs or sharp edges which might cause hose damage under conditions of assembly vibration or pressure impulse.

3.2.4 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 stackup, including variations in hose compression concentricity.

3.2.5 Tube insert collapse during crimping is not permissible, except that this collapse is limited, predictable, controllable, and does not increase the potential for assembly leakage or other malfunction.

3.2.6 Skiving of the hose is not permissible.

3.2.7 The coupling shall be designed for low flow restriction.

3.2.8 Engineering source approval to this specification for all hose types (A, B, C, E, T) will require the following information to be submitted:

1. Blueprints showing the design, dimensions, and tolerances for all components of the assembly, including allowed eccentricity in the hose, tube insert, and coupling OD, and also including the range of hose compression possible under all conditions of dimensional tolerance stack-up.
2. The submission of sectioned coupling samples to demonstrate that all of the above mentioned construction requirements have been met.
3. A description of the statistical process control procedures for the control of coupling diameter dimensions, and hose compression range.
4. The value of hose compression necessary to induce.
 - a. Hose rubber damage (veneer, tube or cover).
 - b. Hose reinforcement damage.

NOTE: Values of hose compression must be reported both in terms of linear compression, and area compression (see Figure 8 for the formula for each calculation).

3.2.9 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.

3.2.10 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, with the exception of 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 Section 3, must be reviewed beforehand and approved by the GM Materials Engineer issuing the approval.

3.3 CRIMP EXAMINATION PROCEDURE.

3.3.1 Sixteen assemblies must be manufactured with maximum wall thickness (as determined by the 3 sigma value of the

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hose manufacturer, not the dimensions allowed per the GM hose specification), minimum crimp/swage OD (3 sigma value of the assembly manufacturer), maximum metal tube insert OD (3 sigma value of the metal tube insert manufacturer), and maximum ferrule wall thickness (3 sigma value of the ferrule manufacturer). These assemblies shall be disassembled and examined for hose veneer, tube, cover, and reinforcement damage as described in 3.3.3. Supplier evaluation of these parts, and the parts themselves, must be returned to the GM Materials Engineer issuing the approval for evaluation. No hose rubber or reinforcement damage generated by the crimping operation is permissible in these samples. This is required for approval to the GM9058P specification for Types A, B, C, E, and T. Assemblies manufactured as above, but with the substitution of nominally dimensioned metal tube insert OD and nominally dimensioned ferrule wall thickness components may be used for this 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 dimensions for this testing must be reviewed beforehand and approved by the GM Materials Engineer issuing the approval.

3.3.2 Additional samples must be crimped and examined to determine the value of hose compression necessary to induce damage to either the hose material, or to the reinforcement.

3.3.2.1 These samples are to be overcrimped per the conditions described in , except that progressive increments of increased hose compression are to be induced through reduction of crimp OD until hose damage is incurred. These increments may not number less than two, nor be more than 4% incremental hose wall compression.

3.3.2.2 Four samples are to be prepared for each increment. Two shall be examined for hose damage, and two for reinforcement damage. After the compression that induces damage is determined, confirmation shall be obtained by a repetition of four additional samples.

3.3.2.3 Determination of damage shall be done in accordance with 3.3.3 of this specification.

3.3.2.4 Other engineering experimental plans are permissible, providing that the approval of the GM Materials Engineer issuing the approval has been obtained.

3.3.2.5 Any exceptions or deviations to this section must have the approval of the GM Materials Engineer issuing the approval and must be addressed completely and clearly in certification packages.

3.3.3 Hose Examination Procedure:

1. For 8 of the assemblies, cut and remove the coupling shell carefully, avoiding damage to the hose. Carefully cut through the hose along the length of the hose, either with one cut (preferable) or with 2 cuts 180° from one another. Remove the hose from the tube stem insert, again minimizing damage to the hose during this process. Evaluate both ID and OD of the hose in the areas adjacent to and under the coupling shell for any evidence of damage induced by the manufacturing operation.
2. For 8 of the assemblies, perform evaluation as described in '1' above. After this is complete separate hose cover stock from tube stock by carefully peeling cover from tube, starting at a point away from the portion of the hose adjacent to or under the coupling and progressing to the end of the hose which was under the coupling. After the cover and tube have been separated, evaluate the reinforcement for any evidence of damage induced by the manufacturing operation.
3. For all 16 assemblies, amount of tube stem collapse must be determined.

4 TESTS.

4.1 COUPLING ASSEMBLY REQUIRED TESTS. Coupled hose assemblies shall be tested for conformance with Table 1.

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TABLE 1

Section	Number of Samples	Test
3.3.1	16	Overcrimp to 3 sigma limits
3.3.2	Design Dependent	Overcrimp to damage
5.1	(See NOTE 1)	Leak
5.2	2	Cleanliness
5.3	2	Tensile (all types)
	16	Tensile (Type A only)
5.4	2	Burst Strength
5.5	2	Heat Aging
5.6	2	Pressure Cycling (Type B, C, E, T, only)
5.7	2	Temperature Cycling
5.8	4	Thermal Cycle (Type B only)
5.9	2	Vibration
	4	Vibration (Quick- connector assm only)
5.10	2	Corrosion
5.11	2	Fuel Soak and Flex (Type A only)
5.12	8	Hot Oil Burst (Type A only)
5.13	8	Vibration and Hot Oil Burst (Type A only)
	16	Vibration and Hot Oil Burst (Type A only, quick- connector containing assm only)
5.14	2	Fuel Soak and Flex (Type C only)
5.15	4	Pressure, vibration, temperature (Type E, T only)
5.16	8	Pressure Temperature Cycling (Type E, T only)

NOTE 1: Performed in conjunction with other tests.

4.1.1 Coupling Assembly Samples. Samples of coupled hose submitted for test shall have an exposed hose length of 500 ± 10 mm and a maximum tube length from coupling to nut of 100 ± 10 mm. All coupled hose samples submitted for test must have three 1.60 mm diameter holes, 120° apart, drilled through the coupling shell at the very end of the hose. Holes shall be drilled on both male and female ends. Each sample must be tagged with the following information: hose coupling assembly manufacturer; GM specification number (GMXXXXM); hose Type (A, B, C, 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 tolerancing defined in . 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 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 manufactured as above, but with the substitution of nominally dimensioned tube insert OD and nominally dimensioned ferrule wall thickness components may be used for this 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 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 $\pm 2.0\%$ of the production mean value.

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4.1.2 For engineering source approval testing to and 5.1 through 5.16, 64 samples are required for Type A, 36 samples are required for Type B, 34 samples are required for Type C, and 44 samples are required for Type E or T. For assemblies containing quick connectors, 10 additional assemblies are required to be tested for Type A assemblies, 2 additional assemblies are required to be tested for all other types. Additional assemblies are required to be tested to meet the requirements of for all types.

4.2 Tolerances. All temperatures shall be held to $\pm 2^\circ\text{C}$ and all pressures to $-0, + 34.5\text{ kPa}$ unless otherwise noted.

5 TEST REQUIREMENTS.

5.1 LEAK TEST. 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 A, B, C, E, or T hose while under water. Care must be taken to insure that an apparent leak is continuous and not the short term escaping of air entrapped between the inner tube and outer cover. This is accomplished by subjecting the assembly to pressure for 3 to 5 minutes.

Type A Hose.....690 kPa
Type B, E, and T Hose 1000 kPa
Type C Hose..... 4825 kPa (Nitrogen or equivalent)

NOTE: 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.

5.2 CLEANLINESS.

5.2.1 Test Specimens. Two hose and coupling assemblies shall be tested.

5.2.2 Test Procedure.

5.2.2.1 Visual Inspection. Visually inspect the hose assemblies for evidence of internal free water and corrosion of internal and external metal surfaces.

5.2.2.2 Contaminant Collection. Bend the coupled hose in a U shape and fill with reagent grade Stoddard Solvent. Agitate the hose and pour the Stoddard Solvent into a clean beaker, cover, and place in a desiccator. After 15 minutes, visually inspect for free water (small globules). Collect insoluble contaminants by filtering the liquid through a 60 mesh screen (240 μm hole size), then through a 30 mL fritted glass, grade fine filtering crucible of known weight. Alternate solvents may be used with engineering approval.

5.2.2.3 To ascertain the cleanliness of the Stoddard Solvent being used in this test run a blank containing Stoddard Solvent equivalent to the amount held in the coupled hose. The final weighing of the frittered crucible shall show no contaminants (weight increase $\leq 0.0004\text{ g}$).

5.2.3 Acceptance Determination. There shall be no internal free water present in the hose assemblies and no corrosion of 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/m^2 of interior surface shall be collected on the crucible (after drying in a desiccator at 65°C for 1.5 h).

5.3 TENSILE STRENGTH.

5.3.1 Test Specimens. Two hose and coupling assemblies shall be tested. (These shall be the same samples used in 5.2.)

5.3.1.1 For Type A hose only, 16 additional assemblies shall be submitted. Eight assemblies shall have hose with maximum wall thickness (as determined by the 3 sigma value of the hose manufacturer, not the dimensions allowed per the GM6163M specification) and minimum crimp OD (3 sigma value of the assembly manufacturer). The other 8 assemblies shall have hose with minimum wall thickness and a maximum value crimp OD (same criteria as above).

5.3.2 Test Procedure. Apply an increasing tensile load at approximately 25 mm/minute along the hose centerline. Tensile load at failure shall be on a permanent recording.

5.3.3 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 tabulated below:

Type A, B.....450 N
Type E.....2220 N
Type T.....890 N
Type C.....1800 N

5.4 BURST STRENGTH.

5.4.1 Test Specimens. Two hose and coupling assemblies shall be tested.

5.4.2 Test Procedure. The burst test shall be in accordance with ASTM D380.

5.4.3 Acceptance Determination. Minimum burst strength shall be no less than those tabulated below:

Type E & T	Type A	Type B	Type C
6895 kPa	6200 kPa	2100 kPa	12 100 kPa

5.5 HEAT AGING.

5.5.1 Test Specimens. Two hose and coupling assemblies shall be tested. The ends should be uncapped for testing.

5.5.2 Test Procedure. Subject the specimens to the leak test per 5.1. Upon completion of the leak test, coil the specimens around a mandrel having a diameter 8 times the nominal outside diameter of the hose (see Figure 1). Place the assemblies