



Fluorocarbon Fuel Hose Assembly

1 Scope

This specification covers coupled hose for use with gasoline, oil, and diesel fuel and related evaporative systems. These hose assemblies are suitable for use at temperatures of 40 °C to +150 °C (continuous), -40 °C to +160 °C (excursion) and operating pressures to 1.0 MPa.

1.1 Material Description.

1.1.1 Hose Construction. The hose shall be defined by the "Type" definition of the hose.

1.1.1.1 Type A Hose. Type A hose shall consist of a hose constructed with four (4) layers. The layers of the hose are as follows:

1.1.1.1.1 Inner Liner. The inner liner of the Type A hose shall consist of a vulcanizable blend of Polyvinylidene Fluoride Polymer (PVDF) and Fluoroelastomer (FKM).

1.1.1.1.2 Backing Layer. The backing layer for the inner liner of the Type A hose shall be Ethylene Tetrafluoroethylene Copolymer (ETFE).

1.1.1.1.3 Intermediate Layer. The intermediate layer of the Type A hose shall be Ethylene Acrylate Compound (AEM).

1.1.1.1.4. Outer Layer. The outer layer of the Type A hose shall be a layer of polyester reinforcement.

1.1.2 Coupling Construction.

1.1.2.1 The coupling shall be designed, inserted, 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 tube compression allowed by supplier production specification.

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

1.1.2.3 Tube Insert. 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.

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

1.1.2.5 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.

1.1.2.6 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 tolerancing allowed by supplier production specifications, or under any condition of hose compression allowed by supplier production specifications.

1.1.2.7 Adhesives. Use of adhesives in the crimped joint is not permissible.

1.1.2.8 Flow Requirements. The coupling shall be designed so that fuel flow is not restricted.

1.1.3 Quick Connectors. Quick connectors used in Fuel and Oil Resistant Coupled Hose Assemblies released to the GMW15733 specification shall meet the requirements of GM9060P.

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1.1.4 Dimensions and Tolerances. Hose furnished to this specification shall conform to the dimensions and tolerances shown in Table 1 for the size (nominal inside diameter) specified by the purchaser. Supplier should demonstrate capability to 3 sigma CPk of 1.33.

Table 1: Metric (SI) Units

Nominal Size (mm)	Hose Inside Diameter (mm)		Tube Wall Thickness (mm)	Hose Wall Thickness (mm)	
	Minimum	Maximum	Minimum	Minimum	Maximum
9.53	9.41	9.91	0.711	1.98	2.45
12.7	12.32	13.10	0.711	1.98	2.45

Customary Units

Nominal Size (inch)	Hose Inside Diameter (inch)		Tube Wall Thickness (inch)	Hose Wall Thickness (inch)	
	Minimum	Maximum	Minimum	Minimum	Maximum
$\frac{3}{8}$	0.370	0.390	0.028	0.078	0.096
$\frac{1}{2}$	0.485	0.515	0.028	0.078	0.096

Note: SI = International System of Units (SI Guide)

1.1.5 Material Identification. To properly define the assembly, the assembly specification number is to be followed by a **Type**, e.g., GMW15733 Type A. Drawing callouts not referencing an assembly **Type**, are assumed to be referencing Type A.

1.1.6 Hose Marking. The hose assembly shall be legibly identified with the manufacturer's name or trademark and the date of manufacture.

1.2 Symbols. Not applicable.

1.3 Applicability. Coupled high-pressure fuel system feed and return hoses.

2 References

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

2.1 External Standards/Specifications.

ASTM D413 SAE J1737 SAE J2044

2.2 GM Standards/Specifications.

9985912 GM9060P GMW3221 GMW14872
9986153 GMW3059 GMW3286 GMW15423

2.3 Additional References.

- Associated Research, Inc.
- TMC003 Material Safety Data Sheet guidance documents (available at www.gmsupplypower.com).

2.3.1 Fuel Specifications.

- GMPT-6-005-B
- GMPT-6-006-B

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3 Requirements

3.1 Sample Conditioning. All samples are to be conditioned prior to each requirement test to GMW3221, Code D.

3.1.1 Basic Test Requirements.

3.1.1.1 Coupling Assembly Required Tests. Coupled hose assemblies shall be tested for conformance per section numbers in Table 2.

Table 2: Test Table

Paragraph	Test	Type A
		Number Samples
3.2.1	Leak	Note 1
3.2.2	Elongation/Contraction	6
3.2.3	Burst Strength Test	6
3.2.4	Tensile Test	18
3.2.5	Heat Aging	6
3.2.6	Kink Test	N/A
3.2.7.1	Cleanliness	6
3.2.8	Conductivity	6
3.2.9	Kink Resistance Test	N/A
3.2.10	Permeation Test	6
3.2.11	Adhesion Test	N/A
3.2.12	Salt Spray Leak Test	6
3.2.13	Cyclical Corrosion Test	6
3.2.14	Overcrimp -3 Sigma Limits	16
3.2.15	Overcrimp to Damage Test	Design Dependent
3.2.16	Accelerated Pressure Impulse Test	6
3.2.17	Temperature Cycling	18
3.2.18	Vibration	6
3.2.18.1.2	Vibration (Quick- Connector Assemblies only)	12
3.2.19	Fuel Soak and Flex	6
3.2.20	Cold Flexibility-Vacuum Collapse Test	6
3.2.21	Sour Gasoline Recirculation Test	6
3.2.22	Fuel Resistance – Recirculation Test	6
3.2.23	Pressure Temperature Cycling Test	18

Note: N/A = Not applicable

Note 1: Performed for all test samples before conducting test procedures - (3.2.5, 3.2.12, 3.2.17, 3.2.18, and 3.2.19).

3.1.1.2 Standard Test Samples. Standard test samples of coupled hose shall have a hose length of 500 mm $\pm$ 10 mm and a maximum tube length from coupling to nut of 110 mm. These standard test samples shall be used for testing to all test procedures for engineering source approval data generation. For testing for Production Part Approval Process (PPAP), production parts shall be used whenever possible, except for test procedures 3.2.14 and 3.2.15.

3.1.1.3 Test Conditions. All temperatures shall be held to ± 2 °C and all pressures to -0 kPa + 34.5 kPa, unless otherwise noted.

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3.1.1.4 Approval Requirements. Approval will require the following information to be submitted. (3.1.1.4.1 through 3.1.1.4.6).

3.1.1.4.1 Blueprints showing the design, dimensions, and tolerances for all components of the assembly. Including allowed eccentricity in the hose, tube insert, and coupling OD. The range of all hose compression possible under each condition of dimensional tolerance stack-up must be determined.

3.1.1.4.2 The submission of sectioned coupling samples to demonstrate that all of the construction requirements in 1.1.1 through 1.1.4 are met.

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

3.1.1.4.4 The value for hose compression necessary to induce hose damage and reinforcement damage.

3.1.1.4.5 Data presented in both tabular and graph form, showing values of hose compression (calculated using both linear and area methods) versus Tensile Test performance (3.2.4), Burst Test performance (3.2.3), and fitting insert collapse. The dimensions of the crimped assembly components for each data point needs to be listed, as well as the resultant hose compression.

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

Note: Values of hose compression must be reported both in terms of linear compression and area compression (refer to Appendix B, for the formula for each calculation).

3.1.2 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 (1) construction of assembly can result in Engineering Source Approvals for two (2) crimp designs or materials by placing each design or material variant on one (1) end of the assembly.

3.1.3 Design Level Requirements. 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. 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 Section 1, Section 3, and Section 4, must be reviewed beforehand and approved by the GM Materials Engineer issuing the approval.

3.1.4 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 (1) time only, for the initial Engineering Source Approval. Testing to 3.2.13, is to be conducted one (1) time only, for the initial Engineering Source Approval.

3.1.5 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 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.

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3.1.6 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.

3.1.7 Requirements on Delivery. Not applicable.

3.1.8 Chemical Requirements. Not applicable.

3.1.9 Mechanical Requirements. Not applicable.

3.2 Tests.

3.2.1 Leak Test.

3.2.1.1 Bulk Hose Leak Test. Supplier shall certify incoming shipments to 4.1 MPa nitrogen for 3 minutes to 5 minutes. There shall be no indications of leakage in the hose length. Samples shall take place in intervals as called out on hose manufacturer's process control plan.

3.2.1.2 Assembly Leak Test. There shall be no indication of air leakage at the coupling or in the hose member when the coupled assembly is subjected to 1 MPa. This test applies only to couple assemblies. Air under water pressure testing may be used. 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 the GM Materials Engineer issuing the Engineering Source Approval. Assembly Leak Testing at 1.0 Map is to be conducted on test assemblies per Note 1 of Table 2, and where Leak Testing is required for part of the test protocol for specification (3.2.5, 3.2.12, 3.2.17, 3.2.18, and 3.2.19).

3.2.2 Elongation and Contraction. Pressurize the test assembly to the pressure shown in Table 3 for the applicable hose size for 5 minutes and, while still pressurized, measure the length. The hose shall not change length in excess of $\pm 3\%$ from the original length of the hose when unpressurized.

Table 3: Elongation and Contraction Pressures Metric (SI) Units

Size (mm)	Pressure MPa, Minimum
6.35	7
7.94	7
9.53	5
12.70	4

Customary Units

Size Inches	Pressure psi, Minimum
$\frac{1}{4}$	1000
$\frac{5}{16}$	1000
$\frac{3}{8}$	750
$\frac{1}{2}$	600

3.2.3 Burst Strength Test. Fasten one (1) end of the assembly to the source of pressure leaving the other end unrestrained. The rate of pressure rise of the test fluid Dexron® III Automated Test Fixture (ATF), 9985912, or other suitable hydraulic fluid shall be 170 MPa/minute $\pm$ 70 MPa/minute, until failure occurs. The minimum burst pressure shall be as shown in Table 4. Specific values for burst strength for those assemblies incorporating quick connectors are also shown in Table 4.

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Table 4: Burst Strength Requirements Metric (SI) Units

Size	Burst Pressure Minimum (Coupled Assemblies)	Burst Pressures with Quick Connectors Minimum
7.94	-	-
9.53	16 MPa	10 MPa
12.70	-	-

Customary Units

Size	Burst Pressure Minimum (Coupled Assemblies)	Burst Pressures with Quick Connectors Minimum
$\frac{5}{16}$	-	-
$\frac{3}{8}$	2400 psi	1500 psi
$\frac{1}{2}$	-	-

3.2.4 Tensile Test. Eighteen (18) assemblies are to be tested, six (6) crimped at minimum hose compression, six (6) crimped at nominal hose compression, and six (6) crimped at maximum hose compression.

3.2.4.1 Apply an increasing tensile load along the hose assembly centerline at approximately 25 mm/minute. The minimum failure tensile load shall be as shown in Table 5.

Table 5: Tensile Test Requirements

Metric (SI) Units		Customary Units	
Size (mm)	Tensile Load (kN)	Size (inch)	Tensile Load (lb)
7.94	.89	$\frac{5}{16}$	200
9.53	.89	$\frac{3}{8}$	200
12.70	1.3	$\frac{1}{2}$	300

3.2.5 Heat Aging.

3.2.5.1 Test Specimens. Six (6) coupled hose assemblies crimped at nominal hose compression shall be tested. The ends should be uncapped for testing.

3.2.5.2 Test Procedure. Subject the specimens to the Assembly Leak Test per 3.2.1.2. Upon completion of the leak test, coil the specimens around a mandrel having a diameter eight (8) times the nominal outside diameter of the hose (Figure 1).

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