



Fuel and Oil Resistant Coupled Hose Assembly Braid Reinforced - Polytetrafluoroethylene

1 Scope

1.1 Material Description.

This specification covers coupled hose for use with gasoline, oil, and diesel fuel and related evaporative systems. These hose assemblies, Type I and Type II, are suitable for use at temperatures of -40 °C to +230 °C and operating pressures to 1.75 MPa. If no type is specified on drawing, it shall be assumed to be Type I. All testing parameters shall apply to both Type I and Type II unless specified.

- a. Type I: Stainless Steel Reinforcement
- b. Type II: Glass Fiber Reinforcement

1.1.1 Hose Construction.

1.1.1.1 Type I.

1.1.1.1.1 The hose shall consist of an inner hose of virgin polytetrafluoroethylene (PTFE) reinforced with a stainless steel wire braid covering.

1.1.1.1.2 Inner Hose. The inner hose shall be a black, conductive smoothbore seamless hose of polytetrafluoroethylene (PTFE) resin conforming to the requirements of virgin Type I Grade 4 Class B resin per ASTM D4895. The inner surface of the hose shall have conductive properties.

1.1.1.1.3 Wire Braid Reinforcement. The reinforcement shall consist of 0.20 mm to 0.40 mm diameter AISI Type 302, Type 304, or Type 316 stainless steel wire applied with a weaving construction of two over and two under such that a minimum 90% coverage is achieved, when using ANSI/SCTE 51 2012.

1.1.1.1.4 Quick Connectors. Quick connectors used in Fuel and Oil Resistant Coupled Hose Assemblies released to the GMW17540 specification shall meet the requirements of GMW17568.

1.1.1.2 Type II.

1.1.1.2.1 The hose shall consist of an inner hose of virgin PTFE reinforced with electrical grade continuous filament glass fibers and aramid fibers.

1.1.1.2.2 Inner Hose. The inner hose shall be black, conductive smoothbore seamless hose of PTFE resin conforming to the requirements of virgin Type I Grade 4 Class B resin per ASTM D4895.

1.1.1.2.3 Fiber Reinforcement. The reinforcement shall consist of (78 to 90)% electrical grade continuous filament glass fibers blended with (10 to 22)% aramid fibers having minimum 9000 yarn denier for 7.94 mm (5/16 in) or less nominal inside diameter hose, 14 000 yarn denier for 9.53 mm (3/8 in) or greater nominal inside diameter hose, and 14 000 yarn denier for 12.70 mm (1/2 in) hose bonded to the hose by means of a Teflon coating with a weaving construction of two over and two under such that a minimum 90% coverage is achieved. Coating pigment shall be black. No glues or adhesives are permissible. The braid is bonded to the hose with a PTFE emulsion.

1.1.2 Coupling Construction.

1.1.2.1 The coupling shall be designed, inserted, and swaged or crimped so that no internal PTFE 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 specification.

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

1.1.2.3 Hose Insert. The end of the hose insert must be radiused to eliminate burrs or sharp edges which might cause PTFE hose damage under conditions of assembly vibration or pressure impulse.

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

1.1.2.5 Hose Collapse. Metal hose 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 hose stem OD, or on the crimp shell ID, except that these grooves, upsets, or serrations do not cause PTFE 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 PTFE 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 for low flow restriction.

1.1.3 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 three (3) sigma CPk of 1.33.

Table 1: Dimensions and Tolerances

Type I	Metric (SI) Units (mm)					Type I	Customary Units (in)				
Nominal Size (mm)	Hose Inside Dia.		Hose Wall Thickness	Hose Wall Thickness		Nominal Size (in)	Hose Inside Dia.		Hose Wall Thickness	Hose Wall Thickness	
	min	max	min	min	max		min	max	min	min	max
6.35	5.97	6.73	0.64	1.27	1.78	1/4	0.235	0.265	0.025	0.050	0.070
7.94	7.57	8.33	0.64	1.27	1.78	5/16	0.298	0.328	0.025	0.050	0.070
9.53	9.35	10.16	0.64	1.27	1.78	3/8	0.368	0.400	0.025	0.050	0.070
12.7	12.12	13.33	0.64	1.27	1.78	1/2	0.477	0.525	0.025	0.050	0.070

Type II	Metric (SI) Units (mm)					Type II	Customary Units (in)				
Nominal Size (mm)	Hose Inside Dia.		Hose Wall Thickness	Hose Wall Thickness		Nominal Size (in)	Hose Inside Dia.		Hose Wall Thickness	Hose Wall Thickness	
	min	max	min	min	max		min	max	min	min	max
4.76	4.36	5.18	0.30	1.01	1.42	3/16	0.172	0.204	0.012	0.040	0.056
6.35	5.99	6.81	0.30	1.62	2.03	1/4	0.236	0.268	0.012	0.064	0.080
7.94	7.44	8.26	0.30	1.80	2.21	5/16	0.293	0.325	0.012	0.071	0.087
9.53	9.02	9.83	0.43	2.36	2.77	3/8	0.355	0.387	0.017	0.093	0.109
11.11	10.54	11.30	0.43	2.36	2.77	7/16	0.415	0.445	0.017	0.093	0.109
12.7	12.57	13.59	0.56	2.36	2.97	1/2	0.495	0.535	0.022	0.093	0.117
15.88	15.24	16.51	0.61	2.39	3.20	5/8	0.600	0.650	0.024	0.094	0.126
19.05	18.49	19.51	0.76	1.98	2.49	3/4	0.728	0.768	0.030	0.078	0.098
22.22	20.82	22.10	0.89	2.41	2.92	7/8	0.820	0.870	0.035	0.095	0.115

Dia. Diameter
Max Maximum
Min Minimum
SI Système international

© Copyright 2018 General Motors Company All Rights Reserved

April 2018

Page 2 of 22

1.1.4 Material Identification. To properly define the assembly, the assembly specification number is to be followed by a Type (e.g., GMW17540 Type II). Drawing Callouts not referencing an assembly "Type" are assumed to be referencing Type I.

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

1.2 Symbols. Not applicable.

1.3 Applicability. This specification covers coupled hose for use with gasoline, oil, and diesel fuel and related evaporative systems.

2 References

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

2.1 External Standards/Specifications.

ASTM D235	ASTM D4895	SAE J1737
ASTM D471	ISO 1817	SAE J2044

2.2 GM Standards/Specifications.

9986153	GMW3286	GMW14872	GMW17568
GMW3059	GMW14270	GMW17540	

2.3 Additional References.

- GMPT-3-18
- GMPT-6-005
- GMPT-6-006
- Safety and Industrial Hygiene (S&IH) Technical Standard (TS), S&IH TS 3.4-160-02

3 Requirements

3.1 Basic Test Requirements.

3.1.1 Coupling Assembly Required Tests.

Coupled hose assemblies shall be tested for conformance with Table 2.

Table 2: Test Table

Item	Test Name	Type I	Type II
		Number of Samples	Number of Samples
3.2.2.1	Leak Test	Note 1	Note 1
3.2.2.2	Elongation and Contraction	6	6
3.2.2.3	Burst Strength Test	6	6
3.2.2.4	Tensile Test	18	18
3.2.2.5	Heat Aging	6	6
3.2.2.6	Kink	N/A	6
3.2.3.1	Cleanliness	6	6
3.2.3.2	Conductivity	6	6
3.2.3.3	Kink Resistance Test	N/A	6
3.2.3.4	Permeation Test	6	6
3.2.3.5	Adhesion Test	N/A	6
3.2.3.6	Salt Spray - Leak Test	6	6
3.2.3.7	Cyclical Corrosion Test	6	6
3.2.4.1	Overcrimp to 3-Sigma Limits	6	6
3.2.4.2	Overcrimp to Damage	Design Dependent	Design Dependent
3.4.2.1	Accelerated Pressure Impulse Test	6	6
3.4.2.2	Temperature Cycling	18	18
3.4.2.3	Vibration (with Quick Connector Assembly)	6 (12)	6 (12)
3.4.2.4	Fuel Soak and Flex	6	6
3.4.2.5	Cold Flexibility - Vacuum Collapse Test	6	6
3.4.2.6	Sour Gasoline Recirculation Test	6	6
3.4.2.7	Fuel Resistance - Recirculation Test	6	6
3.4.2.8	Pressure/Temperature Cycling Test	18	18

Note 1: Performed for all test samples except for 3.2.3.3, 3.2.3.5, 3.2.4.1, and 3.2.4.2.

Note 2: Item 3.2.3.4 can be waived for diesel fuel or oil applications.

N/A = Not applicable

3.1.2 Standard Test Samples.

Standard test samples of coupled tetrafluoroethylene shall have a hose length of 500 mm $\pm$ 10 mm and a maximum hose 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 to test procedures for GP3 approval purposes, production parts shall be used whenever possible except for test procedures 3.3.2.3 and 3.3.2.4. After standard test samples are assembled, a 24 h minimum conditioning period at room temperature is required before testing.

3.1.3 Test Conditions.

All temperatures shall be held to $\pm$ 2 °C and all pressures to -0/+34.5 kPa unless otherwise noted.

3.1.4 Engineering Source Approval.

3.1.4.1 Approval Requirements.

Approval will require the following information to be submitted:

- Blueprints showing the design, dimensions and tolerances for all components of the assembly. Including allowed eccentricity in the PTFE hose, hose insert, and coupling OD. In addition, the range of all PTFE hose compression possible under each condition of dimensional tolerance stack-up must be determined.
- The submission of sectioned coupling samples to demonstrate that all of the previously mentioned construction requirements have been met.
- A description of the statistical process control procedures for the coupling diameter dimensions and the PTFE hose compression range.
- The value for PTFE hose compression necessary to induce:
 - PTFE hose damage.
 - Reinforcement damage.
- Data presented in both tabular and graph form, showing values of PTFE hose compression (calculated using both linear and area methods) vs. Tensile Test performance, (3.2.2.4), Burst Test performance, (3.2.2.3), and fitting insert collapse. The dimensions of the crimped assembly components for each data point need to be listed, as well as the resultant PTFE hose compression.
- Copies of test fixture traces, confirming pressure and temperature regimens imposed on the samples during test.

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

3.1.4.2 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 PTFE hose and coupling components.
- PTFE hose material and construction.
- Coupling design.
- Hose insert material, plating, finish and hardness.
- Coupling shell material, plating, finish and hardness.
- Supplier specifications and manufacturing procedures, supplier (both PTFE 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 each design or material variant on one end of the assembly.

3.1.5 Design Level Requirements.

All hose/PTFE 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 Sections 1, 3, 4, 5, or 6 must be reviewed beforehand and approved by the GM Materials Engineer issuing the approval.

3.1.6 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, including 3.2.4.1 and 3.2.4.2. Testing to 3.2.3.7, the Cyclical Corrosion Test, is to be conducted one time only, for the initial Engineering Source Approval.

3.1.7 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.

3.1.8 Crimp Compression.

Test samples throughout this specification will be referred to as minimum PTFE hose compression, nominal PTFE hose compression or maximum PTFE hose compression samples. The requirements for these conditions are described in Appendix A. If not specified, the test samples shall be of nominal PTFE hose compression.

3.2 Requirements on Delivery.

3.2.1 Chemical Requirements. Not applicable.

3.2.2 Mechanical Requirements.

3.2.2.1 Leak Test.

3.2.2.1.1 Bulk PTFE Hose Leak Test. Supplier shall certify incoming shipments to 4.1 MPa nitrogen for 3 minutes to 5 minutes. All production bulk PTFE Hose shall be leak tested. There shall be no indications of leakage in the PTFE hose length.

3.2.2.1.2 Assembly Leak Test. There shall be no indication of air leakage at the coupling or in the PTFE hose member when the coupled assembly is subjected to 1 MPa. This test applies only to coupled 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 MPa is to be conducted on test assemblies per Note 1 of Table 2, and where Leak Testing is required of part of the test protocol for specification in 3.2.2.2 through 3.4.2.8. All production assemblies shall be leak tested to these requirements.

3.2.2.2 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
Both Type I and Type II

Metric (SI) Units		Customary Units	
Nominal Size (mm)	Test Pressure (MPa) (minimum)	Nominal Size (in)	Test Pressure (psi) (minimum)
4.76	6.90	3/16	1000
6.35	6.90	1/4	1000
7.94	6.90	5/16	1000
9.53	5.20	3/8	750
11.11	4.80	7/16	700
12.7	4.10	1/2	600
15.88	2.70	5/8	400
19.05	1.70	3/4	250
22.22	1.38	7/8	200

3.2.2.3 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® VI ATF, 9986513 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 as shown in Table 4.

Table 4: Burst Strength Requirements

Type I	Metric (SI) Units (MPa)		Customary Unit (psi)		Type II	Metric (SI) Units (MPa)		Customary Units (psi)	
Nominal Size (mm)	Hoses	With QCs	Hoses	With QCs	Nominal Size (in)	Hoses	With QCs	Hoses	With QCs
	min	min	min	min		min	min	min	min
4.76	N/A	N/A	N/A	N/A	3/16	27.58	N/A	4000	N/A
6.35	41.37	10.34	6000	1500	1/4	27.58	10.34	4000	1500
7.94	41.37	10.34	6000	1500	5/16	27.58	10.34	4000	1500
9.53	41.37	10.34	6000	1500	3/8	20.68	10.34	3000	1500
11.11	N/A	N/A	N/A	N/A	7/16	13.79	6.89	2000	1000
12.7	41.37	N/A	6000	N/A	1/2	13.79	6.21	2000	900
15.88	N/A	N/A	N/A	N/A	5/8	110.32	N/A	16000	N/A
19.05	N/A	N/A	N/A	N/A	3/4	89.63	N/A	13000	N/A
22.22	N/A	N/A	N/A	N/A	7/8	6.89	N/A	1000	N/A

Note: "QCs" refers to quick-connector fittings crimped to the hose assembly.

3.2.2.4 Tensile Test. Eighteen assemblies are to be tested, six crimped at minimum PTFE hose compression, six crimped at nominal PTFE hose compression, and six crimped at maximum PTFE hose compression.

3.2.2.4.1 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

Type I	Metric (SI) Units (kN)	Customary Units (lbf)	Type II	Metric (SI) Units (kN)	Customary Units (lbf)
Nominal Size (mm)	Tensile Load minimum	Tensile Load minimum	Nominal Size (in)	Tensile Load minimum	Tensile Load minimum
4.76	N/A	N/A	3/16	0.89	200
6.35	1.33	300	1/4	0.89	200
7.94	1.33	300	5/16	0.89	200
9.53	2.22	500	3/8	0.89	200
11.11	N/A	N/A	7/16	0.89	200
12.7	2.22	500	1/2	0.89	200
15.88	N/A	N/A	5/8	1.33	300
19.05	N/A	N/A	3/4	1.33	300
22.22	N/A	N/A	7/8	1.33	300

3.2.2.5 Heat Aging.

3.2.2.5.1 Test Specimens. Six coupled PTFE assemblies crimped at nominal PTFE hose compression shall be tested. The ends should be uncapped for testing.