

FUEL OIL RESISTANT COUPLED HOSE ASSEMBLY STAINLESS STEEL REINFORCED-POLYTETRAFLUROETHYLENE GM6130M

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

Type I: Stainless Steel Reinforcement

Type II: Glass Fiber Reinforcement

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	GM9060P	ASTM D1457
GM4298P	9985912	SAE J1737
GM9055P	ASTM D235	

3 HOSE CONSTRUCTION.

3.1 TYPE I. The hose shall consist of an inner tube of virgin polytetrafluoroethylene reinforced with a stainless steel wire braid covering.

3.2 INNER TUBE. The inner tube shall be a black, conductive smoothbore seamless tube of tetrafluoroethylene resin conforming to the requirements of virgin Type III Grade 2 Class B resin per ASTM D1457 except that a maximum of 2% by weight of additives is permissible.

3.3 WIRE BRAID REINFORCEMENT. The reinforcement shall consist of 0.20 to 0.40 mm diameter AISI Type 302 or Type 304 stainless steel wire applied with a weaving construction of two over and two under such that a minimum 90% coverage is achieved.

3.4 QUICK CONNECTORS. Quick connectors used in Fuel and Oil Resistant Coupled Hose Assemblies released to the GM6130M specification shall meet the requirements of GM9060P.

3.5 TYPE I - COUPLING CONSTRUCTION.

3.5.1 The coupling shall be designed, inserted and swaged or crimped so that no internal tetrafluoroethylene tube 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 tetrafluoroethylene tube compression allowed by supplier production specifications.

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

3.5.3 Metal 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.

3.5.4 The coupling shall be designed for low flow restriction.

3.6 TYPE II. The hose shall consist of an inner tube of virgin polytetrafluoroethylene reinforced with an electrical grade continuous filament glass fibers.

3.6.1 Inner Tube. The inner tube shall be black, conductive smoothbore seamless tube of tetrafluoroethylene resin conforming to the requirements of virgin Type III Grade 2 Class B resin per ASTM D1457 except that a maximum of 2% by weight of additives is permissible.

3.6.2 Glass Fiber Reinforcement. The reinforcement shall consist of electrical grade continuous filament glass fibers having minimum 14 000 yarn denier for 7.94 mm nominal inside diameter hose and 19 000 yarn denier for 9.53 mm nominal inside diameter hose bonded to the tube 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.

3.7 TYPE II - COUPLING CONSTRUCTION.

3.7.1 The coupling shall be designed, inserted, and swaged or crimped so that no internal tetrafluoroethylene tube 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.

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

3.7.3 Metal 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.

3.7.4 The coupling shall be designed for low flow restriction.

3.8 ENGINEERING SOURCE APPROVAL.

3.8.1 Engineering source approval to this specification for both Type I and Type II 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 PTFE tube/reinforcement composite, tube insert, and coupling OD, and also including the range of PTFE tube compression possible under all conditions of dimensional tolerance stack up.

FUEL OIL RESISTANT COUPLED HOSE ASSEMBLY STAINLESS STEEL REINFORCED-POLYTETRAFLUOROETHYLENE GM6130M

2. The submission of section 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 PTFE tube compression necessary to induce:

- a. PTFE tube damages.
- b. Assembly reinforcement damage.

NOTE: Value of PTFE tube compression must be reported both in terms of linear compression, and area compression (see Table 8 for the formula for each calculation).

3.8.2 Engineering source approvals generated through testing to prove compliance to this specification are specific for combinations of the following factors: Size of PTFE tube and coupling components; PTFE tube material and construction; coupling design; metal tube insert material, plating, hardness, and finish; coupling shell material, plating hardness and finish; supplier specifications and manufacturing procedures, supplier (both PTFE tube/reinforcement composite and assembly) manufacturing sites, any additional process required to preform the PTFE tube.

3.9 CRIMP EXAMINATION PROCEDURE.

3.9.1 Sixteen (16) assemblies must be manufactured with maximum wall thickness (as determined by the 3 sigma value of the PTFE tube manufacturer, not the dimensions allowed per the GM6130M 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 PTFE tube, and reinforcement damage as described in 3.9.3. Supplier evaluation of these parts, and the parts themselves, must be returned to the GM Materials Engineer issuing the approval for evaluation. No PTFE tube or reinforcement damage generated by the crimping operation is permissible in these samples. This is required for approval to the GM6130M specification. 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.

3.9.2 Additional samples must be crimped and examined to determine the values of PTFE tube compression necessary to induce damage to either the PTFE tube, or to the reinforcement.

3.9.2.1 These samples are to be overcrimped per the conditions described in , except that progressive increments of increased PTFE tube compression are to be induced through reduction of crimp OD until PTFE tube damage or reinforcement damage is incurred. These increments may not number less than two, nor be more than 4% incremental PTFE tube wall compression, as defined in Table 8, II. Area Compression techniques.

3.9.2.2 Four (4) samples are to be prepared for each increment. Each sample is to be examined for evidence of PTFE tube damage and reinforcement damage. After the compression that induces damage is determined, confirmation shall be obtained by a repetition of 4 additional samples.

3.9.2.3 Determination of damage shall be done in accordance with 3.9.3 of this specification.

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

3.9.2.5 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.

3.9.3 PTFE tube examination procedure:

1. For all of the assemblies, cut and remove the coupling shell carefully, avoiding damage to the PTFE tube. Carefully cut through the tube along the length of the tube, with two cuts 180 degrees from one another. Remove the PTFE tube from the tube stem insert, minimizing damage to the tube during this process. Evaluate both ID and OD of the tube in the areas adjacent to and under the coupling shell for any evidence of damage induced by the manufacturing operation. Also evaluate the reinforcement of the assembly, looking for any evidence of damage to this reinforcement.
2. For all 16 assemblies, amount of tube stem collapse must be determined.

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.

FUEL OIL RESISTANT COUPLED HOSE ASSEMBLY STAINLESS STEEL REINFORCED-POLYTETRAFLUROETHYLENE GM6130M

**TABLE 1 - DIMENSIONS AND TOLERANCES
TYPE I**

Metric (SI) Units				
Nominal Size mm	Tube Inside Dia		Tube Wall Thickness	
	mm		mm	
	max	min	max	min
6.35	6.93	5.77	.889	.635
7.94	8.53	7.37	.889	.635
9.53	10.95	9.35	.889	.635
12.70	13.33	12.12	.889	.635
Customary Units				
Nominal Size Inch	Tube Inside Dia.		Tube Wall Thickness	
	Inch		Inch	
	max	min	max	min
1/4	.273	.227	.035	.025
5/16	.336	.290	.035	.025
3/8	.431	.368	.035	.025
1/2	.525	.477	.035	.025

TYPE II

Metric (SI) Units				
Nominal Size mm	Tube Inside Dia		Tube Wall Thickness	
	mm		mm	
	max	min	max	min
7.94	8.53	7.37	.508	.254
9.53	10.95	9.35	.635	.385
Customary Units				
Nominal Size Inch	Tube Inside Dia.		Tube Wall Thickness	
	Inch		Inch	
	max	min	max	min
5/16	.336	.290	.020	.010
3/8	.431	.368	.025	.015

5 BASIC TEST REQUIREMENTS.

5.1 COUPLING ASSEMBLY REQUIRED TESTS. Coupled hose assemblies shall be tested for conformance with the following sections:

TEST TABLE

Section	Test	Type I # samples	Type II # samples
3.9.1	Overcrimp to 3 sigma limits	16	16
3.9.2	Overcrimp to damage	Design Dependent	Design Dependent
5.2	Leak	See NOTE 1	
5.3	Cleanliness	6	6
5.4	Elongation and Contraction	6	6
5.5	Burst Strength	6	6
5.6	Accelerated Impulse	6	6
5.9.2.1	Tensile Test (Stack up conditions)	18	18
5.8	Heat Aging	6	6
5.9	Temperature Cycling (Stack up conditions)	18	18
5.10	Vibration	6	6
	Vibration (Quick-Connector Assemblies Only)	12	12
5.11	Fuel Soak and Flex	6	6
5.12	Conductivity	6	6
5.13	Kink Test (Material)	N/A	6
5.14	Kink Resistance Test (Liquid flow)	N/A	6
5.15	Permeation	6	6
5.16	Adhesion Test	N/A	6
6.1	Cold Flex Vacuum Collapse	6	6
6.2	Sour Gasoline Recirculation	6	6
6.3	Fuel Resistance Recirculation	6	6
6.4	Corrosion Leak Test	6	6
3	Pressure Temperature Cycling Test	18	18

NOTE 1: Performed in conjunction with other tests.

FUEL OIL RESISTANT COUPLED HOSE ASSEMBLY STAINLESS STEEL REINFORCED-POLYTETRAFLUROETHYLENE GM6130M

5.1.1 Standard Test Samples.

5.1.1.1 Standard test samples of coupled tetrafluoroethylene shall have a hose length of 500 ± 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 to test procedures for GP3 approval purposes, production parts shall be used whenever possible except for test procedures 5.10 and 5.11.

5.1.1.2 Test samples prepared may be used to qualify two different types of tetrafluoroethylene tube to crimp connections by the incorporation of each of these two tube/crimp connections on opposite ends of one test sample assembly. Test of 18 assemblies prepared in such a manner to Temperature Cycle Test (5.9), for example, would qualify two types of tube/crimp connections to the requirements of this test.

5.1.1.3 For Engineering Source Approval evaluation of tetrafluoroethylene tube coupled assemblies, the following samples are required to be tested:

TYPE I 160 Samples

TYPE II 178 Samples

5.1.1.3.1 For Engineering Source Approval evaluation of tetrafluoroethylene tube coupled assemblies containing quick connectors, an additional 6 assemblies will be required to be tested to the requirements of 5.10.

5.1.1.4 Engineering source approvals generated through testing to prove compliance to this specification are specific for combinations of the following factors: Size of tube and coupling components; tube material and construction; coupling design; tube insert material, plating, and finish; coupling shell material, plating, and finish; supplier specifications and manufacturing procedures; supplier (both tube and assembly) manufacturing sites.

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

5.2 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 4.1 MPa for 3 to 5 minutes while under water.

5.3 CLEANLINESS. Six (6) coupled assemblies shall be tested.

5.3.1 Visual Inspection. Visually inspect the crimped/swaged PTFE tube/reinforcement composite hose assemblies for evidence of internal free water and corrosion of internal and external metal surfaces.

5.3.2 Contaminant Collection. Bend the PTFE assembly in a U shape and fill with reagent grade Stoddard Solvent. Agitate the assembly 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 GM Engineering approval.

5.3.2.1 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 PTFE tube assembly. The final weighing of the frittered crucible shall show no contaminants (weight increase ≤ 0.0004 g).

5.3.3 Acceptance Determination. There shall be no internal free water present in the PTFE 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 0.15 g/m^2 of interior surface shall be collected on the crucible (after drying in a desiccator @ 65°C for 1.5 h).

5.3.4 Protection of Production Assemblies. Assemblies as provided for production purposes, and for engineering source approval submissions, shall have the ends capped to prevent the contamination of the inner surface of the tube.

5.4 ELONGATION AND CONTRACTION. Pressurize the test assembly to the pressure shown in Table 2 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 2 - ELONGATION AND CONTRACTION
PRESSURES**

Metric (SI) Units		Customary Units	
Size mm	Pressure MPa, min	Size in.	Pressure psi, min
6.35	7	1/4	1000
7.94	7	5/16	1000
9.53	5	3/8	750
12.70	4	1/2	600

5.5 BURST STRENGTH. 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 ATF, 9985912, or other suitable hydraulic fluid shall be 170 ± 70 MPa/minute until failure occurs. The minimum burst pressure shall be as shown in Table 3. Specific values for burst strength for those assemblies incorporating quick-connectors are as shown in Table 3.

FUEL OIL RESISTANT COUPLED HOSE ASSEMBLY STAINLESS STEEL REINFORCED-POLYTETRAFLUROETHYLENE GM6130M

**TABLE 3 - BURST STRENGTH REQUIREMENTS -
TYPE I**

Metric (SI) Units		
Size	Burst Pressure min	Burst Pressures with Quick Connectors min
6.35 mm	41 MPa	10 MPa
7.94 mm	41 MPa	10 MPa
9.53 mm	31 MPa	10 MPa
12.70 mm	26 MPa	N/A
Customary Units		
1/4	6000 psi	1500 psi
5/16	6000 psi	1500 psi
3/8	4500 psi	1500 psi
1/2	4000 psi	N/A

TYPE II

Metric (SI) Units		
Size	Burst Pressure	w/Quick Connectors
7.94 mm	28 MPa	10 MPa
9.53 mm	21 MPa	10 MPa
Customary Units		
5/16 in.	4000 psi	1500 psi
3/8 in.	3000 psi	1500 psi

5.6 ACCELERATED PRESSURE IMPULSE TEST.

When tested under conditions outlined in 5.6.3, hose shall not leak or burst prior to 50 000 pressure cycles.

5.6.1 In addition, after completion of impulse testing, the minimum bursting strength of the hose while maintained at a temperature of 150°C shall be 60% of the values shown in Table 3 for the applicable hose size tested.

5.6.2 After hoses are assembled, a 24 h min conditioning period at room temperature is required before testing.

5.6.3 Test conditions are as follows:

9985912 DEXRON III AFT
Cycle rate Uniform @ 30 to 37 CPM
Test cycle pressure impulse wave form Figure 1
Test fluid temperature (in hose) 150 ± 3°C
Ambient temperature Uncontrolled
Test pressure See Table 4

TABLE 4 - IMPULSE TEST PRESSURES

Metric (SI) Units		Customary Units	
Size	Test Pressure	Size	Test Pressure
mm	MPa	in.	psi
6.36	1.75	1/4	250
7.94	1.75	5/16	250
9.53	1.75	3/8	250
12.70	1.75	1/2	250

NOTE: Bend radius measured to inside of bend.

5.6.3.1 Secant Pressure Rise. The straight line drawn through 2 points on the pressure rise curve, one point at 15% of the test pressure and the other at 85% of the test pressure.

5.6.3.2 Point 0. The intersection of the Secant Pressure Rise with 0 pressure.

5.6.3.3 Pressure Rise Rate. The slope of the Secant Pressure rise expressed in MPa (psi) per second.