Low Permeation Fuel Lines: Multilayered Construction

1 Scope

This specification covers requirements for extruded multilayered fuel lines. The lines described by this specification are less permeable to fuel than those described by GM6264M.

Other documents which describe the performance and dimensional requirements of these components and assemblies manufactured from those components are GM9060P, GM9080P, and Chart #10093203.

In addition to the test requirements listed in this specification, additional fuel recirculation and/or permeation testing may be required for validation of the tubing and/or quick-connectors used in the fuel line assembly. Any additional requirements are to be defined by the GM Materials Engineer.

1.1 Material Description.

1.1.1 Construction. (See Figure 1)

1.1.1.1 Type A. This tube shall consist of a smooth-bore tube of Conductive PVDF. The cover shall consist of Nylon 12. There will be a layer of adhesive between the cover and tube. The cover shall be 70 to 90% of the wall thickness.

1.1.1.2 Type B. This tube shall consist of a smooth-bore tube of laminated construction of an inner tube of conductive ETFE (Ethylene-Tetrafluroethylene Copolymer) and an outer tubing of ETFE. The cover shall consist of Nylon 12. The cover shall be 70 to 80% of the total wall thickness and the minimum thickness of the conductive ETFE layer shall be 0.05 mm.

1.1.1.3 Type C. Replaced by GM6406M Type A.

1.1.1.4 Type D. This tube shall consist of 4 layers arranged in a concentric pattern around the smooth bore inner tube. The inner layer shall consist of a conductive Nylon 12 and will have a nominal thickness of 0.1 ± 0.02 mm. The barrier layer shall be PVDF and have a nominal thickness of 0.2 ± 0.05 mm and will be located in the center of the tubing wall. The outer layer and intermediate layer (located in either side of the barrier) will be non-conductive Nylon 12.

1.1.1.5 Type E. Replaced by GM6406M Type B.

1.1.1.6 Type F. This tube shall consist of 3 layers arranged in a concentric pattern around the smooth bore inner tube. The inner layer shall consist of a skin of conductive Polytetrafluoroethylene (PTFE) with a minimum thickness of 0.076 mm. The intermediate layer shall be nonconductive PTFE. The outer layer shall be Nylon 12. The total barrier layer thickness for conductive and non-conductive PTFE shall be 0.381 ± 0.050 mm. The outer layer shall be 55 to 75% of the wall thickness.

1.1.1.7 Type F, Non-Conductive. Replaced by GM6406M Type F.

1.1.1.8 Type G. Replaced by GM6406M Type C.

1.1.1.9 Type H. This tube shall consist of a smooth bore tube of conductive ETFE (Ethylene-Tetrafluoroethylene Copolymer) with a thickness of 0.200 ± 0.076 mm. The cover shall consist of Nylon 12 with a thickness of 0.70 ± 0.13 mm. There will be a layer of adhesive with a thickness of 0.10 ± 0.05 mm between the cover layer of Nylon 12 and the inner layer of ETFE. The cover shall be 70 to 90% of the wall thickness.

1.1.1.10 Type I. This tube shall consist of a smooth bore of conductive EFEP (ethylene-perfluoroethylenepropylene copolymer) with a thickness of 0.200 ± 0.050 mm. The cover shall consist of Nylon 12 with a thickness of 0.80 ± 0.05 mm.

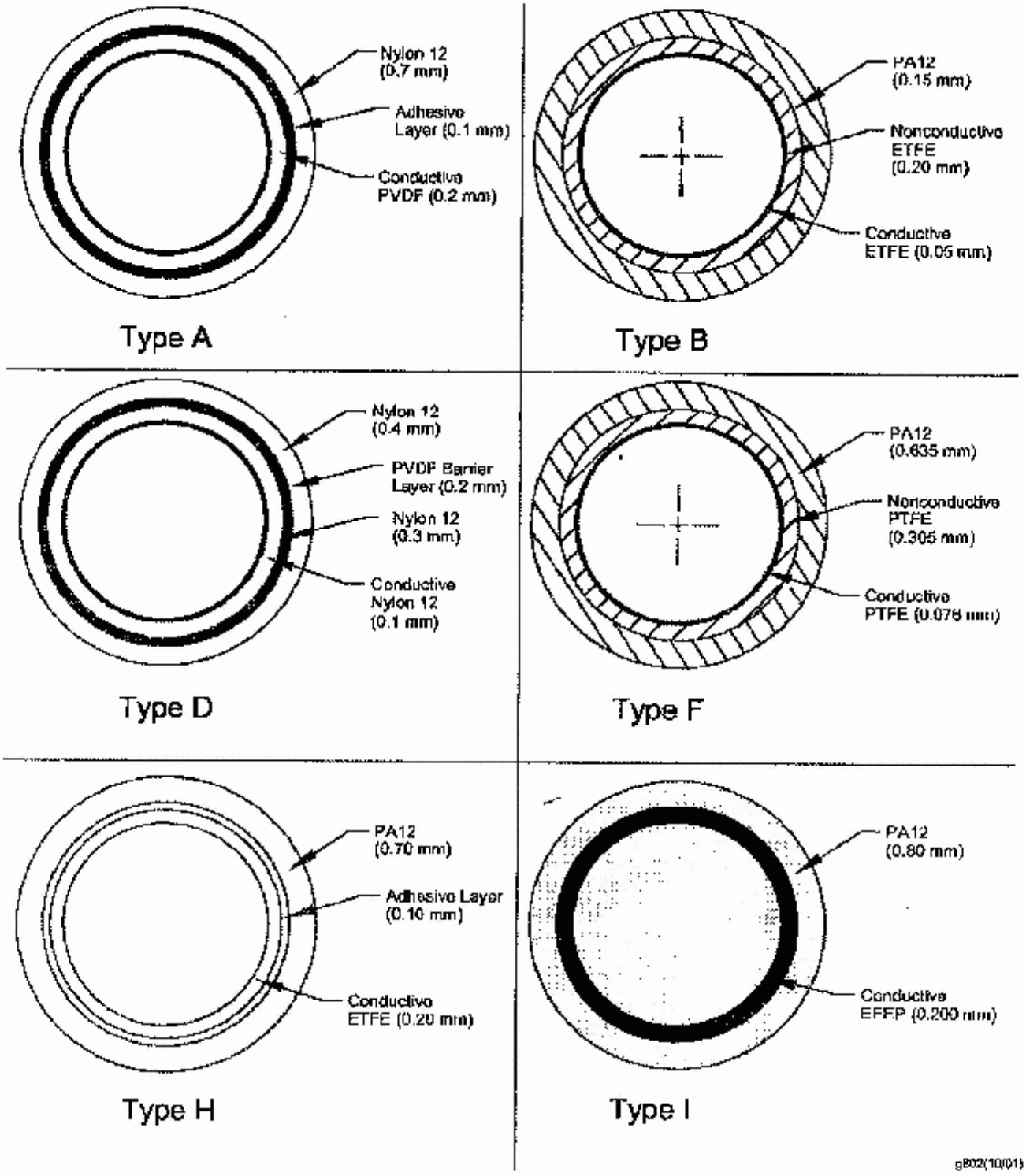

Figure 1: Tube Constructions

1.1.2 Sample Drawing Callout. To fully describe the hose the specification number must be followed by a type.

Example: GM213M Type A

1.1.3 Labeling. Fuel lines released to this specification must be labeled per Figure 6.

1.2 Cross-Reference of Replaced Specifications. Subparagraphs were not applicable.

1.3 Symbol. Not applicable.

1.4 Typical Application. Fuel feed line.

1.5 Remarks.

1.5.1 Parts made from these materials should not be exposed to peak intermittent temperatures greater than 115°C, or continuous usage greater than 90°C.

1.5.2 Only virgin material is to be used.

1.5.3 Unless otherwise noted, for all tests, temperatures shall be held to ± 2°C, all test pressures to ± 35 kPa, and all test sample lengths to ± 5.0 mm. Tests or portions of tests in which the test temperature is not specified shall be conducted at ambient temperature. Ambient temperature is defined to be 23 ± 2°C.

1.5.4 A conductive path must be provided in connectors.

2 References

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

2.1 External Standards/ Specifications.

SAE J400 SAE J1737

2.2 GM Group Standards/Specifications.

GM6264M GM6406M
GM6416M GM9055P
GM9060P GM9080P
GMW3059

2.3 Additional References.

Chart #10093203

3 Requirements

Table 1: Test Table

Section	Test
3.1.1.1	Zinc Chloride
3.1.1.2	Calcium Chloride
3.1.2.1	Burst
3.1.2.2	High-Temperature Burst
3.1.2.3	Cold Temperature Flex
3.1.2.4	Cold Impact
3.1.2.5	Gravelometer
3.1.2.6	Kinking Resistance
3.1.2.7	Tensile Strength
3.1.2.8	Elongation
3.1.3.1	Permeability
3.1.3.2	Surface Resistivity
3.1.3.3	Adhesion
3.3.2.1	Sour Gasoline Recirculation
3.3.2.2	Fuel Resistance Recirculation

Extruded Parts. For testing of the tubing to Section 3 of the specification, each type of connection used in a design released to this specification must be incorporated into the samples tested to 3.1.2.1, 3.1.2.2, 3.1.1.1, 3.1.1.2, 3.3.2.1, and 3.3.2.2. If fuel filters are incorporated into a design, they must be incorporated into the samples tested to 3.3.2.1 and 3.3.2.2.

All sizes of extruded tubing incorporated into a design released to this specification must be tested to all of the requirements of this specification. All processes used to manufacture the production tubing/assemblies for which the Engineering Source Approval is sought must be incorporated into the samples tested to this specification, including forming operations.

For fuel tubing assemblies that consist of crosshead extruded sleeving assemblies, testing to 3.1.1.1 and 3.1.1.2 is not required. For test of the tubing from these assemblies to the requirements of 3.1.2.4, removal of the crosshead extruded sleeving from the tubing prior to test is required.

Where there is a reference in the specification to a minimum bend diameter, the values listed in Table 2 shall be used. The tubes are to be bent in a free state until they form an oval, then the free ends are grasped, wrapped over the first loop of tubing, and secured to form a two-layered coil of nylon tubing. The coil is secured, preferably with copper wire, at the points shown in Figure 2. The measurement of the minimum bend diameter is made from inside wall to inside wall of the coil of nylon tubing (inner diameter).

Table 2: Dimensions and Tolerances, mm

Nominal OD	Inside dia	Wall Thickness	Bend dia, min	Tubing Length
6.35	3.89-4.14	0.98-1.41	76.2	450
7.93	6.20-6.50	0.90-1.15	101.6	630
9.53	7.77-8.07	0.90-1.15	152.4	870
15.30	12.35-12.65	1.20-1.60	236.3	1330
28.40	25.25-25.55	1.35-1.65	380.4	2115

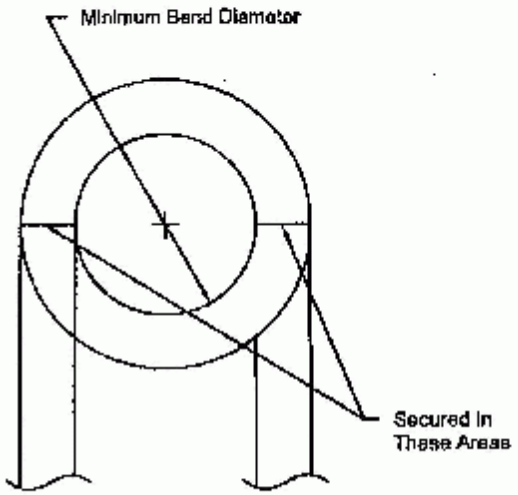

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Figure 2: Coil Securing Points

3.1 Requirements on Delivery.

3.1.1 Chemical Requirements.

3.1.1.1 Resistance to Zinc Chloride Test. See Figure 3.

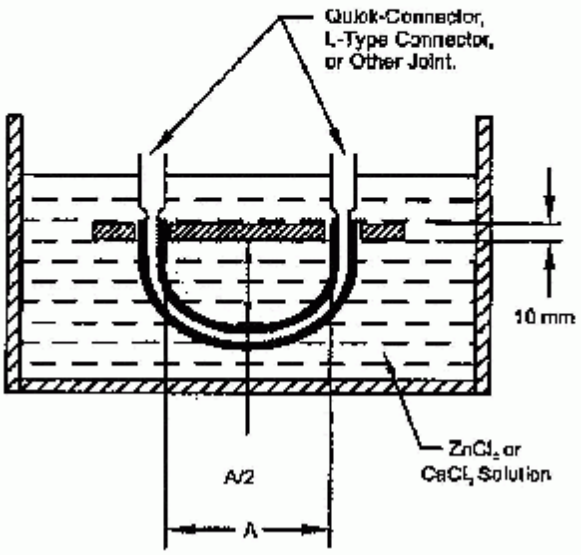
3.1.1.1.1 Test Procedure. The sample is bent to the minimum bend diameter and immersed in a 50% aqueous solution (by weight) of zinc chloride for 200 h at 23 ± 2°C. All interfaces between the tubing and the components directly connected to the tubing must also be immersed for the duration of the test when performing this procedure. The ends of the assembly are to remain unplugged. The sample is removed from the solution and burst tested per 3.1.2.1. The sample may be rinsed with fresh water to clear salt residue from the tubing before bursting.

3.1.1.1.2 Acceptance Determination. There shall be no visible cracks or crazing in the sample. Sample must meet Burst Test requirement of 3.1.2.1.

3.1.1.2 Resistance to Calcium Chloride Test. See Figure 3.

3.1.1.2.1 Test Procedure. The sample is bent to the minimum bend diameter and immersed in a 50% aqueous solution (by weight) of calcium chloride for 200 h at 60 ± 2°C and 200 h out of solution at 60 ± 2°C. All interfaces between the tubing and the components directly connected to the tubing must also be immersed for the duration of the test when performing this procedure. The ends of the assembly are to remain unplugged. The sample is removed from the solution and burst tested per 3.1.2.1. The sample may be rinsed with fresh water to clear salt residue from the tubing immediately before the burst test.

3.1.1.2.2 Acceptance Determination. There shall be no visible cracks or crazing in the sample. Sample must meet Burst Test requirement of 3.1.2.1.



A = Minimum Bend Diameter - Table 2
Free Tubing Length Per Table 2

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Figure 3: Zinc Chloride and Calcium Chloride Fixture

3.1.2 Mechanical Requirements.

3.1.2.1 Burst Test.

3.1.2.1.1 Test Procedure. The test apparatus consists of a suitable source of hydraulic pressure and the necessary gages and piping. The length of the tubing should be 305.0 ± 5.0 mm. Plug one end of the test specimen and mount in the apparatus with the other end unrestrained. The tubing is stabilized for 1 to 3 h at 23°C. Pressure is applied at room temperature, 23 ± 2°C, at a constant rate so as to reach the specified minimum burst pressure within a time period of 10 to 15 s. Fittings shall not separate from the tubing nor shall the assembly visibly leak at less than the specified minimum burst pressure.

3.1.2.1.2 Acceptance Determination. The minimum burst pressure shall be 3100 kPa. For tubing of ID 12.50 mm and larger, used for low pressure (=< 6.9 kPa max operating pressure), and low temperature applications (=< 90°C max intermittent temperature), the minimum burst pressure shall be 1035 kPa.

3.1.2.2 High Temperature Burst Test.

3.1.2.2.1 Test Procedure. The test apparatus consists of a suitable source of hydraulic pressure and the necessary gages and piping. The oil should be at 125 ± 1°C. The length of the tubing should be 305.0 ± 5.0 mm. Plug one end of the test specimen and mount in the apparatus with the other end unrestrained. The tubing shall be stabilized for 1 h at 125°C. Pressure is applied at 125°C at a constant rate so as to reach the specified minimum burst pressure within a time period of 10 to 15 s. Fittings shall not separate from the tubing nor shall the assembly visibly leak at less than the specified minimum burst pressure. For tubing of ID 12.50 mm and larger, used for low pressure (=< 6.9 kPa maximum operating pressure), and low temperature applications (=< 90°C maximum intermittent temperature), there is no high temperature burst requirement.

3.1.2.2.2 Acceptance Determination. The minimum burst pressure shall be 1380 kPa.

3.1.2.3 Cold Temperature Flexibility Test.

3.1.2.3.1 Test Procedure. The sample, consisting of a 305.0 ± 5.0 mm length of tubing, is exposed in an air-circulating oven at 110 ± 2°C for 24 h. The sample is removed from the oven and within 30 minutes exposed for 4 h at -40 ± 2°C. A mandrel having a diameter equal to 12 times the nominal diameter (nominal OD) of the tubing is also exposed for 4 h at -40 ± 2°C. In order to obtain uniform temperatures the tubing and mandrel may be supported by a nonmetallic surface during the entire period of the exposure. Immediately following this exposure, the tubing is bent 180 degrees over the mandrel, with this bending motion completed within a period of 4 to 8 s. For tubing of ID 12.50 mm and larger, the sample length shall be 610.0 ± 5.0 mm.

3.1.2.3.2 Acceptance Determination. The tubing shall show no evidence of fracture.

3.1.2.4 Cold Impact Test.

3.1.2.4.1 Test Procedure. Test Fixture must conform to Figure 7 requirements and the specific test procedures and equipment used must have GM Engineering approval. Sample length to be 305.0 ± 5.0 mm. The tubing sample is exposed to –40°C for 4 h. The impact test apparatus described by Figure 7 is exposed to –40°C for a minimum of 1 h at –40°C. The impact must be performed at –40°C. The sample is inserted into the test apparatus, and impacted by allowing the head to fall 305.0 ± 3.0 mm. The sample is allowed to return to 23 ± 2°C within 30 ± 5 minutes, and then subjected to a room temperature Burst Test per 3.1.2.1. The following requirements for the test must be met:

A. Mass of the impact head = 0.912 ± 0.003 kg.

B. The distance from the impact head to the center of the tubing sample = 305.0 ± 3.0 mm.

C. The temperature of the fixture and the tubing = -40 ± 2°C.

D. The spherical end radius of the impacting mass = 15.88 mm.

E. The maximum radius of curvature of the edge of the supporting platform of the tubing at the circumference of the impact area = 1.3 mm.

F. A chest type cold chamber is required to cold soak the tubing and the fixture (not an upright cold chamber).

G. The mass must be free to impact the tubing throughout the length of the impact without hindrance by any portion of the fixture.

3.1.2.4.2 Acceptance Determination. Sample must meet all of the requirements of 3.1.2.1 (Burst Test). Additionally, each sample burst tested after cold impact exposure per 3.1.2.4.1 must achieve as least 70% of the average burst value for the five samples from the same tubing lot burst tested per 3.1.2.1 (as received Burst Test).

3.1.2.5 Gravelometer Test.

3.1.2.5.1 Test Procedure. Sample is subjected to Gravelometer Test Procedure per SAE J400 at –40°C, using 10 pints of stones. Sample length is 305.0 ± 5.0 mm, and sample must be at –40°C when subjected to Gravelometer Test. Following the Gravelometer Test, sample is subjected to Burst Test per 3.1.2.1.

3.1.2.5.2 Acceptance Determination. Sample must meet all of the requirements of 3.1.2.1 (Burst Test). Additionally, each sample burst tested after gravelometer per 3.1.2.5.1 must achieve at least 70% of the average burst value for the 5 samples from the same tubing lot burst tested per 3.1.2.1 (as received Burst Test).

3.1.2.6 Kinking Resistance Test.

3.1.2.6.1 Test Procedure. The sample length for the test is to equal 1.9 times the bending diameter, as defined in Table 2. The minimum ball diameter for the test ball is to equal 0.4 times the minimum inside diameter, as defined in Table 2. The test fixture to be used for the test is as described in Figure 8. A sample of minimum thickness tubing is to be selected out of a random sample of ten pieces of tubing. The wall thickness and ovality at a point A on the test sample is measured. Wall thickness is also to be measured after completion of the test. The tube is installed in the test fixture described in Figure 8. When the tube is installed, the tube is bent in the same plane and direction as its free state curvature. The tube, installed in the fixture, is placed into an oven at 121 ± 2°C and soaked for 1 h. The tube and fixture is removed from the oven, and within 5.5 minutes, the test ball is passed through the tube, with the tube still in the fixture. Also, surface resistivity is measured per 3.1.3.2 for conductive tubings.

3.1.2.6.2 Acceptance Determination. Test ball must pass through the tube without restriction. Also requirements of 3.1.3.2.2 is to be satisfied.

3.1.2.7 Tensile Strength Test.

3.1.2.7.1 Test Procedure. The sample tubing is clamped into a tensile tester with fixturing allowing tensile strength and elongation testing without slippage of tubing or breakage of the tubing at the tensile tester jaw. The elongation is to be measured with either an extensiometer or with elongation bench marks (i.e., paper dots attached to the tubing). The initial extensiometer measuring distance or the elongation bench marks separation is to equal 50.8 mm. The following test conditions must be met:

Test Speed = 50 mm/minute

Test Temperature = 23 ± 2°C

RH = 50%

The tensile strength and elongation testing is conducted under the test conditions noted above until the ultimate elongation of the test sample is reached. When the tubing breaks, the load, and length of bench marks or extensiometer reading, is recorded. The specific test procedures and equipment for each supplier must have GM Engineering approval.

3.1.2.7.2 Acceptance Determination. The tensile strength value recorded for the tubing sample must be a minimum of 27 MPa.

3.1.2.8 Elongation Test.

3.1.2.8.1 Test Procedure. The test procedure for the Elongation Test is identical to the test procedure of 3.1.2.7, Tensile Strength Test.

The elongation is calculated using the following formula:

$$\text{Elongation} = \frac{\text{Final Reading of Bench Marks} - 50.8}{50.8} \times 100$$

3.1.2.8.2 Acceptance Determination. The elongation value recorded for the tubing sample must be a minimum of 200%.

3.1.3 Physical Requirements.

3.1.3.1 Permeability Test.

3.1.3.1.1 Test Procedure. Two (2) sample sets of tubing must be tested to the requirements of this test procedure. One (1) sample set will be tested using TF1 fuel, winter blend, per GM6416M. The other sample set will be tested using TF2 fuel, winter blend, per GM6416M. Sample is subjected to permeability test per SAE J1737 using TF1 and TF2 fuel using a temperature of 60°C and 2 bar pressure. All permeability testing shall be performed on samples with minimum barrier wall thickness.

3.1.3.1.2 Acceptance Determination. Sample permeability must not exceed the limits specified in Table 3.

Table 3: Permeability Limits

Type	TF1	TF2
A	50.0 g/m2/ 24 h	85.0 g/m2/ 24 h
B	18.0 g/m2/ 24 h	25.0 g/m2/ 24 h
C	---	---
D	21 g/m2/ 24 h	30 g/m2 / 24 h
E	---	---
F	6.0 g/m2/ 24 h	10 g/m2/ 24 h
G	---	---
H	19.0 g/m2/24 h	20.0 g/m2/24 h
I	20.0 g/m2/24 h	30.0 g/m2/24 h

3.1.3.2 Surface Resistivity. The test apparatus consists of a resistivity meter (MEG-CHECK 2100A R-meter from Associates Research Inc. or equivalent) and a set of copper pins.

3.1.3.2.1 Test Procedure:

1. Measure sample length, record as L_o (mm)
2. Measure inner diameter of sample. Record as d (mm).
3. Insert the copper pins to full depth in ends of tube assuring a tight fit. Measure the depth of the copper pin in mm. Attach the leads to the resistivity meter as shown in Figure 9.
4. Record the resistance R (ohm).
5. Calculate: Surface Resistivity (ohm/sq) = $R(\pi d)/(L_o - 2a)$

3.1.3.2.2 Acceptance Determination. The maximum resistivity shall be 10^6 ohm/sq.

3.1.3.3 Adhesion Test.

3.1.3.3.1 Procedure. Cut a strip of tubing into approximately 6 mm wide helical coil equal in length to 5 times the circumferences of the tubing using a tool as shown in Figure 10. Bend the helical coil in reverse of coiling. Apply a weight of 2 kg to the uncoiled end.

3.1.3.3.2 Acceptance Determination. No delamination should occur between layers.

3.1.4 Additional Requirements. Not applicable.

3.2 Processing Requirements. Subparagraphs were not applicable.

3.3 Performance Requirements.

3.3.1 Chemical Requirements. Not Applicable.

3.3.2 Mechanical Requirements.

3.3.2.1 Sour Gasoline Recirculation Test.

3.3.2.1.1 Test Procedure. The assembly is exposed to recirculating sour gasoline (Indolene HO-III/T-Butyl Hydroperoxide Mixture) with a peroxide number of 50 (at a rate of 700 mL/minute for tubing of ID >= 6.35 mm and 300 mL/minute for tubing of ID < 6.35 mm) and a temperature of 40 ± 2°C for 6 weeks on a test apparatus as shown in Figure 4 with a modified fuel reservoir as shown in Figure 5 according to the following procedures:

A. Connect the test sample as per the fuel recirculation test (See Figure 4). Any fuel filters incorporated into the test sample assemblies for test purposes are to be inserted between the flow meter and the fuel reservoir.

B. Mix 3.8 mL of 70% T-Butyl Hydroperoxide per 1000 mL of Indolene. Stir vigorously. Allow the water to settle out of the mixture (no less than 3 h). Decant the fuel into a new container.

C. Remove 5 mL of fuel for the peroxide number measurement per GM9055P. The peroxide number should equal 50 ± 3 initially. Pour the fuel into the reservoir.

D. Set the flow rate at 700 ± 70 mL/minute for tubing with ID >= 6.36 mm, 300 ± 30 mL/minute for tubing with ID < 6.35 mm.

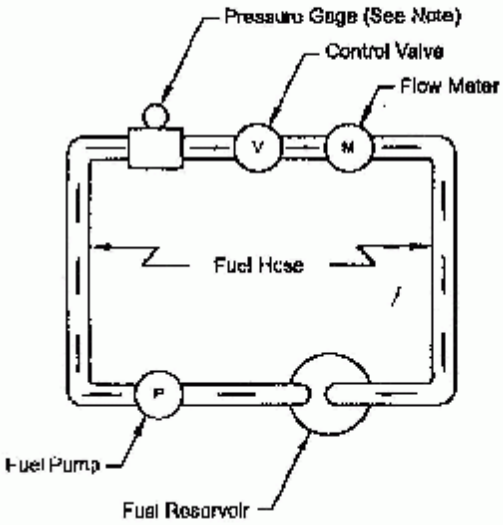
E. Maintain the temperature at 40 ± 2°C.

F. Measure the peroxide number twice each week.

G. Run the test for 6 weeks changing the sour gasoline after the first 24 h and thereafter:

1. When the peroxide number is less than 40 or greater than 55, or
2. Once a week if the peroxide number remains between 40 and 55.

H. Correct for evaporative losses when necessary by adding sour gasoline of peroxide number = 50 ± 3.



Note: Optional for Monitoring Flow

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Figure 4: Fuel Recirculation Apparatus

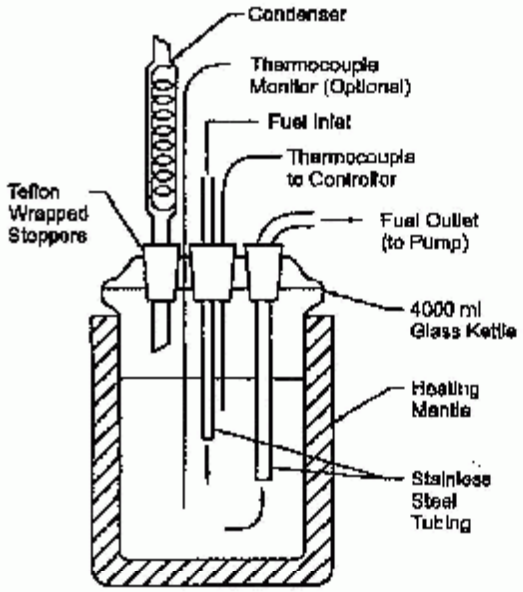

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Figure 5: Sour Gasoline Fuel Reservoir

3.3.2.1.2 Acceptance Determination. After 6 weeks of sour gasoline exposure, the samples shall meet the requirements of the following tests conducted sequentially. If preferred, samples tested to Sections 3.3.2.1.2.F can be from an additional sample set tested to the requirements of 3.3.2.1.2.A through 3.3.2.1.2.D, excluding the Burst Test of 3.3.2.1.2.E:

A. The maximum tubing length change permitted = 2.0% measured at 23°C.

B. Sample must be leak tested per GM9080P, 5.1, and must meet all of these requirements, with the following exceptions:

1. System to be pressurized with air to 70 ± 7 kPa.
2. Maximize air leakage permitted =< 2.0 cc/minute.

C. Sample must be leak tested per GM9080P, 5.1, and must meet of the requirements of 5.1.

D. Sample must be tested per GM213M, 3.1.2.3 (Cold Flexibility Test), omitting the 110 °C oven-age step, and must meet all requirements of 3.1.2.3.

E. Sample must be tested per GM213M, 3.1.2.1 (Burst Test), and must meet all requirements of 3.1.2.1.

F. Sample must be tested for layer adhesion per GM213M, 3.1.3.3, and must meet all requirements of 3.1.3.3.

3.3.2.2 Fuel Resistance - Recirculation Test.

3.3.2.2.1 Test Procedure. Two (2) separate sample sets of tubing must be tested to the requirements of this test procedure. One (1) sample set will be tested using TF1 fuel, winter blend, per GM6416M. The other sample set will be tested using TF2 fuel, winter blend, per GM6416M. Expose the sample to recirculating TF 1 and TF 2 fuel (at a rate of 700 ± 70 mL/minute for tubing of ID >= 6.35 mm, and 300 ± 30 mL/minute for tubing of ID < 6.35 mm) for 30 weeks, using the test apparatus as shown in Figure 4. The temperature of the fuel must be maintained at 40 ± 2°C. Any fuel filters incorporated into the test sample assemblies for test purposes are to be inserted between the flow meter and fuel reservoir. The recirculating fuel is to be replaced with fresh fuel every week.

3.3.2.2.2 Acceptance Determination. At 10 week intervals during this fuel recirculation, samples will be removed from the fuel recirculation apparatus and tested to the requirements of the following tests (3.3.2.2.2 A through G) sequentially. Each sample set removed per 10 week interval must consist of 5 samples for each connector and tube size. If preferred, samples tested to Sections 3.3.2.2.2.F and 3.3.2.2.2.G can be from an additional sample set tested to the requirements of 3.3.2.2.2.A through 3.3.2.2.2.D, excluding the Burst Test of 3.3.2.2.2.E:

A. The maximum tubing length change permitted = 2.0%, measured at 23°C.

B. Sample must be leak tested per GM9080P, 5.1, and must meet all of these requirements, with the following exceptions:

1. System to be pressurized with air to 70 ± 7 kPa.

2. Maximize air leakage permitted =< 2.0 cc/minute.

C. Sample must be leak tested per GM9080P, 5.1, and must meet all requirements.

D. Sample must be tested per GM213M, 3.1.2.3 (Cold Flexibility Test), omitting the 110°C oven-age step, and must meet all requirements of 3.1.2.3.

E. Sample must be tested per GM213M, 3.1.2.1 (Burst Test), and must meet all requirements of 3.1.2.1.

F. Sample must be tested for layer adhesion per GM213M, 3.1.3.3.

G. Sample must be tested for surface resistance per GM213M 3.1.3.2 and must meet all requirements of 3.1.3.2.

3.3.3 Physical Requirements. Not applicable.

3.3.4 Additional Requirements. Not applicable.

3.4 Requirements on other Stages during Life Cycle. Subparagraphs were not applicable.

4 Manufacturing Process

Not applicable.

5 Rules and Regulations

5.1 All materials supplied to this specification must comply with the requirements of GMW3001, **Rules and Regulations for Materials Specifications.**

5.2 All materials supplied to this specification must comply with the requirements of GMW3059, **Restricted and Reportable Substances for Parts.**

5.3 Inspection and Rejection. All shipments of materials or parts under contract or purchase order manufactured to this specification shall be equivalent in every respect to the initial samples approved by engineering. There shall be no changes in formulation or manufacturing process permitted without prior notification and approval by engineering. Lack of notification by the supplier constitutes grounds for rejection of any shipment. While samples may be taken from incoming shipments and checked for conformance to this specification, the supplier shall accept the responsibility for incoming shipments meeting this specification without dependence upon purchaser's inspection.

5.4 Initial Source Approval. No shipments shall be made by any supplier until representative initial production samples to the purchaser's laboratory and/or engineering department have been approved as meeting the requirements of this specification.

5.5 Safety Data Sheets. Completed copies of the Material Safety Data Sheets (MSDS) meeting GM information requirements must be submitted with any new submissions or where a composition change has occurred.

6 Approved Sources

The part supplier is responsible for the testing of samples as described in Section 3. These tests will be performed in his facilities or in outside testing laboratories. All laboratories must be approved laboratories. The requirement will be 5 samples per test for each connector and tube size.

Engineering qualification of an approved source is required for this specification. Only sources listed in the GM Materials File under this specification number have been qualified by engineering as meeting the requirements of this specification. Sources are available through the online MATSPC system.

7 Coding System

This material specification shall be called up in other documents, drawings, VTS, CTS etc. as follows:

Test to GM213M

Sample Drawing Callout. To fully describe the hose the specification number must be followed by a type.

Example: GM213M Type A

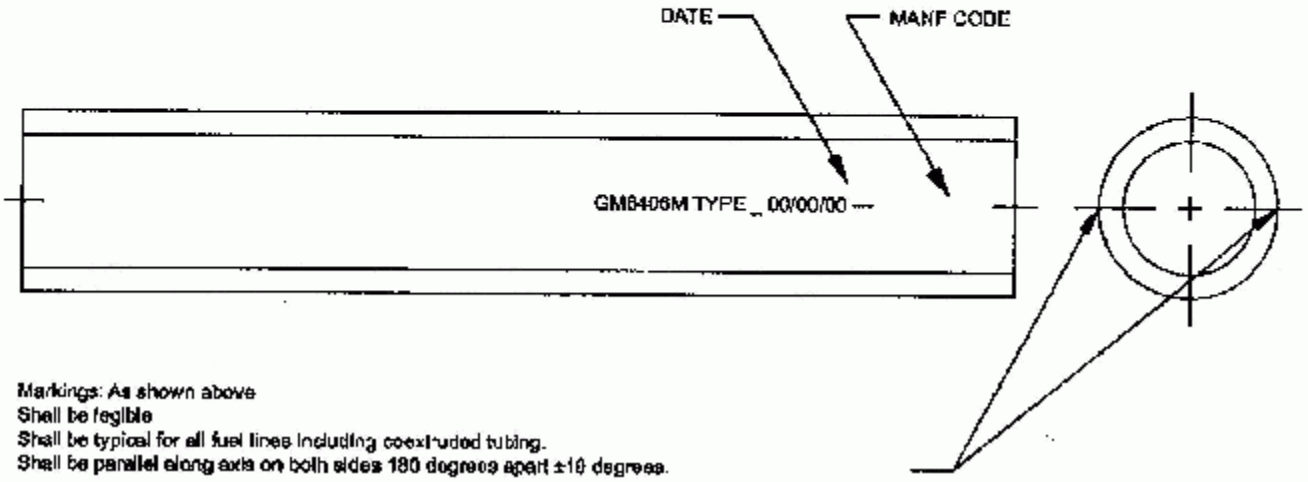
8 Release and Revisions

8.1 Release. The standard was originated by CLCD in April 1993 and published in October 1995.

8.2 Revisions.

Rev.	Date	Description (Organization.)
G	AUG 2002	Fixed Typo (GMNA)
H	APR 2003	Added Type I construction. Revised TF1 permeation limit for Type H. (Hose Specialist Team)

Appendix A



Markings: As shown above
Shall be legible
Shall be typical for all fuel lines including coextruded tubing.
Shall be parallel along axis on both sides 180 degrees apart ±10 degrees.

Marking must appear on at least one side, parallel to the fuel line axis.
If markings are printed on both sides, they most be 180 degrees apart ±10 degrees.

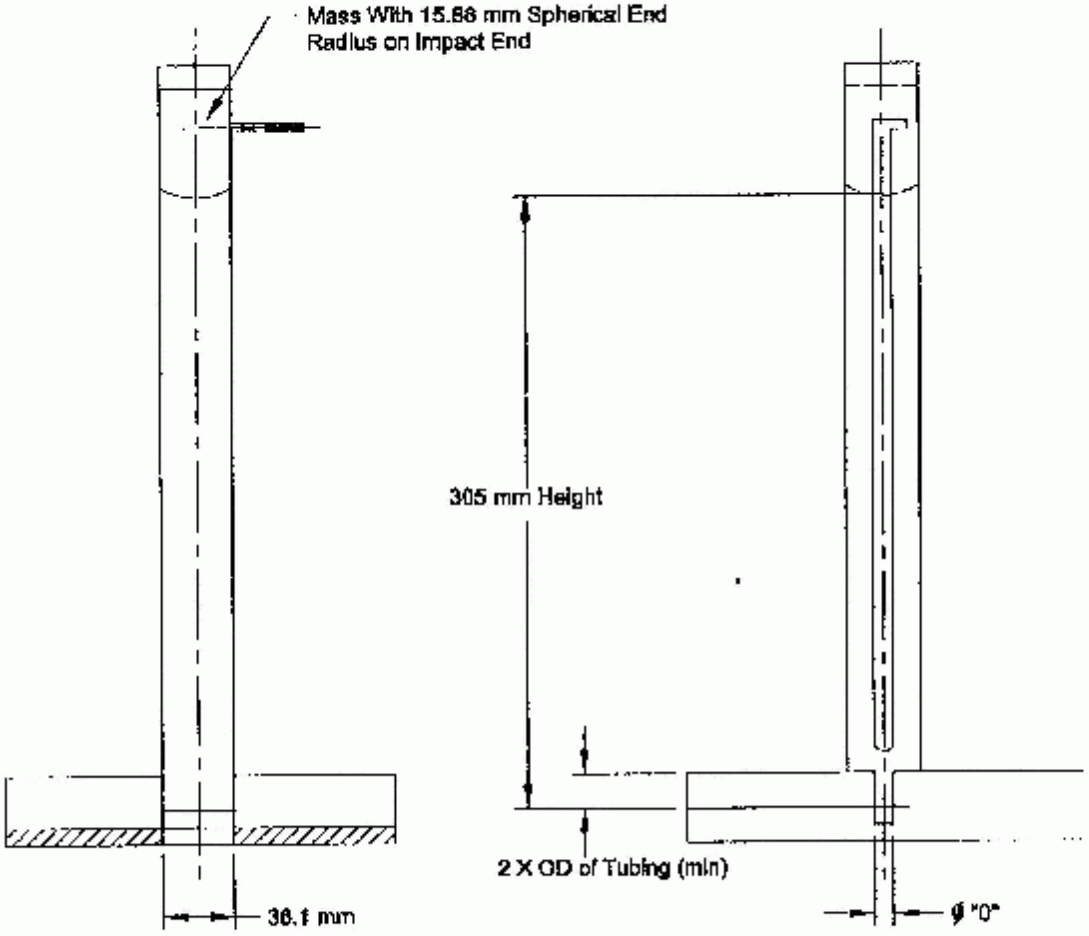
Shall be 2.5 mm min high for 7.93, 9.53 and 15.3 mm Nominal OD tubing.
Shall be 2.0 mm min high for 6.35 mm Nominal OD tubing.
The open space between the markings shall be not more than 100.0 mm.

Color: White or Yellow
Printing must be placed on tubing as extruded (No Pre and Post Treatment Allowed)
Printing must confirm to GM4350M Class AO A, B, C, only except (A) 75 % min, (C) 50 % min

Tubing Color: Black

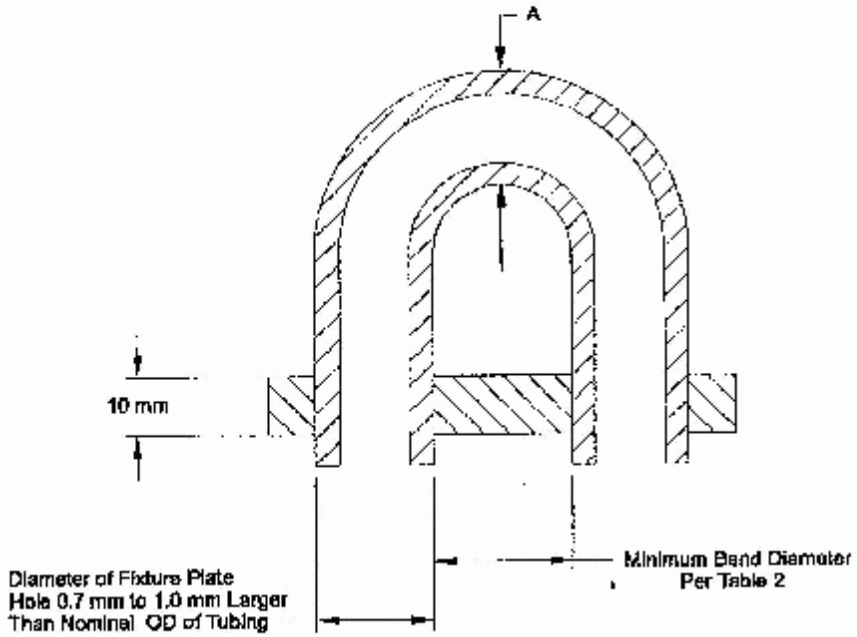
0215-010(08/01)

Figure 6: Labeling



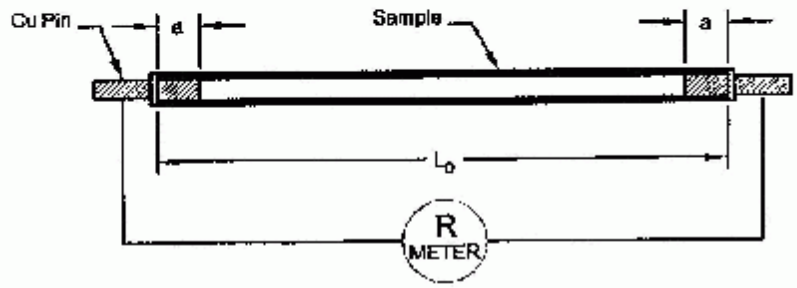
g538(1200)

Figure 7: Cold Impact Test Fixture



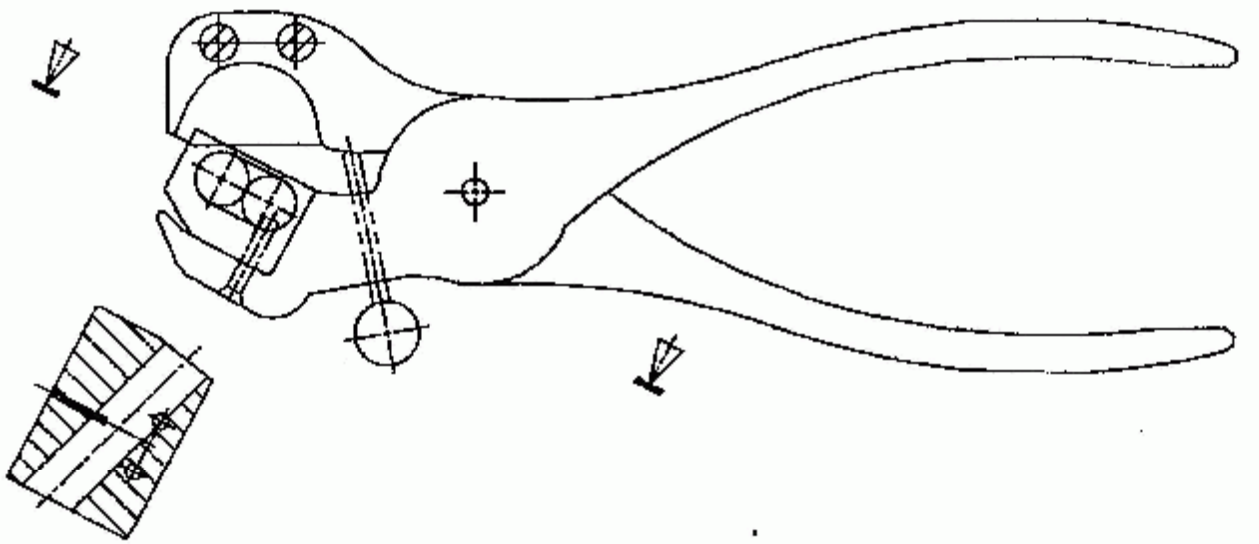
g035(04/01)

Figure 8: Kinking Resistance Test Fixture



g735(04/01)

Figure 9: Conductivity Fixture



G540(IZ00)

Figure 10: Adhesion Test Tool