



Thermoplastic Tubing for Coolant Applications

1 Scope

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose/Material Description. This standard covers material requirements and test procedures for extruded thermoplastic lines used in engine coolant/water applications. Operating temperatures for lines covered by this specification range from -40 °C to 120 °C with excursions to 135 °C. The performance requirements for engine coolant hose assemblies incorporating thermoplastic coolant lines may be defined by additional specifications including GMW16295, GMW14329, GMW17144 and GMW14638. Any additional requirements shall be defined by the GM Materials Engineer. Each material shall be defined by a construction type as defined in 3.2.

1.2 Symbols. Not applicable.

1.3 Applicability. Thermoplastic lines for surge tank degassing lines.

1.4 Remarks. Not applicable.

2 References

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

2.1 External Standards/Specifications.

ASTM D380	DIN 73378	ISO 527-1	ISO 527-2
ASTM D573	ISO 178		

2.2 GM Standards/Specifications.

GMW3059	GMW14329	GMW15272	GMW17558
GMW3221	GMW14638	GMW15468	
GMW3420	GMW14797	GMW16295	
GMW14270	GMW14872	GMW17144	

2.3 Additional References. Not applicable.

3 Requirements

3.1 Requirements on Test Specimens. Reference GMW3221. Unless otherwise specified, the shape and size of test pieces shall be in accordance with the relevant test method. The minimum number of samples (hoses) per test is defined in Table 1. Samples are finished parts or to be taken from finished parts. Where the dimensions on the finished parts do not allow preparing of test pieces, tests are to be performed on material from the same production batch. For testing of a tubing construction to the following performance properties of Table 3 of this specification, each type of quick connector, inline, T connector or Y connector used in a design released to this specification must be incorporated into the samples tested:

- Burst Test
- High Temperature Burst Test
- Burst after Heat Aging
- Coolant Circulation

- Cyclical Corrosion
- Insertion Force
- Pull-off Force
- Leak
- Cold Leak
- Pressure Impulse
- Fatigue Test (including simulation of engine movement)

3.1.1 Tubing Sizes and Processing Requirements for Samples. All sizes of tubing incorporated into a design released to this specification must be tested to all of the requirements of this specification listed in Table 1, Table 2 and Table 3. All processes used to manufacture the production tubing/assemblies for which material approval is being sought must be incorporated into the samples tested to this specification, including forming operations. If tubing is to be formed, representative samples of the formed tube must be selected as a part of validation testing. The effect of forming operations can be tested with straight tubing samples that have been subjected to heat exposure equivalent to that of the production forming operation.

3.2. Construction Types. Materials covered by this specification are divided into several types that define the material content, construction, and performance limits of each specific type of tubing. Construction types with wall and layer thicknesses deviating from the requirements outlined in Appendix A, Figure A1 must have these deviations approved by GM Materials Engineering and must meet all of the performance requirements outlined in this specification. Base materials must be tested for hydrolytic resistance as per GMW15468.

3.2.1 Construction Types. See Appendix A, Figure A1.

3.2.1.1 Type A. This tube consists of a single layer of an extrusion grade, heat stabilized, hydrolysis resistant, impact modified, monowall construction. Polyamide 612 (nylon 612) per GMW17558P-PA612 with a nominal thickness of 1.0 mm $\pm$ 0.05 mm.

3.2.1.2 Type B. This tube consists of a Multilayer Tube (MLT) construction of an extrusion grade, heat stabilized, and hydrolysis resistant resins. Constructions could possibly have a hydrolysis resistant polypropylene material on the inner liner with a Polyamide 12 (PA12) or Polyamide 612 (PA612) outer layer. Nominal thickness of MLT are to 1.0 mm $\pm$ 0.05 mm.

3.3 Labeling. Tubing released to this specification shall be labeling based on the requirements of the region in which it is released. Tubing for GM North America (GMNA) shall be labeled according to Appendix A, Figure A2. Tubing for GM Europe (GME) shall be labeled according to DIN 73378. Labeling requirements for other regions shall be coordinated with the regional Materials Engineer.

Table 1: Requirements Reference Table

Test	Number of Samples	Test Type
Tensile Strength	12	Material Property
Elongation at Break	12	Material Property
Flexural Test	12	Material Property
Burst Test	6	Performance
High Temperature Burst Test	6	Performance
Burst Test After Heat Aging	6	Performance
Coolant Circulation	6 per post-test (48 total)	Performance
Vacuum Test	6 at 24 °C and 6 at 135 °C	Performance
Kink Resistance	6	Performance
Cyclical Corrosion Test	6	Performance
Cold Impact	6	Performance
Cold Flexibility Test	6	Performance

Test	Number of Samples	Test Type
Adhesion Test	6	Performance
Insertion Force Test	6	Performance
Pull-Off Force Test	6	Performance
Leak Test	6	Performance
Cold Leak Test	6	Performance
Pressure Impulse	6	Performance
Fatigue Test (including simulation of engine movement)	6	Performance
Zinc Chloride Resistance Test	6	Performance
Layer Adhesion Test	6	Performance

Table 2: Material Properties (As Received)

Property	Test Procedure	Unit	Value
Tensile Strength			
All Construction Types	ISO 527-1/2 The tubing is clamped into a tensile test fixture which allows tensile strength and elongation to be measured without slippage or breakage of the tubing at the tensile tester jaw. The elongation shall be measured with either an extensometer or with elongation benchmarks (i.e., paper dots attached to the tubing). The initial extensometer measuring distance or the elongation bench marks separation is to equal 50 mm. The following test conditions shall be met: • Test Speed = 50 mm/minute • Test Temperature = +23 °C ± 2 °C • Relative Humidity (RH) = 50% The tensile strength and elongation testing is conducted under the test conditions previously noted until the ultimate elongation of the test sample is reached. When the tubing breaks, the load, and length of benchmarks or extensometer reading is recorded. The specific test procedures and equipment for each supplier must have GM Materials Engineering approval.	MPa	30 Minimum
Elongation at Break			
All Construction Types	ISO 527-1/2 Test procedure is identical to the test procedure for tensile strength. The elongation is calculated using the following formula: Elongation = [(Final Reading of Benchmarks – 50)/50] × 100	Percent (%)	150 minimum

Flexural Test			
All Construction Types	ISO 178 Test Pieces: 120 mm long Support Distance: 80 mm, radius of support: $R2 = 2 \text{ mm} \pm 0.2 \text{ mm}$ Test Speed: $v = 5 \text{ mm/minute}$, preload: $F_v = 0.5 \text{ N}$ Test at $+23 \text{ }^\circ\text{C} \pm 5 \text{ }^\circ\text{C}$ and $50\% \pm 6\% \text{ RH}$. A diagram of force in Newtons (N) to deflection in millimeters (mm) is recorded during the test. The following values are recorded: $F_{\max}$ = Maximum Flexural Force Outer diameter $\leq 8 \text{ mm}$ Outer diameter $> 8 \text{ mm}$ to $\leq 10 \text{ mm}$ Outer diameter $> 10 \text{ mm}$ to $\leq 13 \text{ mm}$ Outer diameter $> 13 \text{ mm}$ to $\leq 16 \text{ mm}$ Outer diameter $> 16 \text{ mm}$ $\delta_{\max}$ = Deflection at $F_{\max}$ Outer diameter $\leq 8 \text{ mm}$ Outer diameter $> 8 \text{ mm}$ to $\leq 10 \text{ mm}$ Outer diameter $> 10 \text{ mm}$ to $\leq 13 \text{ mm}$ Outer diameter $> 13 \text{ mm}$ to $\leq 16 \text{ mm}$ Outer diameter $> 16 \text{ mm}$ $F_{3.5}$ = Flexural Force at 3.5 mm deflection Outer diameter $\leq 8 \text{ mm}$ Outer diameter $> 8 \text{ mm}$ to $\leq 10 \text{ mm}$ Outer diameter $> 10 \text{ mm}$ to $\leq 13 \text{ mm}$ Outer diameter $> 13 \text{ mm}$ to $\leq 16 \text{ mm}$ Outer diameter $> 16 \text{ mm}$ Note to the documented values: The larger the deflection at $F_{\max}$ and $F_{3.5}$, the stronger the kink resistance of the tubing.	N mm N	65 Maximum 110 Maximum 140 Maximum 200 Maximum 410 Maximum 6 Minimum 5 Minimum 5 Minimum 7 Minimum 8 Minimum 44 Maximum 70 Maximum 115 Maximum 125 Maximum 240 Maximum

Table 3: Performance Properties

Property	Test Procedure	Unit	Value
Burst Test			
All Construction Types	ASTM D380 The test apparatus consists of a suitable source of hydraulic pressure and the necessary gages and piping. The length of the tubing should be $305.0 \text{ mm} \pm 5.0 \text{ mm}$. Plug one (1) end of the test specimen and mount in the apparatus with the other end unrestrained. The samples shall be assembled to ensure that the result will be a burst in the tube. The tubing is stabilized for 1 h to 3 h at $+23 \text{ }^\circ\text{C}$. Pressure is applied at room temperature, $+23 \text{ }^\circ\text{C} \pm 2 \text{ }^\circ\text{C}$, at a rate of $7 \text{ MPa/minute} \pm 1 \text{ MPa/minute}$. Continue at this rate until the tubing bursts. If the tube separates from the fitting the result shall not be used. Outer diameter $\leq 8 \text{ mm}$ Outer diameter $> 8 \text{ mm}$ to $\leq 10 \text{ mm}$ Outer diameter $> 10 \text{ mm}$ to $\leq 13 \text{ mm}$ Outer diameter $> 13 \text{ mm}$	MPa	6.5 Minimum 5 Minimum 4 Minimum 3.5 Minimum

Property	Test Procedure	Unit	Value
High Temperature Burst Test			
All Construction Types	ASTM D380 The test apparatus consists of a suitable source of hydraulic pressure and the necessary gages and piping. The oil shall be at $135^{\circ}\text{C} \pm 1^{\circ}\text{C}$. The length of the tubing shall be $305.0\text{ mm} \pm 5.0\text{ mm}$. Plug one (1) end of the test specimen and mount in the apparatus with the other end unrestrained. The samples shall be assembled to ensure that the result will be a burst in the tube. The tubing shall be stabilized for 1 h at $+135^{\circ}\text{C}$. Pressure is applied at $+135^{\circ}\text{C}$ at a rate of $7\text{ MPa/minute} \pm 1\text{ MPa/minute}$. Continue at this rate until the tubing bursts. If the tube separates from the fitting, the result shall not be used. Outer diameter $\leq 8\text{ mm}$ Outer diameter $> 8\text{ mm}$ to $\leq 10\text{ mm}$ Outer diameter $> 10\text{ mm}$ to $\leq 13\text{ mm}$ Outer diameter $> 13\text{ mm}$	MPa	0.8-1.0 Minimum 1.5 Minimum 1.0 Minimum 1.0 Minimum
Burst Test after Heat Aging			
All Construction Types	ASTM D380, ASTM D573 The test apparatus consists of a suitable source of hydraulic pressure and the necessary gages and piping. The length of the tubing shall be $305.0\text{ mm} \pm 5.0\text{ mm}$. Plug one (1) end of the test specimen and mount in the apparatus with the other end unrestrained. The samples shall be assembled to ensure that the result will be a burst in the tube. The tubing shall be heat aged per ASTM D573 for 336 h at $135^{\circ}\text{C} \pm 1^{\circ}\text{C}$. After oven aging is complete the tubing assembly shall be stabilized for 1 h to 3 h at $+23^{\circ}\text{C}$. Pressure is applied at room temperature, $+23^{\circ}\text{C} \pm 2^{\circ}\text{C}$, at a rate of $7\text{ MPa/minute} \pm 1\text{ MPa/minute}$. Continue at this rate until the tubing bursts. If the tube separates from the fitting the result shall not be used. Outer diameter $\leq 8\text{ mm}$ Outer diameter $> 8\text{ mm}$ to $\leq 10\text{ mm}$ Outer diameter $> 10\text{ mm}$ to $\leq 13\text{ mm}$ Outer diameter $> 13\text{ mm}$	MPa	2.0 Minimum 1.5 Minimum 1.0 Minimum 1.0 Minimum