GM	WORLDWIDE ENGINEERING STANDARDS	Material Specification	GMW17334

Single Wall Construction Steel Tubing

1 Scope

1.1 Material Description. This specification covers single wall construction tubing wherein the joint is electric resistance welded. There are requirements for base metal, the optional coating materials and the coated tubing. These requirements are applicable to the product coming out of the tube mills and the coating application lines, which are sometimes separate facilities. This tubing is used in the production of customized parts and assemblies. It is recommended that those parts and assemblies be validated for corrosion performance, conductivity and continuity, strength, appearance and other critical properties unique to the particular application.

1.2 Symbols. Not applicable.

1.3 Applicability. Single wall tubing is typically used for fuel lines, power steering lines, transmission oil cooler lines, lubricating oil lines, vacuum lines, etc.

1.4 Remarks. Not applicable.

2 References

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

2.1 External Standards/Specifications.

ASTM A254	ASTM D3703	ISO 8493	SAE J526
ASTM A875	ASTM E8	SAE J403	SAE J2044
ASTM B750	ISO 6892-1		

2.2 GM Standards/Specifications.

9985670	GMW3356	GMW14700	GMW15282
GMW3059	GMW3420	GMW14729	GMW15487
GMW3286	GMW14124	GMW14829	GMW15891

2.3 Additional References.

2.3.1 Fuels.

- GMPT-5-001 Diesel [Note 1]
- GMPT-5-020 Bio Diesel [Note 1]
- GMPT-5-036 Aggressive Bio Diesel [Note 1]
- GMPT-6-006 TF2 Gasoline [Note 1]
- GMPT-6-019 Oxidized Gasoline [Note 1]
- GMPT-6-020 Corrosive 2-Phase E10
- GMPT-6-023 E85 Low pHe [Note 1]
- GMPT-6-030 M15
- GMPT-6-037 E100 [Note 2]

Note 1: Information regarding GMPT fuels can be obtained by contacting GM Powertrain Materials Engineering. Fuels must be purchased from GM approved Suppliers. Use the most up-to-date suffix level for each fuel, per the GM Powertrain Engineer.
Note 2: E100 (GMPT-6-037) is required for GM Brazil (GMB) only.

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3 Requirements

3.1 Properties. See Table 1 for summary.

Basic tubing material shall be cold rolled mild steel strip to SAE J403 G10060, G10080, or G10100.

Table 1: Summary of Requirements [Note 2]

Requirement	GE	SGE	GN	GY	AN	AY	ZN	ZY	ZP	ZM	Ni [Note 1]	FF [Note 1]
Burst Pressure	Per 3.1.4										N/A	N/A
Finishes	Per Table 1											
Salt Spray	Per 3.4.1.1		Per 3.4.1.2		Per 3.4.1.3		Per 3.4.1.4		Per 3.4.1.5		N/A	N/A
Humidity	Per 3.4.2.1		N/A						Per 3.4.2.2		Per 3.4.2.3	N/A
Solvent Rub	Per 3.4.3		N/A								N/A	N/A
Fluid Resistance	Per 3.4.4.1		Per 3.4.4.2						Per 3.4.4.1		Per 3.4.4.3	N/A
Cyclic Corrosion	Per 3.4.5.1		Per 3.4.5.2						N/A		N/A	N/A
Cleanliness	Per 3.4.6.1										N/A	N/A
Forming and Handling	Per 3.4.6.2										N/A	N/A
Abrasion Resistances	N/A								Per 3.4.7		N/A	N/A
Temperature Resistances	N/A		Per 3.4.8								N/A	N/A
Heat Age	N/A		Per 3.4.9								N/A	N/A
Zinc Chloride Resistance	N/A			Per 3.4.10	N/A	Per 3.4.10	N/A	Per 3.4.10	N/A		N/A	N/A
Fuel Feed Line	N/A			N/A	N/A	N/A	N/A	N/A	N/A		N/A	3.4.11

Note 1: Only the additional requirements beyond those required for the standard tube are listed for Ni and FF.
Note 2: OD and ID coating abbreviations/combinations are defined in Section 8.
Note: N/A = Not applicable.

3.1.1 Mechanical Properties. The following requirements shall apply only to the more common welded-annealed steel tubing. Properties of other classes of tubing, such as work hardened tubing, shall be as specified through special agreement between supplier and purchaser. Test pieces for mechanical test shall be taken at the end of the tube manufacturing process (after coiling, etc.), without any additional cold working. All mechanical tests shall be performed at 23 °C ± 5 °C per ISO 6892-1 or ASTM E8. See Table 2.

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Table 2: Property Requirements

Property	Minimum Requirements
Tensile Strength R_m	290 MPa
0.2% Yield Strength $R_{p0.2}$	170 MPa
Fracture Elongation A_{10}	14%

3.1.2 Drift Expanding Tube Test (ISO 8493). Tubing shall be capable of being expanded over a 60 degree tapered mandrel until the internal diameter at the expanded end is increased 20% without cracking or showing flaws (ASTM A254, Paragraph 6.3). Prior to expansion test, tubing shall be cut off square, edge crowned and deburred. It shall be held firmly and squarely in the die, and punch must be guided on the axis of the tubing.

3.1.3 Bending Test. Tubing shall be capable of being bent on a centerline radius of three (3) times the tubing Outside Diameter (OD) without undue reduction of area of flattening when suitable bending fixtures are used. Using this formula, reduction of area shall be ≤ 6% for the diameters and wall thicknesses covered by this specification.

3.1.4 Static Burst Pressure. Tubing shall be capable of withstanding the following internal static hydraulic pressure:

- ≤ 10.0 mm OD: 35 MPa
- 10.0 mm OD thru 16.0 mm OD: 15 MPa

3.2 Dimensions. Tubing shall conform to the dimensions and tolerances listed by the purchaser.

3.2.1 Welded Tubing. Nominal diameter and wall thickness shall conform to those listed in SAE J526. Maximum OD for the Zinc-aluminum alloy plus Nylon topcoat and Aluminum plate plus Nylon topcoat tubing can be found in Table 3.

Table 3: Maximum OD for Nylon Coated Tubing

Tube Size, Nominal OD (mm)	Coated Tube, Maximum OD (mm)
4.76	5.28
6.00	6.52
6.35	6.87
7.94	8.46
8.00	8.52
9.53	10.05
10.00	10.52
11.11	11.65
12.70	13.24
14.29	14.83
15.88	16.42

3.2.2 Nickel Coated Interior Diameter (ID) Weld Bead. In order to ensure good re-flow of nickel at the weld, it is important that the weld bead have a smooth cross-sectional profile and minimum bead dimensions. Report the bead height dimension (the typical bead height shall be 0.15 mm or less. Continue monitoring the bead height until a maximum bead height requirement has been established).

Note: The tube producer is required to monitor the bead height in production. A bead height requirement will be established after enough data has been collected.

Typical Examples of good versus undesirable bead profiles are shown in Figure 1.

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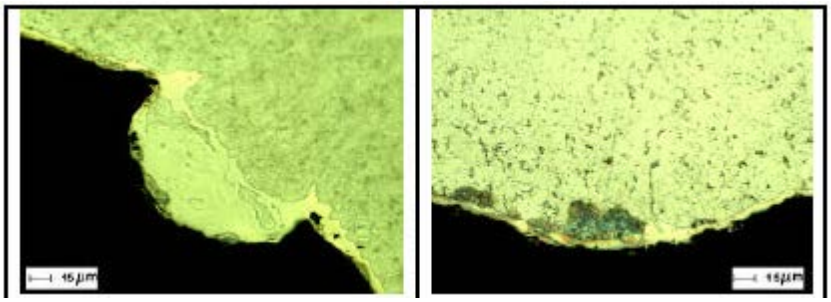
Figure 1: Weld Bead Profile Examples



Left Photo: Typical internal weld bead with undesirable cross-sectional profile.
Right Photo: Typical internal weld bead with good and smooth cross-sectional profile.

3.3 Finishes. Outside finish of the tube shall conform to the specified finish as shown in Table 4.

Table 4: External Finish Codes and Requirements

Finish	Finish Code	Finish Description and Material Requirements
Plain	P	No coating; base metal only (SAE J403 G10060, G10080, or G10100)
Zinc-Aluminum Alloy plus Aluminum Rich Epoxy Paint	GE	Hot dip zinc-aluminum alloy coating consisting of a 5% aluminum-balanced zinc alloy per ASTM B750 with a coating mass of 50 g/m^2 per ASTM A875, Section 8 and a thickness of 3 µm minimum anywhere on the tube per Appendix A. The hot dip zinc-aluminum coating is then subsequently coated with an approved pretreatment process and an approved aluminum-rich epoxy coating. **Film Thickness:** The aluminum-rich epoxy paint of the GE finish shall have a minimum thickness of 3 µm anywhere on the tube as measured by the procedures in Appendix A. Actual thickness of the coatings in the GE finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Zinc-Aluminum Alloy plus Aluminum Rich Epoxy Paint	SGE	Hot dip zinc-aluminum alloy coating consisting of a 5% aluminum-balanced zinc alloy per ASTM B750 with a coating mass of 100 g/m^2 per ASTM A875, Section 8 and a thickness of 7 µm minimum anywhere on the tube per Appendix A. The hot dip zinc-aluminum coating is then subsequently coated with an approved pretreatment process and an approved aluminum-rich epoxy coating. **Film Thickness:** The aluminum-rich epoxy paint of the SGE finish shall have a minimum thickness of 3 µm anywhere on the tube as measured by the procedures in Appendix A. Actual thickness of the coatings in the SGE finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.

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Finish	Finish Code	Finish Description and Material Requirements
Zinc-Aluminum Alloy plus Extruded Nylon 11 or 12	GN	Hot dip zinc-aluminum alloy coating consisting of a 5% aluminum-balanced zinc alloy per ASTM B750 with a coating mass of 50 g/m^2 per ASTM A875, Section 8 and a thickness of 3 µm minimum anywhere on the tube per Appendix A. The hot dip zinc-aluminum coating followed by a conversion coating, an epoxy resin based primer, and a topcoat of Nylon 11 or 12. **Appearance:** The topcoat shall be uniform in color and free from discontinuities such as flow lines, pin holes, craters or abnormal roughness. The topcoat shall be black in color unless otherwise specified on the engineering drawing. **Film Thickness:** The epoxy primer shall be 0.3 µm minimum and the Nylon 11 or 12 topcoat shall have a minimum thickness of 150 µm when tested by microscopic examination per Appendix A. Maximum thickness of the coating shall be controlled by the maximum OD (Table 3). Actual thickness of the coatings in the GN finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Zinc-Aluminum Alloy plus Extruded Nylon 612	GY	Hot dip zinc-aluminum alloy coating consisting of a 5% aluminum-balanced zinc alloy per ASTM B750 with a coating mass of 50 g/m^2 per ASTM A875, Section 8 and a thickness of 3 µm minimum anywhere on the tube per Appendix A. The hot dip zinc-aluminum coating followed by a conversion coating, an epoxy resin based primer, and a topcoat of Nylon 612. **Appearance:** The topcoat shall be uniform in color and free from discontinuities such as flow lines, pin holes, craters or abnormal roughness. The topcoat shall be black in color unless otherwise specified on the engineering drawing. **Film Thickness:** The epoxy primer shall be 0.3 µm minimum and the Nylon 612 topcoat shall have a minimum thickness of 150 µm when tested by microscopic examination per Appendix A. Maximum thickness of the coating shall be controlled by the maximum OD (Table 3). Actual thickness of the coatings in the GY finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Aluminum Plate plus Extruded Nylon 11 or 12	AN	Hot-dip aluminum, coated to a minimum thickness of 100 µm anywhere on the tube, followed by a conversion coating, an epoxy resin based primer, and a topcoat of Nylon 11 or 12. **Appearance:** The topcoat shall be uniform in color and free from discontinuities such as flow lines, pin holes, craters or abnormal roughness. The topcoat shall be black in color unless otherwise specified on the engineering drawing **Film Thickness:** The epoxy primer shall be 0.3 µm minimum and the Nylon 11 or 12 topcoat shall have a minimum thickness of 120 µm when tested by microscopic examination per Appendix A. Maximum thickness of the coating shall be controlled by the maximum OD (Table 3). Actual thickness of the coatings in the AN finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Aluminum Plate plus Extruded Nylon 612	AY	Hot-dip aluminum, coated to a minimum thickness of 100 µm anywhere on the tube, followed by a conversion coating, an epoxy resin based primer, and a topcoat of Nylon 612. **Appearance:** The topcoat shall be uniform in color and free from discontinuities such as flow lines, pin holes, craters or abnormal roughness. The topcoat shall be black in color unless otherwise specified on the engineering drawing. **Film Thickness:** The epoxy primer shall be 0.3 µm minimum and the Nylon 612 topcoat shall have a minimum thickness of 120 µm when tested by microscopic examination per Appendix A. Maximum thickness of the coating shall be controlled by the maximum OD (Table 3). Actual thickness of the coatings in the AY finish

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Finish	Finish Code	Finish Description and Material Requirements
		shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Zinc Plate plus PVF or PVDF Coating	ZP	Electroplated zinc, coated to a minimum thickness of 22 µm anywhere on the tube, followed an approved pretreatment process and an approved PVF coating. **Thickness Measurements:** The PVF or PVDF coating of the ZP finish shall have a minimum thickness of 15 µm anywhere on the tube as measured by the procedures in Appendix A. Actual thickness of the coatings in the ZP finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Zinc Plate plus Extruded Nylon 11 or 12	ZN	Electroplated zinc, coated to a minimum thickness of 22 µm anywhere on the tube, followed by a conversion coating, an epoxy resin based primer, and a topcoat of Nylon 11 or 12. **Appearance:** The topcoat shall be uniform in color and free from discontinuities such as flow lines, pin holes, craters or abnormal roughness. The topcoat shall be black in color unless otherwise specified on the engineering drawing. **Film Thickness:** The epoxy primer shall be 0.3 µm minimum and the Nylon 11 or 12 topcoat shall have a minimum thickness of 150 µm when tested by microscopic examination per Appendix A. Maximum thickness of the coating shall be controlled by the maximum OD (Table 3). Actual thickness of the coatings in the GN finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Zinc Plate plus Extruded Nylon 612	ZY	Electroplated zinc, coated to a minimum thickness of 22 µm anywhere on the tube, followed by a conversion coating, an epoxy resin based primer, and a topcoat of Nylon 612. **Appearance:** The topcoat shall be uniform in color and free from discontinuities such as flow lines, pin holes, craters or abnormal roughness. The topcoat shall be black in color unless otherwise specified on the engineering drawing **Film Thickness:** The epoxy primer shall be 0.3 µm minimum and the Nylon 612 topcoat shall have a minimum thickness of 150 µm when tested by microscopic examination per Appendix A. Maximum thickness of the coating shall be controlled by the maximum OD (Table 3). Actual thickness of the coatings in the GY finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Zinc Plate plus Modified Epoxy Ester Paint	ZM	Electroplated zinc, coated to a minimum thickness of 22 µm anywhere on the tube, followed by an approved pretreatment process and approved modified epoxy ester paint. **Thickness Measurements:** The modified epoxy ester paint of the ZM finish shall have a minimum thickness of 30 µm anywhere on the tube as measured by the procedures in Appendix A. Actual thickness of the coatings in the ZM finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.
Nickel Plating	Ni	Inside diameter electroplated nickel coating. **Thickness Measurements:** The electroplated nickel ID plating thickness of the finished tube shall have a minimum thickness of 3 microns everywhere on the ID of the tube as measured by the procedures in Appendix A. Actual plating thickness of the Ni finish shall be monitored circumferentially and longitudinally for each tube line. A sampling plan shall be referenced in the control plan.

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