



General Requirements for Certification Testing and Approval of Plastic Materials

1 Scope

1.1 Material Description. This specification includes Standard Requirements for GM Worldwide Material Specifications (numbered GMWXXXXX) that apply to plastics as well as some comments on requirements for plastic part performance. It also describes the Plastics Certification Statement which contains certified property data and other information needed to write GMW specifications, and/or approve molding compounds to GMW specifications.

Note that only the minimum requirements for the approval of plastic materials are described herein. The part manufacturer or material processor, reserves the right to specify more requirements to satisfy their processing needs and quality systems.

The main purpose of this structure of the Standard Requirements for Engineering Material Specifications is to provide designers, purchasers and suppliers with a selection of possible alternative materials for certain applications. The GMW specifications for plastics shall be preferred in drawings to local specifications (e.g., QK XXXXXX, GMP.XXX.XXX).

1.2 Symbols. Refer to GMW3116 for the marking and identification of polymer and elastomeric vehicle components and materials.

1.3 Applicability. All plastic material supplied to GM and included in parts supplied to GM.

1.4 Remarks. In GMW Plastics Specifications, materials are described by the chemical, mechanical, physical and other properties of the pellets or test specimens manufactured therefrom. Particular material types are combined in groups according to their chemical structure. These groups differ from each other by their main application, essential additives and characteristic properties as well as type and content of filler (if applicable).

2 References

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

2.1 External Standards/Specifications.

AATCC 23	ISO 75-1	ISO 1183-2	ISO 8256
ASTM D1003	ISO 75-2	ISO 1431-1	ISO 8257
ASTM D1603	ISO 105	ISO 1628	ISO 9002
ASTM D1693	ISO 178	ISO 1817	ISO 9988
ASTM D1894	ISO 179	ISO 1872	ISO 10350
ASTM D3012	ISO 188	ISO 1873	ISO 10350-1
ASTM D3763	ISO 294-3	ISO 1874	ISO 11357
ASTM D3769	ISO 294-4	ISO 2039-2	ISO 11357-3
ASTM E228	ISO 306	ISO 2577	ISO 11358
ASTM E831	ISO 307	ISO 2580	ISO 11359-2
EN 10204	ISO 458-1	ISO 3146	ISO 14910
FMVSS 108	ISO 489	ISO 3167	ISO 15512
FMVSS 302	ISO 527	ISO 3451-1	ISO 28078

IATF 16949	ISO 812	ISO 3451-4	ISO/IEC 17025
IEC 60112	ISO 815-1	ISO 3795	SAE J1645
IEC 60243-1	ISO 815-2	ISO 4577	SAE J1976
IEC 60250	ISO 868	ISO 4892	SAE J2527
ISO 34	ISO 899-1	ISO 6603	UL 94
ISO 37	ISO 974	ISO 7392	
ISO 62	ISO 1133	ISO 7792	

2.2 GM Standards/Specifications.

GMW3059	GMW6992	GMW14688	GMW16172
GMW3116	GMW14162	GMW14698	GMW16853
GMW3205	GMW14270	GMW15468	GMW16883
GMW3221	GMW14334	GMW15571	GMW17141
GMW3232	GMW14335	GMW15634	
GMW3235	GMW14444	GMW15635	
GMW3417	GMW14650	GMW15725	

2.3 Additional References.

- Certification Template, available from GM SupplyPower, <https://gmsupplypower.covisint.com>
- CG4110

3 Requirements

3.1 Requirements on Test Specimens. Reference GMW3221.

3.2 Requirements on Delivery.

3.2.1 General Requirements.

3.2.1.1 Properties. The specified properties for Thermoplastics are primarily a selection from the properties of the Computer Aided Material Preselection by Uniform Standards (CAMPUS) material database (per ISO 10350-1 and the relevant Part 2 of the International Organization for Standardization (ISO) material designation). Generic properties for Thermoplastic Elastomers (TPE) and Thermosets are also tabulated. Where suitable ISO/International Electrotechnical Commission (IEC) test methods are not available, the appropriate national standard or GM test procedure is chosen.

ISO material designations include but are not limited to:

Table 1: ISO Material Designation

Material	ISO Material Designation
ISO 1872	Polyethylene (PE)
ISO 1873	Polypropylene (PP)
ISO 1874	Polyamide (PA)
ISO 2580	Acrylonitrile/Butadiene/Styrene (ABS)
ISO 7392	Polycarbonate (PC)
ISO 7792	Saturated Polyester
ISO 8257	Poly(methyl) methacrylate (PMMA)
ISO 9988	Polyoxymethylene (POM)
ISO 14910	Thermoplastic Polyether/Ester Elastomers
ISO 28078	Poly(phenylene) Sulfide (PPS)

3.2.1.2 Data Sheet. General Motors requires a Certification Template for plastic molding compounds being considered for approval to GMW series specifications. The Certification Template contains certified property data and other information needed to write and approve molding compounds to GMW specifications. GMW3013 Certification Templates are available in GM SupplyPower or from a General Motors Company (GM) materials engineer. Do not combine data from multiple colors unless it can be shown that combining the data does not significantly change the breadth of the data. Do not combine data from multiple processes. In general, properties should be reported as per existing specifications and/or as negotiated with the GM materials engineer.

3.2.1.3 Test Atmosphere. For sampling of molding components or finished parts released to this specification, test specimens shall be conditioned for $23 \text{ h} \pm 2 \text{ h}$, and tests shall be carried out on test specimens at the standard conditions specified in GMW3221 - Code A, unless otherwise specified. When sampling molding compounds, processability on production machines shall be noted.

3.2.1.4 Requirements on Test Specimens. The mean and range values specified in the GMW specifications for plastics, shall be established in cooperation with the raw material manufacturers, who shall document the properties of the plastic molding compounds in a Certification Statement for plastic molding compounds, per the appropriate GMW3013 Certification Template. In any case, the GM materials engineer reserves the right to reject molding compounds with significant standard deviations.

The minimum values or ranges specified in the GMW Plastic Specification property tables, shall be met by test specimens in natural, black or in a standard sampled color if natural or black are not available. For colored grades where other pigment or additive systems (e.g., stabilizer) are used, the impact values shall not decrease more than a given percentage from the specified minimum value, as indicated in the GMW material specification.

3.2.1.4.1 The raw material manufacturer shall test at least three (3) properties of the molding compound regularly at each lot suitable to assure its production process. These tests should include a rheological (viscosity) property for unfilled thermoplastics and filler content test for filled thermoplastics. Also, as one (1) of these three (3) tests, if < 30 lots of data are available on a given product, the raw material manufacturer shall verify and certify at least one (1) of the specified mechanical properties in the inspection certificate of every delivery of molding compound to the processor. The test unit for the certificate shall be randomly obtained from that lot of the molding compound which is being delivered.

A release can only be accomplished, if at inspection the actual values are within the specified range. The GM materials engineer reserves the right to narrow the specified range for parts with special requirements.

3.2.1.5 Requirements on Parts. When sampling finished parts, the part supplier shall certify that the requirements of the part drawing are fulfilled (e.g., Colorfastness to Artificial Light, Resistance to Scratching). At part delivery, the part supplier is obligated to forward a copy of the inspection certificate or Certificate of Analysis (e.g., in Europe, per EN 10204) of the raw material manufacturer to the department in charge of the Production Part Approval Process (PPAP) review at GM. In this, the raw material manufacturer has to verify the properties to the processor. A release can only be accomplished, if at inspection the actual values are within the specified range. GM reserves the right to change material requirements for parts with special requirements.

3.2.1.5.1 For current deliveries, the part supplier shall verify the inspection certificate (in Europe, to EN 10204) of the raw material manufacturer at the receiving inspection according to ISO 9002. According to ISO 9002, the part supplier shall ensure the traceability from his finished part lot number to the raw material lot number and establish records about it according to ISO 9002. GM Automotive Group reserves the right to have a look into the records at any time, e.g., on the occasion of a supplier audit. The values determined on standard test specimens cannot be applied to the finished part; these values could have changed during processing or because of tool structure and/or design of the finished part. Any deviation from the specification shall, however, not affect the function of the finished parts.

3.2.1.5.2 For properties which deviate significantly from the specification due to processing, (e.g., melt flow rate of thermoplastic polyester) limiting values should be determined on the finished part and specified on the drawing. In addition to the general drawing requirements like dimensional stability under heat, etc., these properties are used as the basis of comparison for following quality inspections. The engineering drawing will show the material type as well as the respective GMW number. Also, the part supplier shall certify that the properties of the material specification that can be tested on the finished part are fulfilled. All plastic parts shall include GMW15571 as drawing/math data requirement.

Plastic part performance properties are indicated on GM drawing/math data with the following specifications. Additional part performance properties may be indicated in addition on the GM drawing/math data with the appropriate GM specification(s):

- **Interior.** All plastic parts located in the vehicle interior must perform to GMW14444.
- **Exterior.** All plastic parts located in the vehicle exterior must perform to GMW14650.
- **Underhood.** All plastic parts located in the vehicle engine compartment must perform to GMW15725 and/or GMW16883.

3.2.1.6 Chemical Requirements. All parts manufactured from molding compounds shall be resistant to the media they contact, such as aliphatic and aromatic hydrocarbons, fuels, lubricants, oils, greases, and alcohols at their places of use.

3.2.2 Testing Requirements. The basic property submission requirements per resin family are listed in Appendix A, Figure A1 for reference. Additional testing may be required by the GMW specification or the GM Materials Engineer. A subset of the properties listed in Table 1 through Table 9 should be used in individual GMW specifications for Plastics per ISO 10350-1 and the relevant Part 2 of the ISO material designation.

3.2.2.1 Testing Requirements for All Plastics.

Table 2: Requirements for All Thermoplastics and Thermoplastic Elastomers

Property	Standard	Specimen Type (Dimensions in mm)	Unit	Test Conditions and Supplementary Instructions
Water absorption - saturation value in water at +22 °C	ISO 62 or GMW14335	1 mm, 2 mm or 4 mm plaque or pellets	%	Record dimensions of the specimen.
Saturation value at +22 °C ± 3 °C/50% ± 5% Relative Humidity (RH)			%	
Chemical resistance	GMW14334			
Chemical composition	GMW3059			Material should not contain any restricted/reportable substances, see GMW3059/CG4110 for chemicals and thresholds. Chemical submission must be submitted in the IMDS system.
Interior Emissions VOC/SVOC	GMW15634		µg/g	Requirements see GMW16853
Carbonyls	GMW15635		mg/kg	
Odor	GMW3205	100 mm × 150 mm × 3.2 mm Ratio of test specimen to test container volume shall be 1:100 unless otherwise specified.		All materials: Code B – Dry Condition Plastics containing materials with natural content (e.g., jute, sisal, hemp, flax, cellulose, wood, cotton, etc.) – Code A – Wet Condition, and Code B – Dry Condition

Property	Standard	Specimen Type (Dimensions in mm)	Unit	Test Conditions and Supplementary Instructions
Fogging - photometric (dependent on availability of equipment)	GMW3235		% Reflectance	Bath Temperature +85 °C, +95 °C or +105 °C ± 0.5 °C, Cooling Temperature +21 °C ± 0.5 °C, Test Duration 3 h ± 0.05 h. Choose bath temperature closest to Heat Deflection Temperature (HDT).
Fogging – gravimetric (dependent on availability of equipment)	GMW3235		mg	Bath Temperature +100 °C ± 0.5 °C, Cooling Temperature +21 °C ± 0.5 °C, Test Duration 18 h ± 0.05 h.
Density	ISO 1183-2 Method A	≥ 10 mm × ≥ 10 mm × 4 mm	g/cm ³	
Ash	ISO 3451-1	Type A	% by mass	at +950 °C, (+600 °C for thermoplastic elastomers, +750 °C ± 50 °C for polypropylene) specify filler type exclusive of carbon black. Use ISO 3451-4 for Polyamide (PA).
Carbon black	ASTM D1603 or Thermogravimetric Analysis (TGA)		%	Run for statically dissipative grades.
Relative permittivity – 1 MHz dissipation factor 1 MHz	IEC 60250	1 mm plaque		
Volume resistivity	IEC 62631-3-2		Ω m	Measurement with contact electrodes.
Surface resistivity			Ω	
Dielectric Strength	IEC 60243-1		kV/mm	Use electrode configuration 25/75 mm coaxial cylinders. Immersion in IEC 60296 transformer oil. Short- time test.
Comparative tracking index	IEC 60112	≥ 15 mm × ≥ 15 mm × 4 mm		Use solution A

Ω= Ohm meter

HDT = Heat Deflection Temperature

IEC = International Electrotechnical Commission

RH = Relative Humidity

TGA = Thermogravimetric Analysis

3.2.2.2 Requirements for Thermoplastics.

Table 3: Requirements for Thermoplastics

Property	Standard	Specimen Type (Dimensions in millimeters)	Unit	Test Conditions and Supplementary Instructions
Moisture content for polyamides	ISO 15512 Method A, Method B, or GMW14335	1 mm or 2 mm plaque or pellets	%	
Tensile modulus (Modulus of elasticity in tension)	ISO 527-1 ISO 527-2 or ISO 37 (for PVC only)	ISO 3167, 4 mm thick Type A bar	MPa	Test speed 1 mm/minute; between 0.05% to 0.25% strain
Yield stress			%	Test speed 50 mm/minute; if tensile strain at yield or break ≥ 10%
Yield strain				
Nominal tensile strain at break			MPa	At 50 mm/minute; only if no yield at ≥ 50% strain
Tensile stress at 50% strain				
Tensile stress at break			%	Test speed 5 mm/minute; only if strain at break < 10%
Tensile strain at break				
Poisson's ratio				Tensile method, Test speed 1 mm/minute
Tensile creep modulus	ISO 899-1		MPa	At 1 h, strain ≤ 0.5%
Tensile creep modulus			MPa	At 1000 h, strain ≤ 0.5%
Flexural modulus	ISO 178	80 mm × 10 mm × 4 mm	MPa	Test speed 2 mm/minute, 64 mm span, chord (0.05% to 0.25% strain)
Flexural stress at yield or Break				
Flexural strain at yield or break				
Charpy impact strength at +22 °C	ISO 179/1eU	80 mm × 10 mm × 4 mm	kJ/m ²	Edgewise impact for test at -30 °C: The test specimens shall be exposed to the indicated temperature for 4 h minimum. If the test is not performed inside the cold chamber, the test specimen shall be removed only immediately before performing the test.
Charpy impact strength at -30 °C			kJ/m ²	
Notched Charpy impact strength at +23 °C	ISO 179/1eA	80 mm × 10 mm × 4 mm Machined V-notch, Radius = 0.25 mm	kJ/m ²	
Notched Charpy impact strength at -30 °C			kJ/m ²	
Tensile impact strength at +23 °C	ISO 8256		kJ/m ²	+23 °C; double V 45 degrees notches; radius = 1 mm, record if fracture cannot be observed with notched Charpy test.
Properties after short term heat aging	ISO 188 Ovens that allow 100 ± 50 air changes per hour are acceptable for use.	See test methods for mechanical property testing to determine specimen size.	% retention	1000 h at X °C (temperature as specified in Table 6), followed by indicated property testing at +23 °C ± 2 °C. Test methods are the same as for original mechanical property testing.
Tensile Strength			% retention	
Tensile Elongation			% retention	
Notched Charpy Impact			% retention	
Rockwell hardness	ISO 2039-2	≥ 6 mm thick		
Melt mass-flow rate (MFR)	ISO 1133	Molding Compound	g/10 minutes	Use and record test conditions for temperature and load specified in the appropriate material standard. Temperature (°C) = _____ Load = kilogram (kg) _____

Property	Standard	Specimen Type (Dimensions in millimeters)	Unit	Test Conditions and Supplementary Instructions
Melt volume-flow rate (MVR)			cm ³ /10 minutes	
Molding shrinkage – longitudinal – 48 h after molding	ISO 294-3, ISO 294-4	60 mm × 60 mm × 2 mm per ISO 294-3 Type D2 preferred or larger with maximum thickness = 4.0 mm	%	Use separate specimens for each test. Specimen Dimensions = __ × __ × __ millimeter (mm)
- After 48 h at +80 °C			%	
Molding shrinkage - transverse – 48 h after molding			%	
- After 48 h at +80 °C			%	
Melting temperature	ISO 3146 ISO 11357-3		°C	Method A, Method B, Method C (Differential Scanning Calorimetry (DSC) or Differential Thermal Analysis (DTA) at 10 K/minute).
Glass transition temperature	ISO 11357-2		°C	Method A (DSC or DTA at 10 K/minute)
HDT – 0.45 MPa	ISO 75-1, ISO 75-2 Method B	80 mm × 10 mm × 4 mm	°C	For less rigid materials, test flatwise, unannealed. See template for requirements.
HDT – 1.8 MPa	ISO 75-1, ISO 75-2 Method A		°C	For both soft and rigid materials, test flatwise, unannealed. See template for requirements.
Vicat softening temperature	ISO 306	10 mm × 10 mm × 4 mm	°C	Heating rate +50 °C/h. See specific material template for load requirement.
Coefficient of Linear Thermal Expansion (CLTE) - parallel	ASTM E228, ASTM E831 or ISO 11359-2	from ISO 3167	10 ⁻⁶ mm/mm/ °C	Mean secant value over the temperature range -30 °C to +110 °C for melting points < +200 °C. Mean secant value over the temperature range -30 °C to +160 °C for melting points
CLTE – normal				
Viscosity number	ISO 307, ISO 1628	Molding compound	cm ³ /g	Different polymers may require alternative test methods, (e.g., relative viscosity)
Thermal oxidative stability	ISO 4577 or ASTM D3012			Only for Polypropylene and Thermoplastic Polyolefin (TPO). +150 °C for 336 h
Colorfastness to burnt gas (propane)	AATCC 23 or ISO 105-G02	Color: Light Gray or Beige	ΔE ΔYI	
Scratch and mar	GMW14688			Method A. Required load is in specific material template.
Five (5) finger scratch and mar	GMW14698			
Stress mark susceptibility	GMW17141		Stress Evaluation Test (SET)	Only for Polypropylene copolymers and TPO.
Flammability	GMW3232, ISO 3795	355 mm × 100 mm × 2 mm	mm/minute	The test may be performed to either GMW3232 or ISO 3795 but all reporting must be in accordance with GMW3232.
Environmental stress crack resistance	ASTM D1693			Condition B, 100% Igepal (CAS No.: 9002-93-1), f(50)h
Index of refraction	ISO 489			

Property	Standard	Specimen Type (Dimensions in millimeters)	Unit	Test Conditions and Supplementary Instructions
Luminous transmittance	ASTM D1003			
Haze	ASTM D1003			

ΔE = Delta E (color change)

CLTE = Coefficient of Linear Thermal Expansion

MFR = Melt Flow Rate

MVR = Melt Volume Rate

SET = Stress Evaluation Test

TPO = Thermoplastic Polyolefin

3.2.2.3 Requirements for Thermoplastic Elastomers. These properties generally apply to thermoplastic elastomers with hardness of < 90 Shore A. For thermoplastic elastomers with hardness > 90 Shore A, see instructions in Table 4.

Table 4: Requirements for Thermoplastic Elastomers

Property	Standard	Specimen Type (Dimensions in mm)	Unit	Test Conditions and Supplementary Instructions
Shore A hardness	ISO 868	25 × mm × 25 mm × 6 mm	Shore A	After 15 s ± 1 s, for materials with Shore A < 90
Shore D hardness	ISO 868	25 mm × 25 mm × 6 mm or 80 mm × 80 mm × 6 mm	Shore D	After 15 s ± 1 s, for materials with Shore A > 90
Tear propagation strength	ISO 34-1, Method B	Angle test specimen 2 mm thick	kN/m	Test Speed: 500 mm/minute
Compression set: 72 h at +23 °C ± 2 °C	ISO 815-1	12 mm thick, Ø 29.0 mm	%	Type A
Compression set: 24 h at +70 °C ± 3 °C			%	
Compression set: 72 h at +125 °C ± 3 °C			%	
Compression set: ___ h at -___ °C ± 3 °C	ISO 815-2	12 mm thick, Ø 29.0 mm	%	
Tensile modulus (Modulus of elasticity in tension)	ISO 37 or ISO 527	Type 1 Dumbbell	MPa	Olefinic and Styrenic-based TPEs Use ISO 37 for Hardness < 90 Shore A; Use ISO 527 for hardness > 90 Shore A. Test speed: 500 mm/minute
Tensile stress at break		Type 1A Dumbbell	MPa	
Elongation at break			%	
Tensile stress at 100% elongation			MPa	
Tensile modulus (Modulus of elasticity in tension)	ISO 527	80 mm × 10 mm × 4 mm cut from Type 1A bar (Tensile Modulus Only)	MPa	Ether Ester Block Copolymer (EEBC) and Other TPEs Hardness > 90 Shore A. Test speed: 1 mm/minute for Tensile Modulus Test speed: 50 mm/minute for all other tests
Tensile stress at break		Type 1BA Dumbbell	MPa	
Elongation at break			%	
Tensile stress at 100% elongation			MPa	
Stiffness in torsion	ISO 458-1	60 mm × 6 mm × 3 mm		