

SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE J1639

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CLASSIFICATION SYSTEM FOR AUTOMOTIVE POLYAMIDE (PA) PLASTICS

1. **Scope**—This SAE Recommended Practice provides a system for classification and specification for limited number of polyamides (nylons) used in the Automotive Industry. Based upon ASTM D 4066, it calls for additional descriptive characteristics and properties commonly used in the Automotive Industry. Recycled polyamides meeting requirements of this practice may be used interchangeably with virgin resins.

1.1 **Purpose**—The purpose of this document is to:

- a. Standardize the grades of unreinforced and reinforced polyamides (nylons) 66, 6, and 6/66 used for the Automotive Industry.
- b. Standardize the test methods used to characterize the properties of these materials.
- c. Provide a method for specifying these materials by the use of a simple line call-out designation.

2. **References**

- 2.1 **Applicable Documents**—The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply.

2.1.1 **SAE PUBLICATIONS**—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J369—Flammability of Automotive Interior Materials-Horizontal Test Method

SAE J1344—Marking of Plastic Parts

SAE J1885—Exposure to Interior Xenon-Arc Weatherometer

SAE J1960—Exposure to Exterior Xenon-Arc Weatherometer

SAE J1976—Outdoor Weathering of Exterior Materials

2.1.2 **ASTM PUBLICATIONS**—Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM D 4065—Dynamic Mechanical Properties of Plastics (Shear Modulus)

ASTM D 4066—Nylon Injection and Extrusion Materials (PA)

ASTM E 228—Linear Thermal Expansion of Solid Materials With a Vitreous Silica Dilatometer

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2.1.3 ISO PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 75—Plastics—Determination of temperature of deflection under load
ISO 105/A02—Textiles—Grey scale for assessing change in color
ISO 178—Plastics—Determination of flexural properties of rigid plastics
ISO 180/1A—Plastics—Determination of izod impact strength of rigid materials
ISO 188—Rubber—Accelerated aging
ISO/DIS 294.2—Plastics—Injection molding of test specimens of thermoplastic materials
ISO R 527—Plastics—Determination of tensile properties
ISO 960—Plastics—Polyamides (PA)—Determination of water content
ISO 1183—Plastics—Method for determining the density
ISO 2577—Plastics—Thermosetting molding materials, determination of shrinkage
ISO 3146—Plastics—Determination of melting behavior of semi-crystalline polymers
ISO 3451/4—Plastics—Determination of ash—polyamides
ISO 3795—Road vehicles—Determination of burning behavior of interior materials for motor veh.
ISO 6603/1—Plastics—Determination of multiaxial impact behavior of rigid materials

3. Description

- 3.1 This classification system was developed to permit the addition of descriptive characteristics and values commonly used in Automotive Material Specifications for polyamides. All the requirements are incorporated in Table A1. The additional requirements listed in Sections 6 and 7 shall apply for initial qualification of the material. For product certification, average values shall meet the requirements at a confidence level of 95%.

4. Classification

- 4.1 Polyamide (nylon) plastics are classified into 'groups' according to their chemical composition. These groups are subdivided into 'classes' and 'grades' as shown in Appendix A to this document.

- 4.2 An example of this classification system is as follows:

The designation PA1122 would indicate

PA = polyamide (nylon)
11 = reinforced PA66
2 = glass reinforced, impact modified, heat stabilized
2 = 15% glass

- 4.3 Test specimens shall be prepared by injection molding according to ISO/DIS 294.2

Unless otherwise specified all tests shall be carried out on injection molded one-end gated test specimens.

The following dimensions are required:

- a. 150 minimum x 10 x 4.0 ± 0.2 mm (Tensile Bar)
b. 120 x 10 x 4.0 ± 0.2 mm

Specimens with shorter dimensions shall be cut from the center portion of the test specimen A and/or B. No annealing allowed.

5. Line Call-outs

5.1 A line call-out, which is a specification, shall contain this document's identification number and a material designation from Table 1 as illustrated in 4.2.

TABLE 1—STANDARDIZED AUTOMOTIVE GRADES OF HEAT STABILIZED POLYAMIDES (PA)¹

PA Group	Description ²	Filler Content	Grade ³
66	General	Unreinforced	0121
	Impact modified	Unreinforced	0171
	Impact modified	Unreinforced	0172
	Glass fiber reinforced	15%	1112
	Glass fiber reinforced	35%	1116
	Glass fiber reinforced, impact modified	15%	1122
	Mineral filled	40%	1137
	Glass fiber/mineral reinforced	40%	1147
	Mineral filled; impact modified	35%	1156
	Glass fiber reinforced, hydrolysis resistant	30%	1165
6	General	Unreinforced	0222
	Impact modified	Unreinforced	0282
	Glass fiber reinforced	15%	1212
	Glass fiber reinforced	25%	1214
	Glass fiber reinforced	35%	1216
	Glass fiber reinforced, impact modified	30%	1225
	Mineral filled	30%	1235
	Mineral filled	40%	1237
	Glass fiber/mineral reinforced	40%	1247
6/66 ⁴	Glass fiber reinforced	30%	1815

¹ Grades commonly used in Automotive Industry. Additional grades may be included in the future as agreed to by the SAE Plastics Committee.

² All materials are heat stabilized.

³ Proposed PA Grades for future incorporation in ASTM D 4066 PA Tables.

⁴ Blends of PA6 and PA66 (ASTM D 4066 Grades to be established).

5.2 The line call-out specifies material meeting all requirements of this document. Note additional characterizations in Sections 6 and 7.

The following is an example of a line call-out:

SAEJ1639PA1116

The previous specification would indicate:

- PA = polyamide (nylon), generic symbol according to SAE J1344
- 11 = reinforced/filled PA66 (Appendix, Group 11)
- 1 = glass reinforced, heat stabilized (Appendix, Group 11, Class 1)
- 6 = 35% nominal (Appendix, Group 11, Class 1, Grade 6)

5.3 The following definitions for tables in the Appendix of this document apply to unfilled and filled polyamides.

- Group 01 Unreinforced polyamide 66 (PA66) (all classes heat stabilized)
 - Class 2 Injection and extrusion molding
 - Class 7 Impact modified
- Group 02 Unreinforced polyamide 6 (PA6) (all classes heat stabilized)
 - Class 2 Injection and extrusion molding
 - Class 8 Impact modified
- Group 11 Reinforced/filled polyamide 66 (PA66) (all classes heat stabilized)
 - Class 1 Glass fiber reinforced
 - Class 2 Glass fiber reinforced, impact modified
 - Class 3 Mineral filled
 - Class 4 Mineral/glass fiber filled
 - Class 5 Mineral filled, impact modified
 - Class 6 Glass fiber reinforced, hydrolysis resistant
- Group 12 Reinforced/filled polyamide 6 (PA6) (all classes heat stabilized)
 - Class 1 Glass fiber reinforced
 - Class 2 Glass fiber reinforced, impact modified
 - Class 3 Mineral filled
 - Class 4 Mineral/glass fiber filled
- Group 18 Reinforced/filled polyamide 6/66 (PA6/66) (all classes heat stabilized)
 - Class 1 Glass fiber reinforced

The fourth digit in groups 11, 12, and 18 will define the nominal amount of reinforcement. Numerals 1 to 9 will designate the following:

- | | |
|---------|-----------|
| 1 = 10% | 6 = 35% |
| 2 = 15% | 7 = 40% |
| 3 = 20% | 8 = 45% |
| 4 = 25% | 9 = 50% |
| 5 = 30% | 0 = Other |

6. Initial Characterization of Automotive Materials

- 6.1 Infrared Spectrophotometry and/or Thermal Analysis**—Infrared and/or thermal analysis spectra shall be supplied with initial characterization of material. These spectra shall constitute the reference standard for the material.

Infrared and/or thermal analysis of material supplied to a specification based on this classification system shall be available on request.

- 6.2 Shear Modulus**—A plotted curve described as follows, shall be submitted with an initial characterization of the material. This plot shall constitute the reference standard for the material.

Shear modulus versus temperature curve shall be plotted for -50 °C to +210 °C (PA6), +240 °C (PA66) temperature range, at 5 °C minimum intervals. Tolerance ranges of $\pm 20\%$ for unreinforced, and $\pm 25\%$ for reinforced materials shall also be plotted.

- 6.2.1 TEST METHOD**—ASTM D 4065, forced constant amplitude, fixed frequency of 1 Hz $\pm 15\%$, strain level below 1%. Specimen approx. 60 x 10 x 4.0 ± 0.2 mm cut from the center of tensile specimen (ISO 527). Specimen length between clamps 35 to 40 mm. Soak time at each temperature interval 3 min minimum.

- 6.3 Heat Aging Performance**—After aging for 1000 h at the appropriate temperature listed as follows, the tensile strength, Izod impact strength, or both must retain at least 75 % of their original values. For unreinforced materials, tensile strength retention data is required. Izod impact strength retention data is required for reinforced materials. For impact modified grades, data for both properties are needed.

6.3.1 OVEN AGING TEMPERATURES

110 °C—Unreinforced/impact modified/coolant resistant
140 °C—Reinforced

- 6.3.2 TEST METHOD**—ISO 188, 150 air changes/h ± 50 air changes/h. After heat aging, test specimens are to be conditioned in a desiccator for 3 to 5 h at 23 °C ± 2 °C. Impact strength test specimens shall be notched before heat aging. Unaged property values shall be determined at the time of the aged properties determination.

Test results shall be submitted with an initial characterization of the material.

- 6.4 Engine Coolant Resistance**—Use only for hydrolysis resistant PA66.

6.4.1 TEST METHOD—ISO R 527

After immersion for 1000 h at 130 °C and 103 kPa pressure in 50/50 solution of water and approved automotive coolant concentrate, the tensile strength must retain a minimum of 20% of the original value listed in Table A1. A minimum of 10 samples shall be tested. Unaged property values shall be determined at the time of the aged properties determination.

Aged tensile strength value in MPa shall be submitted with an initial characterization of the material.

6.5 Impact Strength, Izod at $-40\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$

6.5.1 TEST METHOD—ISO 180/1A, test minimum of 10 specimens.

The test specimen must be conditioned for a minimum of 6 h at the previously specified temperature prior to impact test. Low-temperature testing shall be done within the cold chamber.

Test results shall be submitted with an initial characterization of the material.

The initial characterization values in kJ/m^2 are shown in Table A1.

6.6 Impact Strength, Multiaxial—Use only for impact modified materials.

6.6.1 TEST METHOD—ISO 6603/1

Test at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and at $-30\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$, test minimum of 10 specimens for each test.

For $-30\text{ }^{\circ}\text{C}$ test specimens must be conditioned for a minimum of 6 h at the previously specified temperature prior to impact test. Low-temperature testing shall be done within the cold chamber.

Materials with brittle failure at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ may not be qualified as impact modified materials.

Report impact strength in J (minimum value) at maximum load.

6.7 Flammability

6.7.1 TEST METHOD—ISO 3795/SAE J369

100 mm/minute maximum Burn Rate

The specimen size required for material approval is $355 \times 100 \times 1.0\text{ mm} \pm 0.1\text{ mm}$ with a smooth surface.

Test results shall be submitted with an initial characterization of the material.

6.8 Coefficient of Linear Thermal Expansion

6.8.1 TEST METHOD—ASTM E 228 or TMA, -30 to $+30\text{ }^{\circ}\text{C}$

Report average value $\times E-5$ per $^{\circ}\text{C}$

Test results shall be submitted with an initial characterization of the material.

6.9 Mold Shrinkage

6.9.1 TEST METHOD—ISO 2577, fan gated injection molded specimen, $150 \times 100 \times 3.2\text{ mm} \pm 0.2\text{ mm}$

Report values in percent (%) under the following conditions:

- After 48 h storage at $23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ at $50\% \pm 5\%$ relative humidity
- After 48 h at $80\text{ }^{\circ}\text{C}$
- After 30 min at $120\text{ }^{\circ}\text{C}$

All test results shall be submitted with an initial characterization of the material.

7. **Suffixes**—The following requirements shall be added to the basic call-out by use of suffixes Z1, Z2, Z3 as applicable.

7.1 **Weather Resistance, Interior**

Suffix Z1—Interior, UV Stable

Use only for weather resistant materials.

No objectional color change or surface defects allowed.
Visual evaluation overrides instrumental results.

All test results shall be submitted with an initial characterization of the material.

7.1.1 XENON-ARC WEATHEROMETER EXPOSURE

7.1.1.1 *Test Method*—SAE J1885

600 kJ/m² minimum exposure
Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02)
 $\Delta E = 3.0$ maximum

Acceptance criteria shall be specified by the user.

7.1.2 FLORIDA AND ARIZONA EXPOSURE

7.1.2.1 *Test Method*—Applicable method shall be specified by the user of this document.

1 year, 5 degrees south under glass
Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02)
 $\Delta E = 3.0$ maximum

Acceptance criteria shall be specified by the user.

7.2 **Weather Resistance, Exterior**

Suffix Z2—Exterior, UV Stable

Use only for weather resistant materials

No objectional color change or surface defects allowed.
Visual evaluation overrides instrumental results.

All test results shall be submitted with an initial characterization of the material.

7.2.1 XENON-ARC WEATHEROMETER EXPOSURE

7.2.1.1 *Test Method*—SAE J1960

2500 kJ/m² minimum exposure
Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02)
 $\Delta E = 3.0$ maximum

Acceptance criteria shall be specified by the user.

7.2.2 FLORIDA AND ARIZONA EXPOSURE

7.2.2.1 Test Method—SAE J1976

2 years, 5 degrees, south direct exposure
Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02)
 $\Delta E = 3.0$ maximum

Acceptance criteria shall be specified by the user.

7.3 Fogging

Suffix Z3—Fogging Resistance
Use only for interior applications materials.

Test results shall be submitted with an initial characterization of the material.

A minimum Fog number and the applicable test method shall be specified by the user of this document.

- 7.4 The following is an example of a line call-out for weatherable (molded-in-color), interior application material requiring suffixes Z1 & Z3:

SAEJ1639PA1116Z1Z3

where:

Z1 = Interior, UV Stable
Z3 = Fog Number xx, minimum per xxx (specify test method)

PREPARED BY THE SAE PLASTICS COMMITTEE