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## Standard Classification System for Polyamide Molding and Extrusion Materials (PA)<sup>1</sup>

This standard is issued under the fixed designation D6779; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope\*

1.1 This classification system covers polyamide materials suitable for molding and extrusion. Some of these compositions are also suitable for application from solution.

1.2 This classification system allows for the use of recycled polyamide materials provided that the requirements as stated in this classification system are met. The proportions of recycled material used, as well as the nature and amount of any contaminant, however, cannot be covered practically in this specification.

1.3 The properties included in this classification system are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specialized applications. These may be specified by using the suffixes as given in Section 5.

1.4 This classification system and subsequent line callout (specification) are intended to provide a means of calling out plastic materials used in the fabrication of end items or parts. It is not intended for the selection of materials. Material selection should be made by those having expertise in the plastic field after careful consideration of the design and the performance required of the part, the environment to which it will be exposed, the fabrication process to be employed, the costs involved, and the inherent properties of the material other than those covered by this classification system.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 The following precautionary caveat pertains only to the test methods portion, Section 11, of this classification system. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

NOTE 1—This classification system is similar to ISO 1874-1/-2, although the technical content is significantly different.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- D257 Test Methods for DC Resistance or Conductance of Insulating Materials
- D789 Test Methods for Determination of Solution Viscosities of Polyamide (PA)
- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D883 Terminology Relating to Plastics
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D3892 Practice for Packaging/Packing of Plastics
- D4000 Classification System for Specifying Plastic Materials
- D6260 Test Method for Gravimetric Determination of Carbon Black in Nylon Materials (PA)
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

#### 2.2 IEC/ISO Standards:<sup>3</sup>

- IEC 60243-1 Electrical Strength of Insulating Materials—Test Methods—Part 1: Tests at Power Frequencies
- IEC 60250 Recommended Methods for the Determination of the Permittivity and Dielectric Dissipation Factor of Electrical Insulating Materials at Power, Audio and Radio Frequencies Including Metre Wavelengths
- ISO 75-1 Plastics—Determination of Temperature of Deflection Under Load—Part 1: General Test Methods
- ISO 75-2 Plastics—Determination of Temperature of Deflection Under Load—Part 2: Plastic and Ebonite

<sup>1</sup> This classification system is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

\*A Summary of Changes section appears at the end of this standard.

- ISO 179-1 Plastics—Determination of Charpy Impact Strength—Part 1: Non-instrumented Impact Test
- ISO 294-1 Plastics—Injection Moulding of Test Specimens of Thermoplastic Materials—Part 1: General Principles, Multipurpose-Test Specimens and Bars
- ISO 307 Determination of Viscosity Number of Polyamides In Dilute Solutions
- ISO 527-1 Plastics—Determination of Tensile Properties—Part 1: General Principles
- ISO 527-2 Plastics—Determination of Tensile Properties—Part 2: Testing Conditions
- ISO 1183 Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics
- ISO 1874-1 Plastics—Polyamide (PA) Homopolymers and Copolymers for Moulding and Extrusion—Part 1: Designation
- ISO 1874-2.2 Plastics—Polyamide (PA) Homopolymers and Copolymers for Moulding and Extrusion—Part 2: Preparation of Test Specimens and Determination of Properties
- ISO 3167 Plastics, Multipurpose Test Specimens
- ISO 3451-4 Plastics—Determination of Ash—Part 4: Polyamides
- ISO 11357-1 Plastics—Differential Scanning Calorimetry—Part 1: General Principles
- ISO 11357-3 Plastics—Differential Scanning Calorimetry—Part 3: Determination of Temperature and Enthalpy of Melting and Crystallization
- ISO 15512 Plastics—Determination of Water Content

### 3. Terminology

3.1 The terminology used in this classification system is in accordance with Terminologies D883 and D1600.

### 4. Classification

4.1 Polyamide materials are classified into groups in accordance with their composition. These groups are subdivided into classes and grades as shown in the Basic Property Table (Table PA).

NOTE 2—An example of this classification system for unreinforced polyamide is given as follows: The designation PA0123 indicates the following:

- PA = polyamide as found in Terminology D1600,
- 01 (group) = polyamide 66,
- 2 (class) = heat stabilized, and
- 3 (grade) = with a minimum viscosity number of 210 and the requirements given in Table PA.

4.1.1 Grades of reinforced or filled versions, or both, of the basic materials are identified by a single letter that indicates the reinforcement or filler used and two digits, in multiples of 5, that indicate the nominal quantity in percent by weight. Thus, a letter designation G for glass reinforced and 35 for percent or reinforcement, G35, specifies a material with a nominal glass level of 35 %. The reinforcement letter designations and associated tolerance levels are shown as follows:

| Symbol | Material  | Tolerance<br>(Based on the Total Mass)             |
|--------|---|--|
| C      | carbon- and graphite-fiber-reinforced                                   | ±2 %   |
| G      | glass-reinforced  | ±2 %   |
| L      | lubricants (such as PTFE, graphite, silicone, and molybdenum disulfide) | Depends upon material and process—to be specified. |
| M      | mineral-reinforced  | ±2 %   |
| R      | combinations of reinforcements or fillers, or both                      | ±3 %   |

NOTE 3—An example of this classification system for reinforced polyamide is given as follows: The designation PA012G35 indicates the following:

- PA = polyamide as found in Terminology D1600,
- 01 (group) = polyamide 66,
- 2 (class) = heat stabilized, and
- G35 (grade) = nominal 35 % glass with the requirements given in Table PA.

NOTE 4—This part of the classification system uses percent of reinforcements or additives, or both, in the callout of the modified basic material. The types and percentages of reinforcements and additives should be shown on the supplier's technical data sheet unless they are proprietary in nature. If necessary, additional control of these reinforcements and additives can be accomplished by use of the suffix part of the system (see Section 5).

NOTE 5—Materials containing reinforcements or fillers, or both, at nominal levels not in multiples of 5 are included in the nearest PA grade designation. For example, a material with a nominal glass fiber level of 33 % is included with Grade G35 as shown in Note 4.

NOTE 6—Ash content of filled or reinforced materials may be determined using Test Method ISO 3451-4.

4.2 Variations of polyamide materials that are not in Table PA are classified in accordance with Tables PA and A or B. Table PA is used to specify the group of polyamide and Table A or B is used to specify property requirements.

4.2.1 Specific requirements for variations of polyamide materials shall be shown by a six-character designator. The designation will consist of the letter “A” or “B” and the five digits comprising the cell numbers for the property requirements in the order as they appear in Tables A and B.

4.2.1.1 Although the values listed are necessary to include the range of properties available in existing material, users should not infer that every possible combination of the properties exists or can be obtained.

4.2.2 When the grade of the basic material is not known, is not important or does not meet the Table PA requirements, the use of “0” grade classification shall be used for reinforced materials in this classification system.

NOTE 7—An example of this classification system for a reinforced polyamide material is given as follows. The designation PA0110G30A42270 would indicate the following material requirements:

- PA0110 = Polyamide 66, from Table PA,
- G30 = Glass reinforced at 30 % nominal,
- A = Table A property requirements,
- 4 = Tensile strength, 140 MPa, min,
- 2 = Tensile modulus, 4500 MPa, min,
- 2 = Charpy impact, 5.0 kJ/m<sup>2</sup>, min,
- 7 = Deflection temperature at 1.8 MPa, 200°C, min, and
- 0 = Unspecified.

If no properties are specified, the designation would be PA0110G30A00000.

NOTE 8—When a grade of polyamide is not fully identified by a standard callout, it is possible to specify all table properties by the use of an addition of Classification D4000 suffixes. Suffix values will override the PA table values. An example of an unreinforced polyamide material is given as follows: PA0212KN023. This example is a general purpose, low viscosity PA6 material where K denotes tensile properties, N denotes tensile modulus with ISO 527 as the test method, and 023 denotes a value of 2300 MPa. This value for tensile modulus overrides the normal table value. This example can be applied to replace all table values, that is, tensile stress, notched Charpy impact, and heat deflection temperature.

4.3 To facilitate the specification of special materials where the basic property table does not reflect the properties required, Table B has been incorporated into this classification system. This table will be used in a manner similar to Table A.

NOTE 9—Pigmented or colored polyamides can differ significantly from the natural polymers in mechanical properties depending on the choice of colorants and concentrations. The main property affected is ductility, as illustrated by a reduction in Charpy impact and elongation values. In a typical white pigmented polyamide, elongation losses of up to 50 % and Charpy impact losses of up to 30 % are common. If specific properties of pigmented materials are necessary, Table B may be employed to specify property requirements.

NOTE 10—An example of a special material using this classification system is as follows: The designation PA0220B54220 would indicate the following material requirements from Table B:

- PA0220 = Polyamide 6, heat stabilized, from Table PA,
- B = Table B property requirements,
- 5 = Tensile strength, 70 MPa, min,
- 4 = Tensile modulus, 2400 MPa, min,
- 2 = Charpy impact, 4.0 kJ/m<sup>2</sup>, min,
- 2 = Deflection temperature at 1.8 MPa, 55°C, min, and
- 0 = unspecified.

**TABLE PA Requirements for Polyamides Dry-as-Molded<sup>A,B</sup>**

| Group | Description | Class | Description     | Grade | Description <sup>C</sup> | Viscosity Number, ISO 307, min, mL/g | Density, <sup>D</sup> ISO 1183 g/cm <sup>3</sup> | Tensile Strength, ISO 527-1 and ISO 527-2, MPa, min | Tensile Modulus, <sup>E</sup> ISO 527-1 and ISO 527-2, MPa, min | Charpy Impact Resistance, ISO 179/1eA, kJ/m <sup>2</sup> , min | Deflection Temperature, <sup>F</sup> ISO 75-1 and ISO 75-2, at 1.8 MPa, °C, min |
|-------|-------------|-------|-----------------|-------|--------------------------|--------------------------------------|--|---|---|--|---|
| 01    | PA66        | 1     | General-purpose | 1     |                          | 135                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.3  | 60  |
|       |             |       |                 | 2     |                          | 165                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.3  | 60  |
|       |             |       |                 | 3     |                          | 210                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.3  | 60  |
|       |             |       |                 | 4     |                          | 270                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.3  | 60  |
|       |             |       |                 | 5     | recycled                 | 115                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.3  | 60  |
|       |             |       |                 | 6     | recycled                 | 135                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.3  | 60  |
|       |             |       |                 | 7     |                          | 115                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.3  | 60  |
|       |             |       |                 | G15   | 15 % glass               | ...                                  | 1.20 to 1.26                                     | 100   | 4000  | 3.0  | 215   |
|       |             |       |                 | G20   | 20 % glass               | ...                                  | 1.25 to 1.33                                     | 115   | 5000  | 4.0  | 220   |
|       |             |       |                 | G25   | 25 % glass               | ...                                  | 1.29 to 1.37                                     | 140   | 6000  | 5.0  | 225   |
|       |             |       |                 | G35   | 35 % glass               | ...                                  | 1.35 to 1.45                                     | 170   | 8000  | 7.0  | 235   |
|       |             |       |                 | G40   | 40 % glass               | ...                                  | 1.42 to 1.52                                     | 175   | 9000  | 8.0  | 235   |
|       |             |       |                 | G45   | 45 % glass               | ...                                  | 1.45 to 1.55                                     | 180   | 10 000  | 9.0  | 240   |
|       |             |       |                 | G50   | 50 % glass               | ...                                  | 1.51 to 1.61                                     | 190   | 11 000  | 10.0   | 245   |
|       |             | M40   | 40 % mineral    | ...   | 1.45 to 1.55             | 80                                   | 5000   | 2.0   | 100   |  |   |
|       |             | 0     | other           |       |                          |                                      |  |   |   |  |   |
|       |             | 2     | Heat-stabilized | 1     |                          | 135                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.0  | 60  |
| 2     |             |       |                 | 165   | 1.13 to 1.15             | 70                                   | 2300   | 3.0   | 60  |  |   |

**TABLE PA Requirements for Polyamides Dry-as-Molded<sup>A,B</sup>**

| Group | Description | Class | Description                      | Grade | Description <sup>C</sup>  | Viscosity Number, ISO 307, min, mL/g | Density, <sup>D</sup> ISO 1183 g/cm <sup>3</sup> | Tensile Strength, ISO 527-1 and ISO 527-2, MPa, min | Tensile Modulus, <sup>E</sup> ISO 527-1 and ISO 527-2, MPa, min | Charpy Impact Resistance, ISO 179/1eA, kJ/m <sup>2</sup> , min | Deflection Temperature, <sup>F</sup> ISO 75-1 and ISO 75-2, at 1.8 MPa, °C, min |
|-------|-------------|-------|----------------------------------|-------|---|--------------------------------------|--|---|---|--|---|
|       |             |       |                                  | 3     |   | 210                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.0  | 60  |
|       |             |       |                                  | 4     |   | 270                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.0  | 60  |
|       |             |       |                                  | 5     | recycled  | 115                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.0  | 60  |
|       |             |       |                                  | 6     | recycled  | 135                                  | 1.13 to 1.15                                     | 70  | 2300  | 3.0  | 60  |
|       |             |       |                                  | G15   | 15 % glass  | ...                                  | 1.20 to 1.26                                     | 100   | 4000  | 3.0  | 220   |
|       |             |       |                                  | G25   | 25 % glass  | ...                                  | 1.29 to 1.37                                     | 140   | 6000  | 5.0  | 225   |
|       |             |       |                                  | G30   | 30 % glass  | ...                                  | 1.32 to 1.42                                     | 160   | 7000  | 6.0  | 230   |
|       |             |       |                                  | G35   | 35 % glass  | ...                                  | 1.35 to 1.45                                     | 170   | 8000  | 7.0  | 235   |
|       |             |       |                                  | G40   | 40 % glass  | ...                                  | 1.43 to 1.53                                     | 175   | 9000  | 8.0  | 235   |
|       |             |       |                                  | G45   | 45 % glass  | ...                                  | 1.45 to 1.55                                     | 180   | 10 000  | 9.0  | 240   |
|       |             |       |                                  | G50   | 50 % glass  | ...                                  | 1.51 to 1.61                                     | 190   | 11 000  | 10.0   | 245   |
|       |             |       |                                  | M40   | 40 % mineral  | ...                                  | 1.45 to 1.55                                     | 80  | 5000  | 2.0  | 100   |
|       |             |       |                                  | R20   | 20 % filler   | ...                                  | 1.23 to 1.31                                     | 70  | 3200  | 1.5  | ...   |
|       |             |       |                                  | R40   | 40 % filler   | ...                                  | 1.43 to 1.53                                     | 100   | 5500  | 2.5  | 200   |
|       |             |       |                                  | 0     | other   |                                      |  |   |   |  |   |
|       |             | 3     | Nucleated                        | 1     |   | 135                                  | 1.13 to 1.15                                     | 80  | 2500  | 2.8  | 60  |
|       |             |       |                                  | 2     |   | 165                                  | 1.13 to 1.15                                     | 80  | 2500  | 2.8  | 60  |
|       |             |       |                                  | 3     |   | 210                                  | 1.13 to 1.15                                     | 80  | 2500  | 2.8  | 60  |
|       |             |       |                                  | 4     |   | 270                                  | 1.13 to 1.15                                     | 80  | 2500  | 2.8  | 60  |
|       |             |       |                                  | 5     | recycled  | 115                                  | 1.13 to 1.15                                     | 80  | 2500  | 2.8  | 60  |
|       |             |       |                                  | 6     | recycled  | 135                                  | 1.13 to 1.15                                     | 80  | 2500  | 2.8  | 60  |
|       |             |       |                                  | 0     | other   |                                      |  |   |   |  |   |
|       |             | 4     | Nucleated, heat-stabilized       | 1     | Requirements the same as corresponding grades under Group 01, Class 3 |                                      |  |   |   |  |   |
|       |             |       |                                  | 2     |   |                                      |  |   |   |  |   |
|       |             |       |                                  | 3     |   |                                      |  |   |   |  |   |
|       |             |       |                                  | 4     |   |                                      |  |   |   |  |   |
|       |             |       |                                  | 5     |   |                                      |  |   |   |  |   |
|       |             |       |                                  | 0     | other   |                                      |  |   |   |  |   |
|       |             | 5     | Impact-modified                  | 1     |   | ...                                  | 1.06 to 1.12                                     | 52  | 1700  | 9.0  | 50  |
|       |             |       |                                  | 2     | recycled  | ...                                  | 1.06 to 1.12                                     | 50  | 1600  | 8.0  | 50  |
|       |             |       |                                  | G15   | 15 % glass  | ...                                  | 1.15 to 1.23                                     | 85  | 3000  | 6.0  | 210   |
|       |             |       |                                  | G35   | 35 % glass  | ...                                  | 1.31 to 1.41                                     | 110   | 5500  | 6.0  | 225   |
|       |             |       |                                  | 0     | other   |                                      |  |   |   |  |   |
|       |             | 6     | Impact-modified, heat-stabilized | 1     |   | ...                                  | 1.08 to 1.12                                     | 52  | 1700  | 9.0  | 50  |
|       |             |       |                                  | 2     | recycled  | ...                                  | 1.08 to 1.12                                     | 50  | 1600  | 8.0  | 50  |
|       |             |       |                                  | G15   | 15 % glass  | ...                                  | 1.15 to 1.23                                     | 85  | 3000  | 6.0  | 210   |
|       |             |       |                                  | G35   | 35 % glass  | ...                                  | 1.31 to 1.41                                     | 110   | 5500  | 6.0  | 225   |
|       |             |       |                                  | M40   | 40 % mineral  | ...                                  | 1.45 to 1.55                                     | 75  | 4500  | 4.0  | ...   |
|       |             |       |                                  | R35   | 35 % filler   | ...                                  | 1.38 to 1.48                                     | 80  | 5500  | 3.0  | 200   |
|       |             |       |                                  | 0     | other   |                                      |  |   |   |  |   |
|       |             | 7     | Toughened                        | 1     |   | ...                                  | 1.06 to 1.10                                     | 42  | 1500  | 40   | 45  |
|       |             |       |                                  | 2     | recycled  | ...                                  | 1.05 to 1.11                                     | 40  | 1300  | 35   | 45  |
|       |             |       |                                  | G15   | 15 % glass  | ...                                  | 1.15 to 1.23                                     | 70  | 2800  | 9.0  | 180   |
|       |             |       |                                  | G35   | 35 % glass  | ...                                  | 1.28 to 1.38                                     | 110   | 5500  | 11   | 220   |
|       |             |       |                                  | 0     | other   |                                      |  |   |   |  |   |
|       |             | 8     | Toughened, heat-stabilized       | 1     |   | ...                                  | 1.06 to 1.10                                     | 42  | 1500  | 40   | 45  |
|       |             |       |                                  | 2     | recycled  | ...                                  | 1.05 to 1.11                                     | 40  | 1300  | 35   | 45  |
|       |             |       |                                  | G15   | 15 % glass  | ...                                  | 1.15 to 1.23                                     | 70  | 2800  | 9.0  | 180   |
|       |             |       |                                  | G35   | 35 % glass  | ...                                  | 1.28 to 1.38                                     | 110   | 5500  | 11   | 220   |
|       |             |       |                                  | G45   | 45 % glass  | ...                                  | 1.39 to 1.49                                     | 130   | 8000  | 10   | 230   |
|       |             |       |                                  | M35   | 35 % mineral  | ...                                  | 1.37 to 1.47                                     | 70  | 3800  | 6.0  | ...   |
|       |             |       |                                  | 0     | other   |                                      |  |   |   |  |   |
|       |             | 9     | Weather-stabilized <sup>G</sup>  | 1     |   | 135                                  | 1.13 to 1.17                                     | 80  | 2400  | 2.5  | 60  |
|       |             |       |                                  | 2     | recycled  | 115                                  | 1.13 to 1.17                                     | 65  | 2200  | 2.0  | 60  |
|       |             |       |                                  | 0     | other   |                                      |  |   |   |  |   |
|       |             | 0     | Other                            | 0     | other   |                                      |  |   |   |  |   |
| 02    | PA6         | 1     | General-purpose                  | 1     |   | 100                                  | 1.12 to 1.14                                     | 75  | 2400  | 4.0  | 50  |
|       |             |       |                                  | 2     |   | 135                                  | 1.12 to 1.14                                     | 70  | 2200  | 3.0  | 50  |
|       |             |       |                                  | 3     |   | 150                                  | 1.12 to 1.15                                     | 70  | 2200  | 3.0  | 50  |
|       |             |       |                                  | 4     |   | 200                                  | 1.12 to 1.15                                     | 70  | 2200  | 3.0  | 50  |
|       |             |       |                                  | G15   | 15 % glass  | ...                                  | 1.20 to 1.28                                     | 110   | 4200  | 4.0  | 170   |
|       |             |       |                                  | G25   | 25 % glass  | ...                                  | 1.28 to 1.36                                     | 135   | 5000  | 6.5  | 180   |
|       |             |       |                                  | G30   | 30 % glass  | ...                                  | 1.32 to 1.40                                     | 150   | 7000  | 7.5  | 180   |
|       |             |       |                                  | G35   | 35 % glass  | ...                                  | 1.38 to 1.44                                     | 155   | 7500  | 8.0  | 180   |
|       |             |       |                                  | G40   | 40 % glass  | ...                                  | 1.41 to 1.48                                     | 175   | 10 000  | 9.0  | 190   |
|       |             |       |                                  | M30   | 30 % mineral  | ...                                  | 1.30 to 1.40                                     | 70  | 3200  | 2.4  | 50  |
|       |             |       |                                  | M40   | 40 % mineral  | ...                                  | 1.44 to 1.52                                     | 75  | 4500  | 4.0  | 70  |

**TABLE PA Requirements for Polyamides Dry-as-Molded<sup>A,B</sup>**

| Group           | Description | Class | Description                        | Grade | Description <sup>C</sup> | Viscosity Number, ISO 307, min, mL/g | Density, <sup>D</sup> ISO 1183 g/cm <sup>3</sup> | Tensile Strength, ISO 527-1 and ISO 527-2, MPa, min | Tensile Modulus, <sup>E</sup> ISO 527-1 and ISO 527-2, MPa, min | Charpy Impact Resistance, ISO 179/1eA, kJ/m <sup>2</sup> , min | Deflection Temperature, <sup>F</sup> ISO 75-1 and ISO 75-2, at 1.8 MPa, °C, min |
|-----------------|-------------|-------|------------------------------------|-------|--------------------------|--------------------------------------|--|---|---|--|---|
|                 |             |       |                                    | R40   | 40 % glass/mineral other |                                      | 1.42 to 1.50                                     | 100   | 6000  | 3.0  | 180   |
|                 |             | 2     | Heat-stabilized                    | 0     |                          |                                      |  |   |   |  |   |
|                 |             |       |                                    | 1     |                          | 100                                  | 1.12 to 1.14                                     | 75  | 2400  | 4.0  | 50  |
|                 |             |       |                                    | 2     |                          | 135                                  | 1.12 to 1.14                                     | 70  | 2200  | 3.0  | 50  |
|                 |             |       |                                    | 3     |                          | 150                                  | 1.12 to 1.15                                     | 70  | 2200  | 3.0  | 50  |
|                 |             |       |                                    | 4     |                          | 200                                  | 1.12 to 1.15                                     | 70  | 2200  | 3.0  | 50  |
|                 |             |       |                                    | 5     | recycled                 | 135                                  | 1.12 to 1.14                                     | 70  | 2000  | 3.0  | 50  |
|                 |             |       |                                    | G5    | 5 % glass                |                                      | 1.16 to 1.22                                     | 85  | 2500  | 2.5  | 110   |
|                 |             |       |                                    | G15   | 15 % glass               |                                      | 1.20 to 1.28                                     | 110   | 4200  | 4.0  | 180   |
|                 |             |       |                                    | G25   | 25 % glass               |                                      | 1.28 to 1.36                                     | 135   | 5000  | 6.5  | 190   |
|                 |             |       |                                    | G30   | 30 % glass               |                                      | 1.32 to 1.40                                     | 150   | 7000  | 7.5  | 190   |
|                 |             |       |                                    | G35   | 35 % glass               |                                      | 1.38 to 1.44                                     | 155   | 7500  | 8.0  | 190   |
|                 |             |       |                                    | G40   | 40 % glass               |                                      | 1.41 to 1.48                                     | 175   | 10 000  | 9.0  | 190   |
|                 |             |       |                                    | G45   | 45 % glass               |                                      | 1.46 to 1.54                                     | 175   | 10 000  | 10   | 190   |
|                 |             |       |                                    | G50   | 50 % glass               |                                      | 1.52 to 1.60                                     | 175   | 10 000  | 10   | 190   |
|                 |             |       |                                    | G65   | 65 % glass               |                                      | 1.70 to 1.78                                     | 175   | 13 000  | 10   | 200   |
|                 |             |       |                                    | M30   | 30 % mineral             |                                      | 1.30 to 1.40                                     | 70  | 3200  | 2.4  | 50  |
|                 |             |       |                                    | M35   | 35 % mineral             |                                      | 1.39 to 1.47                                     | 70  | 3500  | 3.0  | 60  |
|                 |             |       |                                    | M40   | 40 % mineral             |                                      | 1.44 to 1.52                                     | 75  | 4500  | 4.0  | 70  |
|                 |             |       |                                    | R20   | 20 % glass/mineral       |                                      | 1.25 to 1.33                                     | 80  | 3200  | 2.5  | 120   |
|                 |             |       |                                    | R40   | 40 % glass/mineral other |                                      | 1.42 to 1.50                                     | 100   | 6000  | 3.0  | 180   |
|                 |             | 3     | Nucleated and lubricated           | 0     |                          |                                      |  |   |   |  |   |
|                 |             |       |                                    | 1     |                          | 100                                  | 1.12 to 1.14                                     | 70  | 2300  | 2.5  | 50  |
|                 |             |       |                                    | 2     |                          | 135                                  | 1.12 to 1.14                                     | 70  | 2300  | 2.5  | 50  |
|                 |             |       |                                    | 3     |                          | 150                                  | 1.12 to 1.15                                     | 75  | 2300  | 2.5  | 50  |
|                 |             |       |                                    | 4     |                          | 200                                  | 1.12 to 1.15                                     | 80  | 2300  | 2.5  | 50  |
|                 |             |       |                                    | 0     | other                    |                                      |  |   |   |  |   |
|                 |             | 4     | Nucleated and heat-stabilized      | 1     |                          | 100                                  | 1.12 to 1.14                                     | 70  | 2300  | 2.5  | 50  |
|                 |             |       |                                    | 2     |                          | 135                                  | 1.12 to 1.14                                     | 70  | 2300  | 2.5  | 50  |
|                 |             |       |                                    | 3     |                          | 150                                  | 1.12 to 1.15                                     | 75  | 2300  | 2.5  | 50  |
|                 |             |       |                                    | 4     |                          | 200                                  | 1.12 to 1.15                                     | 80  | 2300  | 2.5  | 50  |
|                 |             |       |                                    | 5     | recycled                 | 135                                  | 1.12 to 1.14                                     | 70  | 2100  | 2.5  | 50  |
|                 |             |       |                                    | 0     | other                    |                                      |  |   |   |  |   |
|                 |             | 5     | Impact-modified                    | 1     |                          |                                      | 1.05 to 1.12                                     | 45  | 1700  | 30   | 45  |
|                 |             |       |                                    | 2     |                          |                                      | 1.05 to 1.18                                     | 55  | 2000  | 6.0  | 45  |
|                 |             |       |                                    | 3     |                          |                                      | 1.05 to 1.18                                     | 40  | 1000  | 6.0  | 35  |
|                 |             |       |                                    | G15   | 15 % glass               |                                      | 1.15 to 1.24                                     | 75  | 3300  | 9.0  | 130   |
|                 |             |       |                                    | G30   | 30 % glass               |                                      | 1.30 to 1.40                                     | 135   | 6500  | 15   | 180   |
|                 |             |       |                                    | G35   | 35 % glass               |                                      | 1.32 to 1.42                                     | 135   | 6800  | 15   | 190   |
|                 |             |       |                                    | G40   | 40 % glass               |                                      | 1.39 to 1.47                                     | 135   | 8000  | 10   | 200   |
|                 |             |       |                                    | 0     | other                    |                                      |  |   |   |  |   |
|                 |             | 6     | Impact-modified, heat-stabilized   | 1     |                          |                                      | 1.05 to 1.12                                     | 45  | 1700  | 30   | 45  |
|                 |             |       |                                    | 2     |                          |                                      | 1.05 to 1.18                                     | 55  | 2000  | 6.0  | 45  |
|                 |             |       |                                    | 3     |                          |                                      | 1.05 to 1.18                                     | 40  | 1000  | 6.0  | 35  |
|                 |             |       |                                    | 4     |                          |                                      | 1.05 to 1.18                                     | 25  | 1000  | 30   | 30  |
|                 |             |       |                                    | G15   | 15 % glass               |                                      | 1.15 to 1.24                                     | 75  | 3300  | 9.0  | 130   |
|                 |             |       |                                    | G30   | 30 % glass               |                                      | 1.30 to 1.40                                     | 135   | 6500  | 15   | 180   |
|                 |             |       |                                    | G35   | 35 % glass               |                                      | 1.32 to 1.42                                     | 135   | 6800  | 10   | 190   |
|                 |             |       |                                    | G40   | 40 % glass               |                                      | 1.39 to 1.47                                     | 135   | 8000  | 10   | 200   |
|                 |             |       |                                    | M35   | 35 % mineral             |                                      | 1.35 to 1.45                                     | 65  | 3200  | 3.0  | 50  |
|                 |             |       |                                    | M40   | 40 % mineral             |                                      | 1.39 to 1.47                                     | 65  | 3200  | 3.0  | 50  |
|                 |             |       |                                    | 0     | other                    |                                      |  |   |   |  |   |
|                 |             | 7     | Flexural-modified, heat-stabilized | 1     | injection molding        |                                      | 1.05 to 1.16                                     | 55  | 2375 max  | 10   | 45  |
|                 |             |       |                                    | 2     | extrusion blends         |                                      | 1.05 to 1.16                                     | 30  | 2000 max  | 7.0  | 25  |
|                 |             |       |                                    | 3     | blends                   |                                      | 1.05 to 1.10                                     | 35  | 1700 max  | 4.5  | 35  |
|                 |             |       |                                    | 0     | other                    |                                      |  |   |   |  |   |
|                 |             |       |                                    | 0     | other                    |                                      |  |   |   |  |   |
| 03 <sup>H</sup> | PA11        | 1     | General purpose                    | 1     |                          | 115 to 140                           | 1.01 to 1.06                                     | 35  | 900   | 4.0  | 36  |
|                 |             |       |                                    | 2     |                          | 160 to 190                           | 1.01 to 1.06                                     | 35  | 900   | 6.0  | 36  |
|                 |             |       |                                    | 0     | other                    |                                      |  |   |   |  |   |

**TABLE PA Requirements for Polyamides Dry-as-Molded<sup>A,B</sup>**

| Group | Description                  | Class | Description                  | Grade | Description <sup>C</sup> | Viscosity Number, ISO 307, min, mL/g | Density, <sup>D</sup> ISO 1183 g/cm <sup>3</sup> | Tensile Strength, ISO 527-1 and ISO 527-2, MPa, min | Tensile Modulus, <sup>E</sup> ISO 527-1 and ISO 527-2, MPa, min | Charpy Impact Resistance, ISO 179/1eA, kJ/m <sup>2</sup> , min | Deflection Temperature, <sup>F</sup> ISO 75-1 and ISO 75-2, at 1.8 MPa, °C, min |     |     |
|-------|------------------------------|-------|------------------------------|-------|--------------------------|--------------------------------------|--|---|---|--|---|-----|-----|
| 04    | PA12                         | 2     | Heat-stabilized              | 1     |                          | 115 to 140                           | 1.01 to 1.06                                     | 35  | 900   | 4.0  | 36  |     |     |
|       |                              |       |                              | 2     |                          | 160 to 190                           | 1.01 to 1.06                                     | 35  | 900   | 6.0  | 36  |     |     |
|       |                              | 3     | Plasticized                  | 0     | other                    | 1                                    | black  | 160 to 190  | 1.01 to 1.06  | 35   | 900   | 4.0 | 36  |
|       |                              |       |                              |       |                          | 2                                    |  | 210 to 255  | 1.01 to 1.06  | 35   | 900   | 6.0 | 36  |
|       |                              |       |                              |       |                          | 3                                    |  | 170 to 200  | 1.01 to 1.06  | 30   | 370   | 25  | 36  |
|       |                              |       |                              |       |                          | 4                                    |  | 180 to 240  | 1.01 to 1.06  | 35   | 500   | 25  | 36  |
|       |                              | 4     | Plasticized, Heat Stabilized | 0     | other                    | 1                                    |  | 170 to 200  | 1.01 to 1.06  | 35   | 400   | 25  | 36  |
|       |                              |       |                              |       |                          | 2                                    |  | 115 to 140  | 1.01 to 1.06  | 30   | 350   | 25  | 36  |
|       |                              |       |                              |       |                          | 3                                    | black  | 175 to 240  | 1.01 to 1.06  | 35   | 400   | 25  | 36  |
|       |                              |       |                              |       |                          | 4                                    |  | 170 to 190  | 1.01 to 1.06  | 30   | 370   | 25  | 36  |
|       |                              |       |                              |       |                          | 5                                    |  | 200 to 230  | 1.01 to 1.06  | 35   | 370   | 25  | 36  |
|       |                              |       |                              |       |                          | 6                                    |  | 160 to 240  | 1.01 to 1.06  | 35   | 340   | 25  | 36  |
|       |                              |       |                              |       |                          | 7                                    | black  | 100 to 210  | 1.00 to 1.06  | 30   | 800   | 2.5 | 35  |
|       |                              |       |                              |       |                          | 0                                    | other  | 100 to 210  | 1.00 to 1.06  | 35   | 1000  | 2.5 | 35  |
|       |                              |       |                              |       |                          | 1                                    | General purpose                                  | 210 to 270  | 1.00 to 1.06  | 35   | 1000  | 2.5 | 35  |
|       |                              |       |                              |       |                          | 2                                    |  | 271 to 340  | 1.00 to 1.06  | 35   | 1000  | 2.5 | 35  |
|       |                              | 2     | Heat-stabilized              | 0     | other                    | 1                                    |  | 100 to 150  | 1.00 to 1.06  | 35   | 800   | 2.5 | 35  |
|       |                              |       |                              |       |                          | 2                                    |  | 151 to 210  | 1.00 to 1.06  | 35   | 800   | 2.5 | 35  |
|       |                              |       |                              |       |                          | 3                                    |  | 211 to 280  | 1.00 to 1.06  | 35   | 1000  | 2.5 | 35  |
|       |                              |       |                              |       |                          | G15                                  | 15 % glass                                       | 1.10 to 1.20  | 75  | 3000   | 10  | 160 |     |
|       |                              |       |                              |       |                          | G25                                  | 25 % glass                                       | 1.10 to 1.25  | 90  | 3000   | 15  | 160 |     |
|       |                              |       |                              |       |                          | G30                                  | 30 % glass                                       | 1.15 to 1.30  | 95  | 4000   | 15  | 160 |     |
|       |                              |       |                              |       |                          | G40                                  | 40 % glass                                       | 1.30 to 1.45  | 100   | 4500   | 15  | 160 |     |
|       |                              |       |                              |       |                          | R30                                  | 30 % filler                                      | 1.18 to 1.32  | 55  | 3500   | 5.0   | 100 |     |
|       |                              |       |                              |       |                          | 0                                    | other  |   |   |  |   |     |     |
|       |                              |       |                              |       |                          | 3                                    | Nucleated  | 1   |   | 100 to 180   | 1.00 to 1.06  | 35  | 800 |
| 4     | Plasticized                  | 0     | other                        | 1     |                          | 181 to 250                           | 1.00 to 1.06                                     | 35  | 800   | 1.0  | 35  |     |     |
|       |                              |       |                              | 2     |                          | 100 to 280                           | 1.00 to 1.06                                     | 30  | 300 to 550  | 15   |   |     |     |
| 5     | Plasticized, heat-stabilized | 0     | other                        | 1     |                          | 100 to 280                           | 1.00 to 1.06                                     | 30  | 450 to 750  | 10   |   |     |     |
|       |                              |       |                              | 2     |                          | 100 to 280                           | 1.00 to 1.06                                     | 20  | 200 to 350  | 20   |   |     |     |
|       |                              |       |                              | 3     |                          | 100 to 280                           | 1.00 to 1.06                                     | 30  | 300 to 550  | 15   |   |     |     |
|       |                              |       |                              | 4     |                          | 100 to 280                           | 1.00 to 1.06                                     | 30  | 450 to 750  | 10   |   |     |     |
|       |                              |       |                              | 5     |                          | 100 to 280                           | 1.00 to 1.06                                     | 35  | 550 to 950  | 5.0  |   |     |     |
| 0     | Other                        | 0     | other                        | 0     | other                    |                                      |  |   |   |  |   |     |     |