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Standard Specification for Polypropylene Injection and Extrusion Materials Using ISO Protocol and Methodology[1]

This standard is issued under the fixed designation D 5857; 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 (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

This material specification is intended to provide a call out system for polypropylene utilizing specimen preparation procedures and test method based on ISO standards.

This specification is not intended for the determination of the suitability of performance of materials in the final application. Selection of these materials is to be made by personnel with expertise in the plastics field in which the environment, inherent properties of the materials, performance of the parts, part design, manufacturing process, and economics are considered.

1. Scope*

1.1 This specification covers polypropylene materials suitable for injection molding and extrusion. Polymers consist of polypropylene homopolymers, polypropylene copolymers, and polypropylene-elastomer compounds produced with or without the addition of impact modifiers (ethylene-propylene rubber, polyisobutylene rubber, and butyl rubber, and so forth), colorants, stabilizers, lubricants, fillers, or reinforcements.

1.2 This specification allows for the use of those polypropylene materials that can be recycled, reconstituted, and reground, provided that the following conditions are met:

1.2.1 The requirements as stated in this specification and other ISO guidelines pertaining to these types of materials are met, and

1.2.2 The material has not been modified in any way to alter its conformance to food contact regulations or similar requirements.

1.3 The proportions of recycled, reconstituted, and regrind material used, as well as the nature and the amount of any contaminant, cannot be practically covered in this specification. It is the responsibility of the supplier and buyer of recycled, reconstituted, and regrind materials to ensure compliance.

NOTE 1—The properties included in this specification are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specific applications. These will be designated by using the suffixes given in Section 5.

1.4 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 and those in Classification System D 4000.

1.5 This classification system and specification are intended to provide a means of calling out polypropylene 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 standard.

1.6 The values stated in SI units are to be regarded as the standard.

1.7 The following precautionary caveat pertains only to the test methods portion, Section 13, of this specification: *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 limitations prior to use.*

NOTE 2—This specification is similar to both ISO 1873-1 and ISO 1873-2, but to different degrees. This specification resembles ISO 1873-1 in title only. The content is significantly different. This specification and ISO 1873-2 differ in approach or detail; data obtained using either are technically equivalent.

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[1] This specification 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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***A Summary of Changes section appears at the end of this standard.**

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 618 Practice for Conditioning Plastics for Testing
D 883 Terminology Relating to Plastics
D 1600 Terminology for Abbreviated Terms Relating to Plastics
D 1999 Guide for the Selection of Specimens and Test Parameters from ISO/IEC Standards
D 3892 Practice for Packaging/Packing of Plastics
D 4000 Classification System for Specifying Plastic Materials
D 5033 Guide for the Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

2.2 *ISO Standards:*[3]

ISO 62 Plastics—Determination of Water Absorption
ISO 75-1 Plastics—Determination of Temperature of Deflection Under Load, Part 1: General Test Method
ISO 75-2 Plastics—Determination of Temperature of Deflection Under Load, Part 2: Plastics and Ebonite
ISO 105 Textiles—Tests for Color Fastness
ISO 178 Plastics—Determination of Flexural Properties of Rigid Plastics
ISO 179 Plastics—Determination of Charpy Impact Strength of Rigid Materials
ISO 180 Plastics—Determination of Izod Impact Strength of Rigid Materials
ISO 293 Plastics—Compression Moulding Test Specimens of Thermoplastic Material
ISO 294 Plastics—Injection Moulding of Test Specimens of Thermoplastic Material
ISO 306 Plastics—Thermoplastic Materials—Determination of Vicat Softening Temperature
ISO 527-1 Plastics—Determination of Tensile Properties, Part 1: General Principles
ISO 527-2 Plastics—Determination of Tensile Properties, Part 2: Test Conditions for Molding and Extrusion Plastics
ISO 537 Plastics—Testing with Torsional Pendulum
ISO 604 Plastics—Determination of Compressive Properties
ISO 868 Plastics and Ebonite—Determination of Indention Hardness by Mans of a Durometer (Shore Hardness)
ISO 877 Plastics—Methods of Exposure to direct Weathering, to Weathering Using Glass-Filtered Daylight, and to Intensified Weathering by Daylight Using Fresnel Mirrors
ISO 899 Plastics—Determination of Tensile Creep
ISO 974 Plastics—Determination of the Brittleness Temperature by Impact
ISO 1133 Plastics—Determination of Melt Flow Rate of Thermoplastics
ISO 1183A Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics
ISO 1191 Plastics—Polyethylene and Polypropylenes in Dilute Solutions—Determination of Viscosity Number and of Limiting Viscosity Number
ISO 1628-3 Plastics—Determination of Viscosity Number and Limiting Viscosity Number, Part 3: Polyethylene and Polypropylene Resins
ISO 1873-1 Plastics—Propylene and Propylene-Copolymer Thermoplastics, Part 1: Designation
ISO 1873-2 Plastics—Polypropylene (PP) and Propylene-Copolymer Thermoplastics, Part 2: Preparation of Test Specimens and Determination of Properties
ISO 2039-1 Plastics—Determination of Hardness, Part 1: Ball Indention Method
ISO 2039-2 Plastics—Determination of Hardness, Part 2: Rockwell Hardness
ISO 2818 Plastics—Preparation of Test Specimens by Machining
ISO 3167 Plastics—Preparation and Use of Multipurpose Test Specimens
ISO 3451-1 Plastics—Determination of Ash, Part 1: General Methods
ISO 3795 Road Vehicles, and Tractors and Machinery for Agriculture and Forestry—Determination of Burning Behavior of Interior Materials
ISO 4577 Plastics—Polypropylene and Propylene-Copolymers—Determination of Thermal Oxidative Stability in Air—Oven Method
ISO 4582 Plastics—Determination of Changes in Colour and Variations in Properties after Exposure to Daylight Under Glass, Natural Weathering or Artificial Light
ISO 4589 Plastics—Determination of Flammability by Oxygen Index
ISO 4892–1 Methods of Exposure to Laboratory Light Sources, Part 1: General Guidance
ISO 4892-2 Plastics—Methods of Exposure to Laboratory Light, Part 2: Xenon Arc Exposure
ISO 4892-3 Plastics—Methods of Exposure to Laboratory Light, Part 3: Fluorescent UV Lamps

[2] 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.

[3] Available ~~through~~ from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

ISO 6427 Plastics—Determination of Matter Extractable by Organic Solvents (Conventional Methods)
ISO 6602 Plastics—Determination of Flexural Creep by Three-Point Loading
ISO 6603-1 Plastics—Determination of Multiaxial Impact Behavior of Rigid Plastics, Part 1: Falling Dart Method
ISO 6603-2 Plastics—Determination of Multiaxial Impact Behavior of Rigid Plastics, Part 2: Instrumented Puncture Test
ISO 8256 Plastics—Determination of Tensile Impact Properties
ISO 9113 Plastics—Polypropylene (PP) and Propylene-Copolymer Thermoplastics—Determination of Isotactic Index
ISO 10350 Plastics—Acquisition and Presentation of Comparable Single-Point Data
ISO 11357–3 Plastics—Differential Scanning Calorimetry (DSC), Part 3: Determination of Temperature and Enthalpy of Melting and Crystallization
ISO 11403-1 Plastics—Acquisition and Presentation of Comparable Multi-Point Data, Part 1: Mechanical Properties
ISO 11403–2 Plastics- Acquisition and Presentation of Comparable Multi-point Data- Part 3; Environmental Influences on Properties

2.3 *IEC Standards:*[3]

IEC 93 Recommended Methods of Test for Volume and Surface Resistivities of Electrical Insulation Materials
IEC 112 Recommended Method for Determining the Comparative Tracking Index of Solid Insulation Materials Under Moist Conditions
IEC 243-1 Recommended Methods of Test for Electric Strength of Solid Insulating Materials at Power Frequencies
IEC 250 Recommended Methods for the Determination of the Permittivity and Dielectric Dissipation Factor of Electrical Insulation Materials at Power, Audio, and Radio Frequencies Including Metre Wavelengths
IEC 296 Specification for Unused Mineral Insulating Oils for Transformers and Switchgear
IEC 60695–11–10 Fire Hazard Testing-Part 11–10: Test Flames-50 W Horizontal and Vertical Test Methods

2.4 *SAE Standards:*[4]

SAE J1545 Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Color Trim
SAE J1767 Instrumental Color Difference Measurement for Colorfastness of Automotive Interior Trim Materials
SAE J1885 Accelerated Exposure of Automotive Interior Materials Using Controlled Irradiance Water Cooled Xenon-Arc Apparatus
SAE J1960 Accelerated Exposure of Automotive Exterior Materials Using Controlled Irradiance Water Cooled Xenon-Arc Apparatus
SAE J1976 Outdoor Weathering of Exterior Materials

3. Terminology

3.1 *Definitions*— Definitions of terms and abbreviations applying to this specification appear in Terminologies D 883 and D 1600 and Guide D 5033.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *back pressure, n*—the constant pressure that is applied to the end of the screw while the screw is rotating and retracting to prepare for the next injection.

3.2.2 *cooling time, n*—the time during which the material is in the closed mold with no pressure applied.

3.2.3 *cycle time, n*—the time required to complete a full injection molding cycle, including injection time, cooling time, and mold open time.

3.2.4 *injection pressure, n*—the constant pressure that is applied to the end of the screw, causing the melted material to fill the mold.

3.2.4.1 *Discussion*—The injection pressure along with the injection speed determines the volumetric fill rate of the mold.

3.2.5 *injection time, n*—the time during which a constant specified pressure is applied to the melted material.

3.2.6 *injection velocity, n*—the average velocity of the melt as it passes through the cross-sectional area of a cavity of a single- or multi-cavity mold at the position that forms the critical portion of the test specimen.

3.2.7 *melt temperature, n*—the temperature of the material as it is being injected into the mold, measured by a pyrometer.

3.2.8 *mold open time, n*—the time beginning when the mold is opened and ending when the mold is closed.

3.2.9 *mold temperature, n*—the temperature of the mold during the molding cycle, measured in all mold cavities and on both platens.

3.2.10 *polypropylene (PP)*—a propylene plastic prepared by the polymerization of propylene or propylene with other alpha olefins (see also *PP-H, PP-R, and PP-B*).

3.2.11 *polypropylene heterophasic copolymers (PP-B)*—a propylene plastic consisting of two or more separate phases. These include PP+EPR, PP+EPDM, PP+IIR, PP+BR, and so forth.

3.2.11.1 *Discussion*—The phases consist of a polypropylene homopolymer (PP-H) or a polypropylene random copolymer (PP-R) matrix containing a dispersed olefinic elastomer having no other functional group, added in situ or physically blended into the polypropylene matrix.

[4] Available from Society ~~for~~ of Automotive Engineers (SAE), 400 Commonwealth ~~Drive,~~ Dr., Warrendale, PA 15096-0001.

3.2.12 *polypropylene homopolymer (PP-H)*—a propylene plastic prepared by the polymerization of propylene only.

3.2.13 *polypropylene random copolymer (PP-R)*— a propylene plastic containing another olefinic monomer (or monomers) having no functional group other than the olefinic group copolymerized with propylene.

3.2.13.1 *Discussion*—Polypropylene random copolymers containing more than one additional monomer are often called terpolymers.

4. Classification

4.1 Unreinforced polypropylene materials are classified into groups in accordance with basic composition. These groups are subdivided into classes and grades, as shown in Table PP.

NOTE 3—An example of this classification system is as follows. The designation PP0113 would indicate: PP = polypropylene, as found in Terminology D 1600, 01 (group) = homopolymer, 1 (class) = general purpose, and 3 (grade) = with requirements given in Table PP.

4.1.1 The values in Table PP are based on testing that was conducted 40 to 96 h after molding. Testing was conducted in a standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity

4.1.2 To facilitate the incorporation of future or special materials not covered by Table PP, the other/unspecified category (0) for group, class, and grade is indicated on the table with the basic properties to be obtained from Table B, as it applies.

4.1.3 Specific requirements for unreinforced, pigmented, filled (when added for reduced costs), or lubricated polypropylene materials not covered by Table PP shall be shown by a six-character designation. The designation shall consist of the letter A and the five digits comprising the cell numbers for the property requirements in the order in which they appear in Table B.

NOTE 4—The mechanical properties of polypropylene materials with pigments or colorants can differ from the mechanical properties of natural material, depending on the choice and the concentration.

NOTE 5—An example of a special material using this classification system is as follows. The designation PP0310B55143 would indicate the following with the material requirements from Table B:

PP0310	=	Low impact polypropylene copolymer,
B	=	Table B property requirements,
5	=	25 MPa tensile strength, min,
5	=	1000 MPa flexural modulus (1 % secant, min),
1	=	1.6 kJ/m^2 Charpy impact, min,
4	=	80°C deflection temperature, min, and
3	=	>1.0 to 3.0 nominal flow rate.

4.1.4 Table PP was developed using data generated from natural color materials. However, Table PP can be used to specify black or other color polypropylenes if the compounded materials meet the requirements found in the table.

4.2 Reinforced versions of the polypropylene materials are classified in accordance with Tables PP, A, C, G, and T, Tables C, G, and T are used when the filler or reinforcement is known to be either calcium carbonate, talc, or glass. Table A is used when the material cannot be classified by Tables PP, C, G, or T. These tables specify the properties after the addition of reinforcements, or fillers for mechanical properties improvement, at the nominal level indicated (see 4.2.1).

4.2.1 *Fillers and Reinforcing Materials* —A symbol (single letter) shall be used for the major reinforcement or combinations thereof (see Table 1), along with two numbers that indicate the nominal percentage of addition by mass (see Table 2).

NOTE 6—This part of the system uses the type and percentage of additive to designate modification of the base material. To facilitate this designation, the type and percentage of additive may be shown on the supplier's technical data sheet, unless it is proprietary in nature. If necessary, additional requirements shall be indicated by the use of the suffix part of the system, as given in Section 5.

4.2.2 Specific requirements for reinforced, or filled polypropylene materials shall be shown by a six-character designation. The designation shall consist of the letter A, C, G, or T and the five digits comprising the cell numbers for the property requirements in the order in which they appear in Tables A, C, G, or T.

4.2.2.1 Although the values listed are necessary to include the range of properties available in existing materials, they should not be interpreted as implying that every possible combination of the properties exists or can be obtained.

4.2.3 When the grade of the basic materials is not known or is not important, the use of 0 grade classification shall be used for reinforced materials in this system (see Note 7).

NOTE 7—An example of this classification system for a reinforced polypropylene material is as follows. The designation PP0110T20T6150 would indicate the following, with the material requirements for Table A:

PP0110	=	general purpose polypropylene homopolymer from Table PP,
T20	=	Talc filled, 20 %,
T	=	Table T property requirements,
6	=	30 MPa tensile strength, min,
5	=	2100 MPa flexural modulus, min,
1	=	2.0 kJ/m^2, Charpy Impact, min,

5 = 56°C deflection temperature, min, and
0 = unspecified

If no properties are specified, the designation would be PP0110T20T00000.

5. Suffixes

5.1 When additional requirements are needed for the materials covered in this specification that are not covered in Tables PP, A, B, C, G, or T those requirements shall be designated through the use of suffixes. The primary suffix list can be found in Classification System D 4000, Section 7, Suffix Requirements. Other suffixes that pertain only to the material requirements in this specification are listed below. In general, the suffix letter indicates the requirement needed; the first number (digit) indicates the test condition, and the second number (digit) indicates the specimen requirement.

NOTE 8—Suffixes from Classification System D 4000 contain two letters followed by three numbers, while suffixes from Specification D 5857 contain a single letter followed by two or three numbers. An example would be weatherability. A designation of WA510 would indicate that it is a Classification System D 4000 suffix.

Suffixes:

E = electrical requirements as designated by the following digits:

First Digit

0 = to be specified.
1 = specimens preconditioned 40 h at 23°C and 50 % relative humidity, then 14 days in distilled water at 23 ± 1°C.
2 = specimens preconditioned 88 h at 23°C and 50 % relative humidity, then 14 days in distilled water at 23 ± 1°C.

Second Digit

0 = to be specified.
1 = insulation resistance, dielectric constant, and dissipation factor meet property limits as shown below. These are electrical limits usually applied to unreinforced polypropylene when control of their electrical properties is required. Specimen size and thickness shall be in accordance with Guide D 1999.

Electrical Properties:		
Dielectric constant, max	IEC 250	2.3
Dissipation factor, max	IEC 250	0.0005
Volume resistance, min, ohm-cm	IEC 93	1×10^{15}
Water immersion stability	IEC 250	[A]

[A] Shall meet the dielectric constant and dissipation factor requirements.

W = weatherability requirements as designated by the following digits:

First Digit

1 = specimens exposed in a xenon arc test apparatus to conditions specified in SAE J1960 for exterior applications.
2 = specimens exposed in a xenon arc test apparatus to conditions specified in SAE J1885 for interior applications.
3 = Natural weathering in accordance with ISO 877, for interior applications.
4 = Natural weathering in accordance with ISO 877 for exterior applications.
5 = Specimens exposed in a xenon arc test apparatus to conditions specified in ISO 4892-2 for interior applications.
6 = Specimens exposed in a xenon arc test apparatus to conditions specified in ISO 4892-2 for exterior applications.
7 = Specimens exposed in a fluorescent UV/condensation test apparatus to conditions specified in ISO 4892-3.
8 = Natural weathering in accordance with SAE J1976 for exterior applications.

Second Digit

0 = to be specified.
1 = 200 h exposure.
2 = 500 h exposure.
3 = 1000 h exposure.
4 = 2000 h exposure.
5 = 1240.8 kJ/(m^2.nm) at 340 nm.
6 = 2500 kJ/(m^2 .nm) at 340 nm.
7 = 225.6 kJ/(m^2.nm) at 340 nm.
8 = 601.6 kJ/(m^2 .nm) at 340 nm.

NOTE 9—Conversion from hours to kilojoules (kJ) varies with irradiance and the light/dark cycle. Conversion to kJ from actual light hours is based on the following relation:

$$kJ = Irradiance\ in\ Watts \times 3.6\ kJ/h \times hours\ of\ light$$

Thus, at an irradiance level of 0.55 W/(m^2.nm) at 340 nm, the multiplication factor for converting light hours to kJ is 1.98 (0.55 × 3.6). Therefore, 100 light hours is equivalent to 396 kJ/(m^2 .nm) at 340 nm at this irradiance level.

Third Digit

0 = to be specified.
1 = the exposed specimens shall not exhibit surface changes (such as dulling and chalking) or deep-seated changes (such as checking, crazing, warping, and discoloration).

2 = The tensile strength after exposure shall be no less than 50 % of the original.
3 = the tensile strength after exposure shall be no less than 90 % of the original.
4 = ISO 105 grey scale rating.
5 = colorfastness by SAE J1545 for exterior materials, CIELAB color difference, 10 degrees observer, illuminant D65, specular included. ΔE = 2.5 max.
6 = colorfastness by SAE J1545 for exterior materials, CIELAB color difference, 10 degrees observer, illuminant D65, specular included. ΔE = 3.0 max.
7 = colorfastness by SAE J1767 for interior materials, CIELAB color difference, 10 degrees observer, illuminant D65, specular included. ΔE = 3.0 max.
Z = Other special requirements characteristics (for example, internal mold release agent) not covered by existing call out capabilities may be assigned. These shall be spelled out in detail and identified in sequence, that is, 01 ultraviolet (UV)-stabilized, 02 special color, and 03, etc.

Additional suffixes shall be added to this specification as test methods and requirements are developed or requested, or both.

6. Basic Requirements

6.1 The basic requirements from property or cell tables, as they apply, are always in effect unless these requirements are superseded by specific suffix requirements in the line callout.

7. General Requirements

7.1 The plastic composition shall be uniform and shall conform to the requirements specified herein. The color and form of the material shall be specified. Note specification changes due to the effects of colorants and, when necessary, cover them by suffixes.

7.2 For recycled, reconstituted, and regrind materials, the level of contamination by nonpolymeric materials, other than fillers and additives, shall not be of such a significant level that it prevents the product from meeting the performance criteria for which it was manufactured.

8. Detail Requirements

8.1 Test samples for the various materials shall conform to the requirements prescribed in Tables PP, A, B, C, G, and T and to the suffix requirements as they apply.

8.2 Observed or calculated values obtained from analysis, measurement, or test shall be rounded in accordance with Practice E 29 to the nearest unit in the last right-hand place of figures used in expressing the specified limiting value. The value obtained is compared directly with the specified limiting value. Conformance or nonconformance with the specification is based on this comparison.

9. Sampling

9.1 Adequate statistical sampling shall be considered an acceptable alternative. A batch or lot of resin shall be considered as a unit of manufacture as prepared for shipment and may consist of a blend of two or more production runs of material.

10. Number of Tests

10.1 The number of tests conducted shall be consistent with the requirements of the specific ISO test method.

11. Sample Preparation

11.1 The method of sample preparation and type of specimen used for each test is specified in Table 3.

11.2 *Injection Molding*:

11.2.1 *Specimen Mold*— Specimens shall be injection molded using a mold design specified in ISO 294. A mold of the same design as ISO 294, but with shutoff valves to allow balanced molding of single types of specimens without making a complete mold change, can be used if it can be shown that it provides specimens of the same quality with mechanical properties equivalent to specimens molded in the ISO 294 design.

11.2.2 *Cavity Gate Dimensions*—The gate height and width shall be a minimum of two-thirds of the height and width of the specimen.

11.2.3 *Injection Velocity*—The following calculations shall be used to determine the injection velocity:

$$V_I = (pi \times D^2 \times v_s)/(4 \times n \times A_c) \quad (1)$$

or

$$v_{av} = V_s/(t_I \times A_c \times n) \quad (2)$$

where:
V_{AV} = average injection velocity, mm/s
V_I = injection velocity, mm/s,
D = screw diameter, mm,
v_s = screw speed, mm/s,
n = number of cavities,

A_c = cross section at the position that forms the critical portion of the test specimen,
V_s = shot volume, mm^3, and
t_I = injection time, s.

NOTE 10—Eq 1 and 2 may give slightly different values to some extent due to different contributions of the compression of the whole melt in front of the screw and from different amounts of back flow.

11.2.4 For a given molding machine and given mold, the injection pressure and injection velocity shall be set to produce equal part weights, including sprue and runners, within 1 % regardless of the material's melt flow rate.

11.2.5 *Reporting*—Report the injection molding conditions in accordance with ISO 294 and 1873-2.

11.3 *Compression Molding*:

11.3.1 *Specimens*—For electrical testing or when the specimens cannot be injection molded, specimens shall be prepared by stamping or machining (see ISO 2818) from a compression-molded sheet. Compression molding of sheet shall be conducted in accordance with ISO 293, with the following additional points specified in ISO 1873-2:

11.3.1.1 *Mold*—A simple three-plate frame.

11.3.1.2 *Predrying*—No drying is normally necessary.

11.3.1.3 *Molding Temperature*—210 ± 5°C.

11.3.1.4 *Average Cooling Rate*—Method B; 15 ± 5°C/min.

11.3.1.5 *Molding Procedure*—The contact pressure time shall be 5 to 10 min, and the full-pressure time shall be 2 to 5 min. The demolding temperature shall be less than or equal to 40°C.

11.4 The method of sample preparation may affect the level of crystallinity or orientation in the test specimen. As a consequence, test specimens may yield different test results. Thus, the method of preparation shall be taken into account when comparing results. In cases of disagreement, injection-molded specimens shall be the referee standard.

12. Conditioning

12.1 *Conditioning*:

12.1.1 Once specimens are molded, they shall be moved to a standard laboratory atmosphere or a controlled laboratory atmosphere. For natural unfilled polypropylene the controlled laboratory atmosphere shall be 23 ± 2°C. Various storage medium may be used including, boxes, paper bags or envelopes, plastic bags, or racks, whichever is most practical for the laboratory storing the specimens. It is recommended that specimens be allowed to cool individually for about 30 min on a bench, or in a rack, or on the injection molded runner before they are placed in any container where the specimens may come in contact with each other. For filled and reinforced polypropylene or polypropylene blends, which contain a hydrophilic comonomer or modifier the specimens shall be conditioned in a standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity, unless sufficient testing has been conducted that indicates the specific material type's properties are not affected by humidity. In those cases, the storage medium can be the same as for unfilled materials. Materials whose properties are affected by humidity, must be stored in accordance with Practice D 618, Procedure A. For all materials to be conditioned for electrical testing, conditioning shall comply with the requirements of the standard test methods for electrical testing. In all cases the laboratory shall report both the temperature and humidity conditions during the conditioning procedure.

NOTE 11—When the temperature in the molding area exceeds 28°C or the humidity level exceeds 55 % (applies only to filled material) specimens shall be moved as quickly as possible to the controlled or standard laboratory atmosphere.

12.1.2 Testing, except for those tests where a test time is specified, shall be conducted within 40 to 96 h after molding. This test time range shall apply to all testing conducted for development of a line callout, data for publication, for certification, or for cases of dispute over testing values.

12.1.3 Specimens that are to be tested for Izod or Charpy impact shall be notched within 1 to 16 h after molding. Once notched the specimens shall condition for a minimum of 40 h before testing. Specimens shall be tested within 96 h after molding.

NOTE 12—Extending the conditioning time may result in increased or decreased test results. Polypropylene properties change with time as a result of amorphous densification and, in some cases, due to a small degree of secondary crystallization in the rubbery phase.

12.2 *Test Conditions*:

12.2.1 Natural unfilled polypropylene shall be tested in a controlled laboratory atmosphere of 23 ± 2°C. For filled and reinforced polypropylene or polypropylene blends that contain a hydrophilic comonomer or modifier, the specimens shall be tested in a standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity, unless sufficient testing has been conducted that indicates that specific material type's properties are not affected by humidity. For all materials to be tested for electrical properties, the laboratory shall comply with the requirements of the standard test methods for electrical testing. In all cases the laboratory shall report both the temperature and humidity conditions during testing.

13. Test Methods

13.1 Determine the properties enumerated in this specification in accordance with the methods as they apply, unless otherwise stated herein.

13.1.1 *Flow Rate*—Condition 12 (230°C with 2.16 kg load) of ISO 1133. Make two determinations on the material in the form that it is to be molded (such as powder, pellets, or granules).

NOTE 13—This test method serves to indicate the degree of uniformity of the flow rate of the polymer of a single manufacturer as made by an individual process and, in this case, may be indicative of the degree of uniformity of molded specimens and therefore other properties. However, uniformity of flow rate among various polymers of various manufacturers as made by various processes does not, in the absence of other tests, indicate uniformity of other properties and vice versa.

13.1.2 *Tensile Strength*— Test an ISO 3167 Type A specimen using ISO 527. For materials that show a breaking strain greater than 10 %, use a test speed of 50 mm/min. For materials that break at a strain less than 10 %, use a test speed of 5 mm/min.

13.1.3 *Flexural Modulus (Chord Modulus)* —Using ISO 178, determine a chord modulus between 0.0005 and 0.0025 mm/mm strain. Use a rectangular 80 by 10 by 4-mm specimen cut from the center of the ISO 3167 Type A multipurpose specimen. Set the test span at 64 mm and test speed to 2 mm/min. The support rods and loading nose shall be 5 ± 0.1 mm in radius. Test results shall be corrected for machine compliance.

NOTE 14—If the ISO 3167 Type A specimens were molded on a mold containing a draft angle, the specimens will be trapezoidal. Therefore, the flexural modulus may vary slightly, depending on which side is placed away from the loading nose.

13.1.4 *Charpy Impact Resistance*—The center section of the ISO 3167 Type A multipurpose bar shall be tested in accordance with ISO 179, Method 1A, with the V-notch having 0.25-mm radius at bottom. The test temperature is 23°C.

13.1.5 *Falling Mass Impact Resistance* —Testing shall be conducted in accordance with ISO 6603-2, with a 60-mm diameter by 2-mm thick specimen or a 60-mm square by 2-mm thick specimen (the square specimen is preferred as this specimen may also be used to measure mold shrinkage properties). The specimen is supported by a 40-mm diameter ring and impacted with a 20-mm diameter dart. The test may be conducted by a variable height or variable weight method. Determine the total energy to failure.

13.1.6 *Temperature of Deflection Under Load*—ISO 75-1 and 75-2 shall be used to test a rectangular 80 by 10 by 4-mm specimen in the flatwise position. A load is applied at the center of the specimen to give a fiber stress of 1.8 MPa.

13.1.7 Refer to Table 4, ISO 10350, and ISO 11403 for a listing of additional test methods that may be required to characterize the material.

14. Inspection and Certification

14.1 Inspection and certification of the material supplied under this specification shall be for conformance to the requirements specified herein.

14.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of those tests that ensure process control during manufacture as well as those necessary to ensure certifiability. Tests are melt flow rate, percent of reinforcement or filler, tensile strength at yield, flexural modulus, Charpy impact, and temperature of deflection under load (HDT).

14.3 Periodic check inspection shall consist of the tests specified for all requirements of the material under this specification. Inspection frequency shall be adequate to ensure that the material is certifiable in accordance with 14.4.

14.4 Certification shall be that the material was manufactured, sampled, tested, and inspected in accordance with this specification and that the average values meet the requirements at a confidence level of 95 %.

14.5 A report of the test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and results of the most recent periodic-check inspection.

15. Rejection and Rehearing

15.1 Material that fails to conform to the requirements of this specification may not be certified. If any failure occurs, the materials may be retested to establish conformity. Rejection shall be reported to the supplier promptly and in writing. In case of dissatisfaction with the results of the test, a claim for a rehearing may be made.

16. Packaging and Package Marking

16.1 The provision of Practices D 3892 apply for packaging, packing, and marking of plastic materials.

17. Keywords

17.1 injection and extrusion materials; polypropylene; recycled

TABLE PP Requirements for Unreinforced, Reinforced, and Filled Polypropylene

Group	Description	Class	Description	Grade	Description	Nominal Flow Rate,[A] ISO 1133, Condition 230/2.16, g/10 min	Density, Maximum, ISO 1183, kg/m^3,[B] (for reference only)	Tensile[C] Stress at Yield, ISO 527, minimum, MPa	Flexural Modulus[D,E] (Chord), ISO 178, minimum, MPa	Charpy Impact[D] Resistance at 23°C, ISO 179, minimum, kJ/m^2	~~Multi-axial Impact Behavior at –30°C, ISO 6603-2, minimum,[F]~~ ~~J~~	~~Deflection~~De Tempera at 1.8 M Stress, ISO 75 Flatwis minimum
01	Homopolymer	1	general purpose	1	unfilled	≤0.3	910	26	1075	3.5	48	
				2	unfilled	>0.3 ≤1.0	910	26	1025	3.1	48	
				3	unfilled	>1.0 ≤3.0	910	26	1025	2.9	46	
				4	unfilled	>3.0 ≤7.0	910	26	975	2.5	45	
				5	unfilled	>7.0 ≤20	910	24.5	875	2.1	45	
				6	unfilled	>20 ≤40	910	23.5	825	1.9	43	
				7	unfilled	>40 ≤100	910	22.5	825	1.7	43	
				8	unfilled	>100 ≤200	910	21.5	875	1.7	43	
				9	unfilled	>200	910	20	875	1.4	46	
				0	other							
		2	nucleated	1	unfilled	>1.0 ≤3.0	915	31.5	1375	3.1	53	
				2	unfilled	>1.0 ≤3.0	915	29	1175	3.1	50	
				3	unfilled	>3.0 ≤7.0	915	29	1175	2.6	53	
				4	unfilled	>3.0 ≤7.0	915	29	1175	2.5	50	
				5	unfilled	>7.0 ≤20	915	28.5	1175	2.4	52	
				6	unfilled	>7.0 ≤20	915	27	1175	2.1	49	
				7	unfilled	>20	915	27	1075	2.1	47	
				0	other							
		3	high crystallinity	1	unfilled	≤1.0	920	36	2050	2.5	53	
				2	unfilled	>1.0 ≤3.0	920	34	1850	2.5	53	
				3	unfilled	>3.0 ≤7.0	920	34	1650	2.5	53	
				4	unfilled	>7.0 ≤20	920	31	1425	2.6	52	
				5	unfilled	>20 ≤40	920	28.5	1325	2.8	50	
				6	unfilled	>40	920	24.5	1325	3.0	50	
				0	other							
		0	other	0	other							
02	Random Copolymer	1	general purpose	1	unfilled	. . .	910	22.5	1025	3.3	47	
				2	unfilled	. . .	910	22.5	825	3.3	44	
				3	unfilled	. . .	910	21	700	3.3	44	
				4	unfilled	. . .	910	19	600	4.2	42	
				5	unfilled	. . .	910	16	525	4.6	42	
				6	unfilled	. . .	910	15	425	5.1	42	
				7	unfilled	. . .	910	14	350	5.1	42	
				0	other							
		2	nucleated	1	unfilled	. . .	915	24.5	1000	3.8	49	
				2	unfilled	. . .	915	22.5	700	4.2	46	
				3	unfilled	. . .	915	21	600	4.2	45	
				4	unfilled	. . .	915	20	400	5.1	44	
				0	other							
		3	high crystallinity	0	other							
		4	heat stabilized	0	other							
03	Heterophasic Copolymers or Impact Modified	1	low impact	1	unfilled	. . .	. . .	24.5	1025	1.7	47	
				2	unfilled	. . .	. . .	20	875	1.6	43	
				3	unfilled	. . .	. . .	22	875	3.3	45	
				4	unfilled	. . .	. . .	17	675	3.3	43	
				5	unfilled	. . .	. . .	16	450	3.3	42	
				6	unfilled	. . .	. . .	22.5	825	5.1	46	
				7	unfilled	. . .	. . .	21	775	5.1	45	
				8	unfilled	. . .	. . .	19	775	5.1	45	
				9	unfilled	. . .	. . .	17	675	5.1	43	
				0	other							
		2	moderate impact	1	unfilled	. . .	. . .	25.5	1025	6.0	49	
				2	unfilled	. . .	. . .	23.5	875	6.9	47	
				3	unfilled	. . .	. . .	22	875	6.9	46	
				4	unfilled	. . .	. . .	20	775	6.9	45	
				5	unfilled	. . .	. . .	18	575	6.9	45	
				6	unfilled	. . .	. . .	18	575	6.9	42	
				7	unfilled	. . .	. . .	21	725	8.6	46	
				8	unfilled	. . .	. . .	16	675	8.6	43	
				9	unfilled	. . .	. . .	14	575	8.6	42	
				0	other							

TABLE PP Requirements for Unreinforced, Reinforced, and Filled Polypropylene

Group	Description	Class	Description	Grade	Description	Nominal Flow Rate,[A] ISO 1133, Condition 230/2.16, g/10 min	Density, Maximum, ISO 1183, kg/m^3,[B] (for reference only)	Tensile[C] Stress at Yield, ISO 527, minimum, MPa	Flexural Modulus[D,E] (Chord), ISO 178, minimum, MPa	Charpy Impact[D] Resistance at 23°C, ISO 179, minimum, kJ/m^2	~~Multi-axial Impact Behavior at –30°C, ISO 6603-2, minimum,[F] J~~	~~Deflection~~Deflection Temperature at 1.8 MPa Stress,[D] ISO 75-2 Flatwise, minimum,°
		3	medium impact	1	unfilled	. . .	. . .	23.5	1025	9.5	46	
				2	unfilled	. . .	. . .	22	925	11	45	
				3	unfilled	. . .	. . .	18	725	11	43	
				4	unfilled	. . .	. . .	16	525	11	42	
				5	unfilled	. . .	. . .	16	625	14	43	
				6	unfilled	. . .	. . .	23.5	875	18	45	
				7	unfilled	. . .	. . .	19	875	18	45	
				8	unfilled	. . .	. . .	19	725	18	45	
				9	unfilled	. . .	. . .	15	525	18	42	
				0	other							
		4	high impact	1	unfilled	. . .	. . .	22.5	825	27	47	
				2	unfilled	. . .	. . .	20	825	27	46	
				3	unfilled	. . .	. . .	20	575	27	45	
				4	unfilled	. . .	. . .	16	525	27	43	
				5	unfilled	. . .	. . .	14	475	27	42	
				6	unfilled	. . .	. . .	15	525	36	43	
				7	unfilled	. . .	. . .	22.5	775	53	45	
				8	unfilled	. . .	. . .	19	725	53	43	
				9	unfilled	. . .	. . .	18	525	53	42	
				0	other							
		5	nucleated	1	unfilled	. . .	. . .	27.5	1025	1.6	46	
				2	unfilled	. . .	. . .	25.5	1325	3.3	52	
				3	unfilled	. . .	. . .	22	975	3.3	50	
				4	unfilled	. . .	. . .	20	875	3.3	49	
				5	unfilled	. . .	. . .	22	1075	5.1	49	
				6	unfilled	. . .	. . .	18	825	5.1	49	
				7	unfilled	. . .	. . .	24.6	1175	7.1	49	
				8	unfilled	. . .	. . .	21	875	7.1	47	
				9	unfilled	. . .	. . .	18	575	9.5	47	
				0	other							
04	heterophasic copolymers or impact modified and heat stabilized	1	low impact, heat stabilized	1	unfilled							
				0	other							
		2	moderate impact, heat stabilized	1	unfilled							
				0	other							
		3	medium impact, heat stabilized	1	unfilled							
				0	other							
		4	high impact, heat stabilized	1	unfilled							
				0	other							
		5	nucleated, heat stabilized	1	unfilled							
				0	other							
~~11~~	~~Glass-filled~~	~~1~~	~~reinforced~~	~~G10~~	~~10 % glass~~	~~...~~	~~970~~	~~55~~	~~2000~~	~~...~~	~~...~~	81
11	~~homopoly~~Glass-filled homopolymer	1	reinforced	G10	10 % glass	...	1000	35	2000	3.0	...	
				G15	15 % glass	...	1010	35	2700	2.4	...	
				G20	20 % glass	...	1060	50	3500	4.5	...	120
				G30	30 % glass	...	1150	54	5000	5.5	...	130
				0	other							
		~~2~~	~~reinforced, heat stabilized~~	~~G15~~	~~15 % glass~~	~~...~~	~~1010~~	~~35~~	~~2700~~	~~2.4~~	~~...~~	110
		2	reinforced, heat stabilized	G15	15 % glass	...	1020	35	2700	2.4	...	
				G20	20 % glass	...	1060	50	3500	4.5	...	
				G30	30 % glass	...	1150	54	4100	5.5	...	
				0	other							
		3	chemically coupled	G20	20 % glass	...	1090	54	3800	5.0	...	125
				G30	30 % glass	...	1160	55	5000	6.0	...	130
				G40	40 % glass	...	1270	70	8000	7.7	...	140
				0	other							

TABLE PP Requirements for Unreinforced, Reinforced, and Filled Polypropylene

Group	Description	Class	Description	Grade	Description	Nominal Flow Rate,[A] ISO 1133, Condition 230/2.16, g/10 min	Density, Maximum, ISO 1183, kg/m^3,[B] (for reference only)	Tensile[C] Stress at Yield, ISO 527, minimum, MPa	Flexural Modulus[D,E] (Chord), ISO 178, minimum, MPa	Charpy Impact[D] Resistance at 23°C, ISO 179, minimum, kJ/m^2	~~Multi-axial Impact Behavior at –30°C, ISO 6603-2, minimum,~~[F] ~~J~~	~~Deflection~~De Tempera at 1.8 M Stress, ISO 75 Flatwis minimum
		~~4~~	~~chemically-~~	~~G10~~	~~10 % glass~~	~~...~~	~~1000~~	~~34.5~~	~~1800~~	~~4.0~~	~~...~~	~~100~~
		4	~~chemically~~ coupled,	G10	10 % glass	...	1000	34	1800	3.0	...	...
			~~heat~~	~~G20~~	~~20 % glass~~	~~...~~	~~1090~~	~~54~~	~~3200~~	~~5.5~~	~~...~~	...
			~~stabilized~~ heat stabilized	G20	20 % glass	...	1090	54	3200	5.3	...	...
				~~G25~~	~~25 % glass~~	~~...~~	~~1090~~	~~60~~	~~4000~~	~~5.5~~	~~...~~	...
			G25		25 % glass	...	1090	60	4000	5.5	...	...
			G30	30 % glass	...	1160	55	4300	6.0	...	130	
			G40	40 % glass	...	1270	70	8000	7.7	...	140	
				0	other							
		5	highly coupled	0	other							
		~~6~~	~~highly coupled,~~	~~G45~~	~~45 % glass~~	~~...~~	~~1310~~	~~100~~	~~10 000~~	~~9.5~~	...	...
		6	~~heat stabilized~~ highly coupled, heat stabilized	G45	45 % glass	...	1310	100	10 000	9.5	...	
			0		other							
12	Glass-filled copolymer	1	reinforced	G20 0	20 % glass other	...	1060	45	2850	3.8	...	130
		2	reinforced, heat stabilized	G10	10 % glass	...	1000	37	2600	2.5	...	108
				G15	15 % glass	...	1020	40	2500	2.9	...	112
				G20	20 % glass	...	1060	45	2850	3.8	...	128
				G30 0	30 % glass other	...	1150	57	5350	6.0	...	135
		3	chemically-coupled	G15	15 % glass	...	1020	30	2000	10.0	...	110
				0	other							
		~~4~~	~~chemically coupled,~~	~~G15~~	~~15 % glass~~	~~...~~	~~1020~~	~~30~~	~~2000~~	~~10.0~~	...	110
		4	~~heat stabilized~~ chemically coupled, heat stabilized	G15	15 % glass	...	1030	30	2000	10.0	...	...
			G20		20 % glass	...	1090	55	3800	5.7	...	130
				G30	30 % glass	...	1150	60	5400	6.2	...	134
				G45 0	45 % glass other	...	1270	68	6200	10.0	...	135
		5	highly coupled	0	other							
		6	highly coupled, heat stabilized	0	other							
21	Talc-filled homopolymer	1	general purpose	T15	15 % talc	...	1000	23	1750	2.0	...	47
				~~T20~~	~~20 % talc~~	~~...~~	~~1080~~	~~26~~	~~2010~~	~~2.0~~	...	59
		~~T30~~		T20 ~~30 % talc~~	20 % talc ~~...~~	... ~~1180~~	1100 ~~23~~	26 ~~2800~~	2010 ~~1.9~~	1.8 ~~...~~	... ~~65~~	59
		T30	30 % talc	...	1190	23	2500	1.9	...	~~65~~ 64		
			T40	40 % talc	...	1290	25	3000	2.2	...	63	
		~~2~~	~~heat~~	~~T20~~	~~20 % talc~~	~~...~~	~~1100~~	~~26~~	~~1750~~	~~2.2~~	...	~~58~~
		2	~~stabilized~~ heat stabilized	T20 ~~T30~~	20 % talc ~~30 % talc~~	... ~~...~~	1110 ~~1180~~	25 ~~26~~	1750 ~~2800~~	1.6 ~~1.9~~	... ...	
			T30		30 % talc	...	1180	26	2800	1.7	...	65
			~~T40~~	~~40 % talc~~	~~...~~	~~1290~~	~~27~~	~~3000~~	~~2.5~~	...	~~70~~	
			T40	40 % talc	...	1300	24	2900	1.7	...	~~70~~ 64	
				0	other							
		3	high crystallinity	0	other							
		4	high crystallinity, heat stabilized	0	other							

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Group	Description	Class	Description	Grade	Description	Nominal Flow Rate,[A] ISO 1133, Condition 230/2.16, g/10 min	Density, Maximum, ISO 1183, kg/m^3,[B] (for reference only)	Tensile[C] Stress at Yield, ISO 527, minimum, MPa	Flexural Modulus[D,E] (Chord), ISO 178, minimum, MPa	Charpy Impact[D] Resistance at 23°C, ISO 179, minimum, kJ/m^2	~~Multi-axial Impact Behavior at 30°C, ISO 6603-2, minimum,[F] J~~	~~Deflection~~Deflection Temperature at 1.8 MPa Stress,[D] ISO 75-2 Flatwise, minimum,°
		5	Extrusion Grade	T20 0	20 % talc other	...	1050	31	2119	...	...	66
		~~6~~	~~Extrusion Grade, heat stabilized~~	~~T20~~	~~20 % talc~~	~~...~~	~~1070~~	~~27~~	~~1800~~	~~...~~	~~...~~	60
		6		Extrusion Grade, heat stabilized	T20	20 % talc	...	1100	23	1800	2.4	...
					~~T40~~	~~40 % talc~~	~~...~~	~~1270~~	~~25~~	~~4000~~	~~...~~	~~...~~
			T40 0		40 % talc other	...	1280	24	4000	2.5	...	~~75~~ 73
~~22~~	~~Talc-filled copolymer~~	~~1~~	~~general purpose~~	~~T10~~	~~10 % talc~~	~~...~~	~~1000~~	~~23~~	~~1300~~	~~2.3~~	~~...~~	47
22		Talc-filled copolymer		1	general purpose	T10	10 % talc	...	1020	23	1300	2.3
				~~T15~~		~~15 % talc~~	~~...~~	~~1020~~	~~20~~	~~1737~~	~~...~~	~~...~~
		T15		15 % talc		...	1030	20	1500	3.0	...	51
				~~T20~~		~~20 % talc~~	~~...~~	~~1090~~	~~19~~	~~1750~~	~~2.0~~	~~51~~
				T20		20 % talc	...	1130	19	1500	2.0	51
			T25	25 % talc		...	1130	20	2000	2.2	53	
			~~T40~~	~~40 % talc~~	~~...~~	~~1280~~	~~19~~	~~2300~~	~~3.5~~	~~...~~	57	
			T40	40 % talc	...	1280	19	2300	2.3	...	57	
			0	other								
		~~2~~	~~heat stabilized~~	~~T10~~	~~10 % talc~~	~~...~~	~~1000~~	~~22~~	~~1300~~	~~4.5~~	~~...~~	47
		2		heat stabilized	T10	10 % talc	...	1010	18	1250	3.0	...
					~~T20~~	~~20 % talc~~	~~...~~	~~1070~~	~~20~~	~~1500~~	~~3.0~~	~~53~~
					T20	20 % talc	...	1080	17	1500	3.0	53
					~~T25~~	~~25 % talc~~	~~...~~	~~54 1090~~	~~19~~	~~2100~~	~~3.8~~	~~53~~
					T25	25 % talc	...	1090	19	2100	3.8	53
			T30		30 % talc	...	1150	19	1560	4.0	59	
			~~T40~~	~~40 % talc~~	~~...~~	~~1280~~	~~19~~	~~2300~~	~~3.5~~	~~...~~	57	
			T40	40 % talc	...	1280	19	2300	2.3	...	57	
			0	other								
		3	high crystallinity	0	other							
		4	high crystallinity, heat stabilized	T15	15 % talc	...	1100	27	1900	3.3	67	
				0	other							
		5	Extrusion Grade	0	other							
		6	Extrusion Grade, heat stabilized	0	other							
~~31~~	~~Calcium carbonate-filled homopolymer~~	~~1~~	~~general purpose~~	~~K10~~	~~10 % $CaCo_3$~~	~~...~~	~~990~~	~~29~~	~~1548~~	~~...~~	~~...~~	58
31		Calcium carbonate-filled homopolymer		1	general purpose	K10	10 % $CaCo_3$	...	990	29	1540	...
				0	other							
			~~2~~	~~heat stabilized~~	~~K10~~	~~10 % $CaCo_3$~~	~~...~~	~~990~~	~~25~~	~~1400~~	~~5.0~~	~~...~~
			2		heat stabilized	K10	10 % $CaCo_3$	...	1000	22	1180	2.5
						K25	25 % $CaCo_3$	...	1090	22	1600	3.2
			0	other								
		3 chemically reactive	0	other								
		4	chemically reactive	0	other							
			heat stabilized	0	other							
		~~5~~	~~Extrusion Grade~~	~~K40~~	~~40 % $CaCo_3$~~	~~...~~	~~1250~~	~~24~~	~~2531~~	~~...~~	~~...~~	59
		5		Extrusion Grade	K40	40 % $CaCo_3$	...	1250	24	2530	...	...
			0		other							

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Group	Description	Class	Description	Grade	Description	Nominal Flow Rate,[A] ISO 1133, Condition 230/2.16, g/10 min	Density, Maximum, ISO 1183, kg/m^3,[B] (for reference only)	Tensile[C] Stress at Yield, ISO 527, minimum, MPa	Flexural Modulus[D,E] (Chord), ISO 178, minimum, MPa	Charpy Impact[D] Resistance at 23°C, ISO 179, minimum, kJ/m^2	~~Multi-axial Impact Behavior at –30°C, ISO 6603-2, minimum,[F] J~~	~~Deflection~~De Tempera at 1.8 M Stress, ISO 75 Flatwis minimum
		~~6~~	~~Extrusion Grade heat stabilized~~	~~K40~~	~~40 % $CaCo_3$~~	~~...~~	~~1280~~	~~20~~	~~2200~~	~~5.0~~	~~...~~	~~52~~
		6	Extrusion Grade heat stabilized	K40	40 % $CaCo_3$	...	1280	17	2200	5.0	...	
			0	other								
~~32~~	~~Calcium carbonate-filled copolymer~~	~~1~~	~~general purpose~~	~~K20~~	~~20 % $CaCo_3$~~	~~...~~	~~1060~~	~~31~~	~~1520~~	~~...~~	~~...~~	~~111~~
32	Calcium carbonate-filled copolymer			1	general purpose	K20	20 % $CaCo_3$	...	1060	31	1520	...
				0		other						
		2		heat		K10	10 % $CaCo_3$	...	1000	25	1300	4.6
		~~K20~~		stabilized		~~20 % $CaCo_3$~~	~~...~~	~~1080~~	~~20~~	~~1200~~	~~9.0~~	~~...~~ 50
		K20	20 % $CaCo_3$			...	1060	20	1600	5.0	...	50
			0	other								
		3	chemically reactive	0	other							
		4	chemically reactive, heat stabilized	0	other							
		5	Extrusion Grade	0	other							
		6	Extrusion Grade, heat stabilized	~~K05~~	~~5 % $CaCo_3$~~	~~...~~						
		~~K20~~		~~20 % $CaCo_3$~~	~~...~~	~~1060~~	~~28~~	~~480~~	~~5.8~~	~~...~~	~~80~~	
		0		other								
41	Mica-filled homopolymer	1	general purpose	P10	10 % Mica	...	1040	28	2200	2.0	...	62
				P20	20 % Mica	...	1080	23	2200	2.4	...	64
				0	other							
		~~2~~	~~general purpose, heat stabilized~~	~~P10~~	~~10 % Mica~~	~~...~~	~~1040~~	~~28~~	~~1200~~	~~1.0~~	~~...~~	~~60~~
		2		general purpose, heat stabilized	P10	10 % Mica	...	1040	28	1200	1.0	...
					~~P20~~	~~20 % Mica~~	~~...~~	~~1100~~	~~28~~	~~2000~~	~~2.4~~	~~...~~
					P20	20 % Mica	...	1100	25	2000	1.9	... ~~65~~ 59
					0	other						
		3	high crystallinity	0	other							
		4	high crystallinity, heat stabilized	0	other							
		5	Extrusion Grade	0	other							
		6	Extrusion Grade, heat stabilized	P20	20 % Mica	...	1080	32	2000	2.8	...	70
				0	other							
42	Mica-filled copolymer	1	general purpose	P10	10 % Mica	...	1040	22	1400	5.0	...	52
				P20	20 % Mica	...	1080	20	1800	5.8	...	58
				~~P25~~	~~25 % Mica~~	~~...~~	~~1130~~	~~22~~	~~2400~~	~~2.5~~	~~...~~	~~58~~
				P25	25 % Mica	...	1150	22	2400	2.3	...	58
				P35	35 % Mica	...	1230	19	2600	3.0	...	63
			0	other								
		2	general purpose, heat stabilized	P10	10 % Mica	...	1040	23	1440	4.7	52	
				P20	20 % Mica	...	1090	24	2110	2.1	63	
				~~2~~	~~general purpose, heat stabilized~~	P40	40 % Mica	...	1260	31	3800	2.5
				0		other						

TABLE PP Requirements for Unreinforced, Reinforced, and Filled Polypropylene

Group	Description	Class	Description	Grade	Description	Nominal Flow Rate,[A] ISO 1133, Condition 230/2.16, g/10 min	Density, Maximum, ISO 1183, kg/m^3,[B] (for reference only)	Tensile[C] Stress at Yield, ISO 527, minimum, MPa	Flexural Modulus[D,E] (Chord), ISO 178, minimum, MPa	Charpy Impact[D] Resistance at 23°C, ISO 179, minimum, kJ/m^2	~~Multi-axial Impact Behavior at 30°C, ISO 6603-2, minimum,[F] J~~	~~Deflection~~Deflection Temperature at 1.8 MPa Stress,[D] ISO 75-2 Flatwise, minimum,°
		3	high crystallinity	0	other							
		4	high crystallinity, heat stabilized	0	other							
51	Glass/talc-filled homopolymer	1	general purpose	R15	15 % glass/talc	...	1050	28	2100	4.7	...	94
				0	other							
		2	general purpose, heat stabilized	0	other							
		3	chemically coupled	0	other							
		~~4~~	~~chemically coupled, heat stabilized~~	~~R20~~	~~20 % glass/talc~~	~~...~~	~~1080~~	~~47.4~~	~~2990~~	~~7.5~~	~~...~~	~~130~~
		4	chemically coupled, heat stabilized	R20	20 % glass/talc	...	1080	44	2990	3.7	...	~~130~~ 115
				R30	30 % glass/talc	...	1160	53	3500	5.5	...	131
				R35	35 % glass/talc	...	1220	55	5000	5.7	...	130
				R40	40 % glass/talc	...	1250	52	4100	6.2	...	135
				0	other							
52	Glass/talc-filled copolymer	1	general purpose	0	other							
		2	general purpose, heat stabilized	0	other							
		3	chemically coupled	R15	15 % glass/talc	...	1030	27	2100	4.0	95	
				0	other							
		4	chemically coupled, heat stabilized	0	other							
53	Glass/ calcium carbonate filled homopolymer	1	general purpose	0	other							
		2	general purpose, heat stabilized	0	other							
		3	chemically coupled	0	other							
		4	chemically coupled, heat stabilized	R30	30 % glass/ calcium carbonate	...	1150	55	3800	5.6	130	
				0	other							

TABLE PP Requirements for Unreinforced, Reinforced, and Filled Polypropylene

Group	Description	Class	Description	Grade	Description	Nominal Flow Rate,[A] ISO 1133, Condition 230/2.16, g/10 min	Density, Maximum, ISO 1183, kg/m^3,[B] (for reference only)	Tensile[C] Stress at Yield, ISO 527, minimum, MPa	Flexural Modulus[D,E] (Chord), ISO 178, minimum, MPa	Charpy Impact[D] Resistance at 23°C, ISO 179, minimum, kJ/m^2	~~Multi-axial Impact Behavior at 30°C, ISO 6603-2, minimum,~~[F] ~~J~~	~~Deflection~~De Tempera at 1.8 M Stress, ISO 75 Flatwis minimum
54	Glass/ calcium carbonate filled copolymer	1	general purpose	0	other							
		2	general purpose, heat stabilized	0	other							
		3	chemically coupled	0	other							
		4	chemically coupled, heat stabilized	0	other							
55	Glass/mica filled homopolymer	1	general purpose	0	other							
		2	general purpose, heat stabilized	0	other							
		3	chemically coupled	R40	40 % glass/mica	...	1260	40	6000	3.5	...	125
				0	other							
		4	chemically coupled, heat stabilized	R35	35 % glass/mica	...	1220	55	5000	5.7	...	130
				~~R40~~	~~40 % glass/mica~~	~~...~~	~~1260~~	~~75~~	~~6000~~	~~7.5~~	~~...~~	~~...~~
				R40	40 % glass/mica	...	1290	44	6000	4.7	...	... 12
				0	other							
~~56~~	~~Glass/mica filled copolymer~~	~~1~~	~~general purpose~~	~~R35~~	~~35 % glass/mica~~	~~...~~	~~1200~~	~~65~~	~~6000~~	~~7.0~~	~~...~~	~~...~~
56	Glass/mica filled copolymer	1		general purpose	R35	35 % glass/ mica	...	1200	65	6000	7.0	...
			0		other							
		2	general purpose, heat stabilized	0	other							
		3	chemically coupled	R35	35 % glass/mica	...	1020	47	5500	6.5	...	128
				0	other							
		4	chemically coupled, heat stabilized	R35	35 % glass/mica	...	1200	43	4850	6.8	...	122
				0	other							
00	Other	0	other	0	other							

[A] Nominal flow rate is as supplied by the manufacturer of the material. Maximum allowable tolerance ±30 % per individual lot.

[B] For general information, not a requirement.

[C] Test specimens are unannealed ISO 3167 Type A multi-purpose specimen and shall be tested at 50 mm/min, unless elongation at break is less than 10 %, then speed shall be 5 mm/min.

[D] Test specimens are nominal 4.0 mm by 10 mm cross section and are cut from center section of unannealed ISO 3167 Type A multi-purpose specimen.

[E] Span is a nominal 64 mm. Rate of crosshead is 2.0 mm/min. ~~FTest specimens are a nominal of 2.0 mm in thickness.~~

TABLE A Detail Requirements[A] of Filled and Reinforced Polypropylene Not Called Out by Tables C, G, or T

Designation or Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile stress at yield,[B] ISO 527, min, MPa	unspecified	20	33	47	60	75	90	105	120	specify value[C]
2	Flexural modulus (chord),[D,E] ISO 178, min, MPa	unspecified	1000	2000	3000	4000	5000	6000	7000	8000	specify value[C]
3	Charpy impact resistance[D] at 23°C, ISO 179, min, kJ/m^2	unspecified	2.0	3.3	4.7	6.0	8.6	12	17	23	specify value[C]
4	Deflection temperature at 1.8 MPa,[D] ISO 75-2 Flatwise, min, °C	unspecified	47	52	56	61	67	72	78	84	specify value[C]
5	To be determined	unspecified									specify value[C]

[A]It is recognized that detailed test values, particularly Charpy Impact, may not predict nor even correlate with performance of parts molded of these materials.
[B]Test specimens are unannealed ISO 3167 Type A multi-purpose specimen and shall be tested at 50 mm/min, unless elongation at break is less than 10 %, then speed shall be 5 mm/min.
[C]If a specific value is required, it must appear on the drawing or contract.
[D] Test specimens are the center of the unannealled ISO 3167 Type A multi-purpose specimen with a nominal 4.0 by 10.0-mm cross section.
[E]Span is a nominal 64 mm. Rate of crosshead is 2.0 mm/min.

TABLE B Detail Requirements[A] of Unfilled and Unreinforced Polypropylene

Designation or Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile stress at yield,[B] ISO 527, min, MPa	unspecified	5	10	15	20	25	29	33	38	specify value[C]
2	Flexural modulus (chord),[D,E] ISO 178, min, MPa	unspecified	100	250	500	750	1000	1250	1500	1750	specify value[C]
3	Charpy impact resistance[D] at 23°C, ISO 179, min, kJ/m^2	unspecified	1.6	5.1	9.5	18	27	36	45	62	specify value[C]
4	Deflection temperature at 1.8 MPa,[D] ISO 75-2 Flatwise, min, °C	unspecified	39	42	47	49	50	55	58	60	specify value[C]
5	Flow rate,[F] ISO 1133 Condition 230/2.16, g/10 min	unspecified	<0.3	>0.3-1.0	>1.0-3.0	>3.0-10	>10-20	>20-40	>40-100	>100	specify value[C]

[A]It is recognized that detailed test values, particularly Charpy Impact, may not predict nor even correlate with performance of parts molded of these materials.
[B]Test specimens are unannealed ISO 3167 Type A multi-purpose specimen and shall be tested at 50 mm/min, unless elongation at break is less than 10 %, then speed shall be 5 mm/min.
[C]If a specific value is required, it must appear on the drawing or contract.
[D] Test specimens are the center of the unannealled ISO 3167 Type A multi-purpose specimen with a nominal 4.0 by 10.0-mm cross section.
[E]Span is a nominal 64 mm. Rate of crosshead is 2.0 mm/min.
[F] Nominal flow rate is as supplied by the manufacturer of the material. Allowable tolerance ±30 % per individual lot.

TABLE C Detail Requirements[A] of Calcium Carbonate Filled Polypropylene

Designation or Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile stress at yield,[B] ISO 527, min, MPa	unspecified	10	13	16	20	23	26	29	32	specify value[C]
2	Flexural modulus (chord),[D,E] ISO 178, min, MPa	unspecified	800	1100	1400	1750	1950	2250	2550	2750	specify value[C]
3	Charpy impact resistance[D] at 23°C, ISO 179, min, kJ/m^2	unspecified	2.0	3.8	5.5	7.3	8.6	10.4	12.6	14.4	specify value[C]
4	Deflection temperature at 1.8 MPa,[D] ISO 75-2 Flatwise, min, °C	unspecified	45	47	49	51	53	55	57	59	specify value[C]
5	To be determined	unspecified									specify value[C]

[A]It is recognized that detailed test values, particularly Charpy Impact, may not predict nor even correlate with performance of parts molded of these materials.
[B]Test specimens are unannealed ISO 3167 Type A multi-purpose specimen and shall be tested at 50 mm/min, unless elongation at break is less than 10 %, then speed shall be 5 mm/min.
[C]If a specific value is required, it must appear on the drawing or contract.
[D] Test specimens are the center of the unannealled ISO 3167 Type A multi-purpose specimen with a nominal 4.0 by 10.0-mm cross section.
[E]Span is a nominal 64 mm. Rate of crosshead is 2.0 mm/min.

TABLE G Detail Requirements[A] of Glass Reinforced Polypropylene

Designation or Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile stress at yield,[B] ISO 527, min, MPa	unspecified	23	30	38	45	54	61	70	77	specify value[C]
2	Flexural modulus (chord),[D,E] ISO 178, min, MPa	unspecified	1000	1950	2850	3750	4700	5600	6500	7450	specify value[C]
3	Charpy impact resistance[D] at 23°C, ISO 179, min, kJ/m^2	unspecified	2.0	3.8	5.5	7.7	9.5	12	14	16	specify value[C]
4	Deflection temperature at 1.8 MPa,[D] ISO 75-2 Flatwise, min, °C	unspecified	50	70	90	100	110	120	130	140	specify value[C]
5	To be determined	unspecified									specify value[C]

[A]It is recognized that detailed test values, particularly Charpy Impact, may not predict nor even correlate with performance of parts molded of these materials.
[B]Test specimens are unannealed ISO 3167 Type A multi-purpose specimen and shall be tested at 50 mm/min, unless elongation at break is less than 10 %, then speed shall be 5 mm/min.
[C]If a specific value is required, it must appear on the drawing or contract.
[D] Test specimens are the center of the unannealled ISO 3167 Type A multi-purpose specimen with a nominal 4.0 by 10.0-mm cross section.

[E]Span is a nominal 64 mm. Rate of crosshead is 2.0 mm/min.

TABLE T Detail Requirements[A] of Talc Filled Polypropylene

Designation or Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile stress at yield,[B] ISO 527, min, MPa	unspecified	11	15	19	23	26	30	34	38	specify value[C]
2	Flexural modulus (chord),[D,E] ISO 178, min, MPa	unspecified	650	1000	1350	1750	2100	2450	2800	3150	specify value[C]
3	Charpy impact resistance[D] at 23°C, ISO 179, min, kJ/m^2	unspecified	2.0	3.8	5.5	7.3	9.1	11	12.5	14.5	specify value[C]
4	Deflection temperature at 1.8 MPa,[D] ISO 75-2 Flatwise, min, °C	unspecified	44	47	50	53	56	59	62	65	specify value[C]
5	To be determined	unspecified									specify value[C]

[A]It is recognized that detailed test values, particularly Charpy Impact, may not predict nor even correlate with performance of parts molded of these materials.

[B]Test specimens are unannealed ISO 3167 Type A multi-purpose specimen and shall be tested at 50 mm/min, unless elongation at break is less than 10 %, then speed shall be 5 mm/min.

[C]If a specific value is required, it must appear on the drawing or contract.

[D] Test specimens are the center of the unannealled ISO 3167 Type A multi-purpose specimen with a nominal 4.0 by 10.0-mm cross section.

[E]Span is a nominal 64 mm. Rate of crosshead is 2.0 mm/min.

TABLE 1 Coding System for Fillers and Reinforcing Materials

Code	Material
B	boron
C	carbon
E	clay
F	flame retardant
G	glass
K	calcium carbonate
L	lubricants
M	minerals
N	other minerals
O	metals
P	mica
R	mixture of filler/reinforcement
S	organic synthetics
T	talc
U	wallastonite
W	wood
X	not specified
Y	proprietary
Z	others

TABLE 2 Coding System for the Mass Content of Fillers and Reinforcement

Code	Nominal Mass Content (%)
XX	proprietary
00	≤2.5
05	>2.5 to 7.5
10	>7.5 to 12.5
15	>12.5 to 17.5
20	>17.5 to 22.5
25	>22.5 to 27.5
30	>27.5 to 32.5
35	>32.5 to 37.5
40	>37.5 to 42.5
45	>42.5 to 47.5
50	>47.5 to 55
60	>55 to 65
70	>65 to 75
80	>75 to 85
90	>85

TABLE 3 Recommended Processing Conditions

Material MFR, g/10 min[A]	Melt Temperature, °C[B,C,D]	Mold Temperature, °C[E]	Cycle Time, s[F]	Hold Time, s	Injection Velocity, mm/s[G]	Injection and Hold Pressure,[G,H]	Back Pressure, MPa	Demolding Temperature, °C
<1	255 ± 5	40 ± 5	60	40	200 ± 20	variable	7	60
≥1, ≤7	230 ± 5	40± 5	60	40	200 ± 20	variable	7	60
>7	200 ± 5	40 ± 5	60	40	200 ± 20	variable	7	60

[A]The MFR is determined in accordance with ISO 1133 at 230°C and load of 2.16 kg.

[B]The melt temperature shall be measured on cycle by taking the temperature of several successive free shots with a needle-type pyrometer to an accuracy of ±3°C. The needle shall be moved around in the plastic mass and a sufficient number of measurements be made to establish a reliable result. To minimize heat loss from the plastic during the measurement, the mass should be collected in a heated container, or in one made from material of low thermal conductivity. The quantity of plastic in

the free shot should be controlled to be equivalent to the weight of a complete injection-molded shot. To avoid excessive thermal history, the shot size shall be kept to a minimum; therefore, the cushion shall be 5 to 10 mm. Since the needle-type pyrometer technique is somewhat tedious, a second technique using an infrared pyrometer may be used. The infra-red pyrometer used must have an accuracy of 1 % of reading or ±1°F or ±1°C, a response time of at least 0.5 s, and a distance to target ratio of at least 30 to 1. It is recommended that the infra-red pyrometer have a laser beam to establish the position being measured on the molten mass of polymer. This second technique shall only be used after a correlation between the needle-type pyrometer and the infra-red pyrometer has been established. This correlation shall be verified at least every six months. The correlation shall be re-established each time either pyrometer is recalibrated.

[C] If other temperatures have to be used because of the nature of the polymer, they shall be reported, together with the reasons for use.

[D] Heat-sensitive polymers may undergo molecular breakdown during molding; therefore, an increase in the MFR to 1.5 times the original value shall be avoided. If the MFR increases by more than 1.5 times the original value, the melt temperature shall be lowered, 10°C at a time, until the increase in MFR is <1.5 times the original value.

[E] Temperature measurements shall be made in each cavity of the mold after machine conditions are at equilibrium and shall be made with a surface-type pyrometer, or equivalent, to an accuracy of ±2°C.

[F] The cycle time will be dependent on the time it takes the material to reach the demolding temperature.

[G] For a given molding machine and given mold, the injection pressure and injection velocity shall be set to produce equal part weights, including sprue and runners, within 1 % regardless of the material melt flow rate.

[H] The injection pressure and hold pressure shall be set at a level that does not produce flash, sink marks, or voids in the specimens. The maximum amount of flash shall not exceed 1 mm and shall be acceptable only in the nontesting areas of the specimen.

TABLE 4 Properties and Test Conditions

Number	Properties	Standard	Specimen Type, Dimensions, mm	Processing Method	Unit	Suffix	Test Conditions and Supplementary Instructions
1.0	Rheological properties						
1.1	Melt flow rate—mass	ISO 1133	granule or powder		g/10 min		230°C, 2160 g
1.2	Melt flow rate—volume		granule or powder		mL/10 min		230°C, 2160 g
2.0	**Mechanical Properties**						
2.1	Tensile modulus	ISO 527-1, -2	ISO 3167 Type A (also referred to as ISO 527 Type 1A)	injection	MPa		For modulus, speed is 1 % of gage length/min. Test speed is 50 mm/min for ductile materials, 5 mm for brittle material, see Footnote A for definition of ductile and brittle failure;[A] see Footnote B for measurement of break properties.[B]
2.2	Tensile yield stress						
2.3	Tensile yield strain						
2.4	Tensile break stress						
2.5	Tensile break strain						
2.6	Tensile creep modulus	ISO 899 ISO 11403-1	20 by 2.5 by 1.6	injection	MPa		Test at seven temperatures, one of which is +23°C. Temperature shall be selected to span the useful working range of the polymer. For PP, the following temperatures are recommended for use: –40, –20, 0, +23, +50, +80, and +100°C. For each temperature, test at five stress levels up to 10 000 h. Stress levels shall be 20, 40, 60, 80, and 100 % of the maximum stress that can be maintained for prolonged periods of time at the test temperature. Determine the creep modulus at 1 h and 1000 h at strain level less than 0.5 %.
2.7	Flexural modulus	ISO 178	center of ISO 3167 Type A	injection	MPa		Test speed 2 mm/min, 64-mm span, and chord modulus between 0.0005 and 0.0025 mm/mm strain, and results corrected for machine compliance
2.8	Flexural strength						
2.9	Flexural creep modulus	ISO 6602	center of ISO 3167 Type A	injection	MPa		Same requirements as tensile creep (2.6)
2.10	Compressive strength and modulus	ISO 604	for strength 10 by 10 by 4, for modulus 50 by 10 by 4	injection	MPa		Speed of test 0.02 mm/min for modulus, 0.1 mm/min for brittle materials, and 0.5 mm/min for ductile materials
2.11	Shear modulus	ISO 537	60 by 10 by 1	injection	MPa		Method A at 1 Hz, from –100 to +150°C
2.12	Charpy impact strength	ISO 179	center of ISO 3167 Type A	injection	kJ/m^2		Method 1 unnotched (edgewise)
2.13	Charpy notched impact strength	ISO 179	center of ISO 3167 Type A	injection	kJ/m^2		Method 1A (edgewise)
2.14	Izod impact strength	ISO 180	center of ISO 3167 Type A	injection	kJ/m^2		Method 1A, V-notch 0.25 mm radius
2.15	Tensile impact strength	ISO 8256	80 by 10 by 4 Double-V notch, r = 1	injection	kJ/m^2		Determined only when fracture cannot be achieved in the Izod or Charpy test
2.16	Falling dart impact	ISO 6603-1	60 by 60 by 2 (or 60 mm diameter by 2 mm)	injection	J		50 % failure energy, Method A
2.17	Instrumented falling dart impact	ISO 6603-2	60 by 60 by 2 (or 60 mm diameter by 2 mm)	injection	J		20 mm diameter dart, 40 mm support velocity 4.4 m/s, report peak and total values

TABLE 4 *Continued*

Number	Properties	Standard	Specimen Type, Dimensions, mm	Processing Method	Unit	Suffix	Test Conditions and Supplementary Instructions
2.18	Ball indention hardness	ISO 2039-1	50 by 50 by 4	injection	N/mm^2		
2.19	Rockwell hardness	ISO 2039-2	min 50 by 50 by 6 (min)	injection	HRR		Thickness can be achieved by plying
2.20	Shore A or D hardness	ISO 868	min 50 by 50 by 6 (min)	injection	Value A or D		Value at 1 s, durometer A or D, thickness can be achieved by plying
3.0	**Thermal Properties**						
3.1	Peak melting temperature	ISO 11357–3	powder, granules, sheet		°C		Heating rate 10°C/min on second heat in accordance with ISO 10350, after first heat and cool down at a rate of 20°C/min
3.2	Temperature of deflection under load	ISO 75-1 ISO 75-2	120 by 10 by 4	injection	°C		Stress level 0.45 MPa or 1.80 MPa, span 100 mm for specimens in edgewise position, 64 mm for specimens positioned flatwise
3.3	Vicat softening temperature	ISO 306	min 10 by 10^2 or 10 mm diameter disk by min 3 mm thickness	injection	°C		Method A with 10 N load at 50°C/h
3.4	Brittleness temperature	ISO 974	20 by 2.5 by 1.6	injection	°C		Unnotched specimens
3.5	Coefficient of linear thermal expansion	TMA	ISO 3167 Type A	injection	1/K		Secant value over temperature range of 23 to 55°C
3.6	Flammability	IEC 60695–11–10	120 by 10 by 4	injection or sheet	mm/s, or s, or extent of burn		Horizontal burn, either time or length of burn, 20 mm flame, 30 s exposure to the flame
		IEC 60695–11–10	120 by 10 by 4	injection or sheet	rating		Vertical burn, two 10 s exposures to flame, 20 mm flame height
		ISO 3795	356 by 100 by 1.5 min	injection or sheet	mm/s		38 mm flame height, 15 s exposure to flame
3.7	Oxygen index	ISO 4589	80 by 10 by 4	injection	%		Procedure A—top surface ignition
4.0	**Electrical Properties**						
4.1	Relative permittivity	IEC 250	80 by 80 by 1	compression			Frequency 1 MHz
4.2	Dissipation factor	IEC 250	80 by 80 by 1	compression			Frequency 1 MHz
4.3	Volume resistivity	IEC 93	80 by 80 by 1	compression	ohm-m		Voltage 500 V
4.4	Surface resistivity	IEC 93	80 by 80 by 1	compression	ohm		
4.5	Dielectric strength	IEC 243-1	80 by 80 by 1	compression	kv/mm		Use electrode configuration 25 mm/75 mm coaxial cylinders; immersion in transformer oil IEC 296; use 20 step by step test
4.6	Comparative tracking index	IEC 112	100 by 100 by 3 (min) or 100 mm diameter disk by 3 (min) thickness	compression			Use 0.1 % ammonium chloride (aqueous solution), at 50 Hz
5.0	**Aging Properties**						
5.1	Natural Weathering	ISO 877	Dependent on secondary testing to be conducted	Injection		W3	Interior Applications, 5° southern exposure, under glass, 12 months, Florida. Refer to ISO 4582 for determination of change and to footnote D for criteria of failure.
5.2	Natural Weathering	ISO 877	Dependent on secondary testing to be conducted	Injection		W4	Exterior Applications, 5° southern exposure, direct weathering, 12 and 24 month exposures, Florida. Refer to ISO 4582 for determination of change and to footnote D for criteria of failure.
5.3	Natural Weathering	SAE J 1976	Dependent on secondary testing to be conducted	Injection		W8	Exterior Applications, 5° southern exposure, direct weathering, 12 and 24 month exposures, Florida. Refer to ISO 4582 for determination of change and to footnote[C] for criteria of failure.
5.4	Artificial Weathering	ISO 4892-1 ISO 4892-2 Method B	ISO 3167 Type A multipurpose specimen	Injection		W5	(Artificial daylight behind window glass) Specimens exposed in a xenon-arc accelerated test apparatus with window glass filters that conforms to ISO 4892, Part 2 Method B, Cycle 6 for interior applications. See footnote[D] for exposure duration. Refer to ISO 4582 for determination of change and to footnote[C] for criteria of failure.

TABLE 4 *Continued*

Number	Properties	Standard	Specimen Type, Dimensions, mm	Processing Method	Unit	Suffix	Test Conditions and Supplementary Instructions
5.5	Artificial Weathering	ISO 4892-1 ISO 4892-2 Method A	ISO 3167 Type A multipurpose specimen	Injection		W6	(Unfiltered artificial daylight) Specimens exposed in a xenon-arc accelerated test apparatus with daylight filters that conforms to ISO 4892, Part 2 Method A, Cycle 1 for exterior applications. See footnote[D] for exposure duration. Refer to ISO 4582 for determination of change and to footnote[C] for criteria of failure.
5.6	Artificial Weathering	ISO 4892-1 ISO 4892-3	Type 1 Tensile Bar	Injection		W7	Specimens exposed in a fluorescent UV/condensation accelerated test apparatus that conforms to ISO 4892, Part 3 and operated in accordance with exposure Cycle 1. See footnote[D] for exposure duration. Refer to ISO 4582 for determination of change and to footnote[C] for criteria of failure.
5.7	Artificial Weathering	SAE J1885	Type 1 tensile bar for physical testing and minimum 65.5 by 63.5 square or 63.5 diameter disk by 3.2 for color change	Injection		W2	Specimens exposed in a xenon-arc accelerated test apparatus that conforms to condi- tions in SAE J1885 or equivalent for interior applications. Radiant exposure of 1240.8 kJ/(m^2.nm) at 340 nm. Refer to ISO 4582 for determination of change and to footnote[C] for criteria of failure.
5.8	Artificial Weathering	SAE J1960	Type 1 tensile bar for physical testing and minimum 65.5 by 63.5 square or 63.5 diameter disk by 3.2 for color change	Injection		W1	Specimens exposed in a xenon-arc accelerated test apparatus that conforms to conditions in SAE J1960 or equivalent for exterior applications. Radiant exposure of 2500 kJ/(m^2.nm) at 340 nm. Refer to ISO 4582 for determination of change and to footnote[C] for criteria of failure.
6.0	**Other Properties**						
6.1	Water absorption	ISO 62	50 mm square or disk by 3 mm	injection	%		24 h immersion at 23°C
6.2	Density	ISO 1183A	10 by 10 by 4	injection	kg/m^3		
6.3	Limiting viscosity number	ISO 1191 or 1628-3	granules or powder		mL/g		Decalin at 135°C
6.4	Xylene solubles	ISO 6427 Appendix B	granules or powder		%		1 % solution of PP in xylene 30 min cooling time
6.5	Isotactic index	ISO 9113	granules or powder		%		Solubility in boiling heptane 24 h extraction
6.6	Ash	ISO 3451	any form		%		

[A] Ductile Failure—If the polymer shows ductile failure, that is, breaking strain beyond 10 %, the testing speed shall be 50 mm/min, and the values for yield stress and strain and the nominal strain at break are recorded. If breaking occurs above 50 % nominal strain, record >50 for the nominal strain at break. If no yielding is observed up to 50 % nominal strain, the stress at 50 % nominal strain shall be recorded. Determination of the nominal strain is based on the initial and final grip separations instead of the extensometer measurements. Brittle failure—If the polymer shows brittle failure, that is, breaking without yielding and with the strain at break less than 10 %, the testing speed shall be 5 mm/min, and the values for stress and strain at break shall be recorded.

[B] The measurement of break properties for polypropylene is not very reproducible and should not be reported unless requested.

[C] Failure is when the material loses tensile strength or Izod impact resistance. If color change is critical, ΔE cannot exceed 3.0

[D] The minimum exposure time used shall be that necessary to produce a substantial change in the tensile or impact resistance for the least stable material being evaluated.

SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

D 5857 – 04:
(*1*) The Multi-axial Impact column of the table was deleted.
(*2*) Thirty different filled polypropylene grades (group 11 through group 56) were updated in one or more properties.
(*3*) Nine new grades of polypropylene were added to the table.
(*4*) Three grades were deleted.
(*5*) A grade of 0 was added to group 12 class 3 (other) which was previously missing.
(*6*) The unfilled grades, Group 01-04 were not changed at this time.
NOTE: All call-outs previously used in Industry documentation will not be contradicted by any of the changes made with the new table updates.
D 5857 – 03b:
(*1*) Deleted ISO 3146.
(*2*) Added ISO 11357–3 to subsection 2.2.
(*3*) Changed conditions in Table 4, Section 3.1.
D 5857 – 03a:
(*1*) Revisions were made in Section 2, Section 5, and Section 11.
(*2*) Revisions were made in Table 4 and Table PP.
D 5857 – 03:
(*1*) Deleted ISO 3268 from Referenced Documents.
(*2*) Deleted reference to ISO 3268, the Type B specimen, and the 2 mm/min crosshead speed from Table 4.
(*3*) Added mandatory machine compliance correction sentence to 13.1.3.
(*4*) Additional information to Section 2.7 of Table 4.
D 5857 – 02a:
(*1*) Made revisions in the following paragraphs: 1.1, 3.2.11, 4.1.2, 4.1.3, 4.2, 4.2.1, 4.2.2, 5.1, 8.1, 11.2.3, 13.1.2, 13.1.5.
(*2*) Revised Footnote A of Table 4.
(*3*) Added paragraph 4.1.4.
(*4*) Revised Note 1.
(*5*) Revised Tables PP and A
D 5857 – 02:
(*1*) Additional information was added to Footnote B in Table 3.
(*2*) Added Section 3.6 on Flammability to Table 4.
D 5857 – 01a:
(*1*) Deleted ISO 1210 from Referenced Documents and Table 4, Section 3.6 on Flammability.
(*2*) Added IEC 60695–11–10 to Referenced Documents and Table 4, Section 3.6 on Flammability.
D 5857 – 01:
(*1*) Revised conditioning requirements in 12.1.1.
(*2*) Revised testing requirements in 12.2.1.
D 5857 – 00a:
(*1*) The terms “propylene” and “propylene plastics” changed to “polypropylene” throughout the standard.
D 5857 – 00:
(*1*) Added definitions for polypropylene, polypropylene homopolymer, polypropylene random copolymer, and polypropylene heterophasic copolymers.
(*2*) Revised conditioning requirements and test atmosphere in 12.1.
(*3*) Revised testing atmosphere in 12.2.
(*4*) Added data values and revised footnotes to Table PP.
(*5*) Added data values and revised footnotes to Table A.
(*6*) Added data values and revised footnotes to Table B.
(*7*) Added Table C.
(*8*) Added Table G.
(*9*) Added Table T.