Designation: D 5857 – 03

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 based on ISO standards. This callout system is based on test data collected using ISO standards.

This specification is not intended for the determination 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 values stated in SI units are to be regarded as the standard.

1.5 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/DIS 1873-1-1994 in title only. The content is significantly different. This specification and ISO/DIS 1873-2-1994 differ in approach or detail; data obtained using either are technically equivalent.

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics for Testing[2]

D 883 Terminology Relating to Plastics[2]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 1898 Practice for Sampling of Plastics[3]

D 1972 Practice for Generic Marking of Plastic Products[2]

D 1999 Guide for the Selection of Specimens and Test Parameters from ISO/IEC Standards[4]

[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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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] Discontinued. See *1998 Annual Book of ASTM Standards*, Vol 08.01.

[4] Discontinued. See *1999 Annual Book of ASTM Standards*, Vol 08.01.

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

D 3892 Practice for Packaging/Packing of Plastics[5]
D 4000 Classification System for Specifying Plastic Materials[5]
D 5033 Guide for Development of ASTM Standards Relating to Recycling and Use of Recycled Plastics[6]
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[7]

2.2 *ISO Standards:*[8]

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 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 3146 Plastics—Determination of Melting Behavior (Melting Temperature or Melting Range) of Semi-Crystalline Polymers
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 4589 Plastics—Determination of Flammability by Oxygen Index
ISO 4607 Plastics—Methods of Exposure to Natural Weathering
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
ISO 4892-4 Plastics—Methods of Exposure to Laboratory Light, Part 4: Filtered Open Flame Carbon Arc Exposure
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 11403-1 Plastics—Acquisition and Presentation of Comparable Multi-Point Data, Part 1: Mechanical Properties

2.3 *IEC Standards:*[8]

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

[5] *Annual Book of ASTM Standards*, Vol 08.02.
[6] *Annual Book of ASTM Standards*, Vol 08.03.
[7] *Annual Book of ASTM Standards*, Vol 14.02.
[8] Available through American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

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:*[9]

SAE J1545 Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Color Trim
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 J2019 Accelerated Exposure of Automotive Exterior Materials Using Controlled Irradiance Air Cooled Xenon Arc Apparatus
SAE J2212 Accelerated Exposure of Automotive Interior Materials Using Controlled Irradiance Air Cooled Xenon Arc Apparatus

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.

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,

[9] Available from Society for Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

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 to conditions specified in SAE J1960 or SAE J2019.
2 = specimens exposed to conditions specified in SAE J1885 or SAE J2212.
3 = ISO 4607.
4 = ISO 4892-2.
5 = ISO 4892-3.
6 = ISO 4892-4.

Second Digit

0 = to be specified.
1 = 200 h exposure.
2 = 500 h exposure.
3 = 1000 h exposure.
4 = 2000 h exposure.
5 = 1250 kJ/m^2 at 340 nm.
6 = 2500 kJ/m^2 at 340 nm.

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). The tensile strength after exposure shall be no less than 50 % of the original.
2 = ISO 105 grey scale rating.
3 = colorfastness by SAE J1545, CIELAB color space, 10 degrees observer, illuminant D65. E = 2.5, max.

% = 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 Unless otherwise specified, the materials shall be sampled in accordance with the sampling procedure prescribed in Practice D 1898. 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 9—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 10—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 11—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 12—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 13—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