This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

Designation: D5989 – 18

Standard Specification for Extruded and Monomer Cast Shapes Made from Nylon (PA)[1]

This standard is issued under the fixed designation D5989; 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 specification is intended to be a means of calling out plastic products used in the fabrication of end items or parts.

1. Scope*

1.1 This specification covers requirements and test methods for the material, dimensions, and workmanship, and the properties of extruded and cast sheet, plate, rod and tubular bar, excluding pipe and fittings, manufactured from nylon or monomers.

1.2 The properties included in this specification are those required for the compositions covered. Requirements necessary to identify particular characteristics important to specialized applications are described by using the classification system given in Section 4.

1.3 This specification allows for the use of recycled plastics (as defined in Guide D7209).

1.4 The values stated in English units are regarded as standard. The values in parentheses are for information only.

1.5 The following precautionary caveat pertains only to the test method portions 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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—There is no known ISO equivalent to this standard.

NOTE 2—This specification is intended to replace Federal Standard LP-410A and PS 50.

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D638 Test Method for Tensile Properties of Plastics

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D883 Terminology Relating to Plastics

D3892 Practice for Packaging/Packing of Plastics

D6779 Classification System for and Basis of Specification for Polyamide Molding and Extrusion Materials (PA)

D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)[3]

2.2 *Federal Standard:*[4]

LP-410A Nylon Stock Shapes

3. Terminology

3.1 *Definitions:*

3.1.1 *regrind (plastic), n*—a product or scrap such as sprues, runners and edge trim that have been reclaimed by shredding and granulating for use in-house.

3.1.2 For definitions of other technical terms pertaining to plastics used in this specification, see Terminology D883 or Guide D7209.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *finished product (F), n*—product that meets the dimensional criteria of Table 1, Table 2, Table 3, or Table 4 of this specification.

[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] 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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

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

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TABLE 1 Dimensional Requirements for Extruded Nylon Rod[A]

Size, in.[B]	Length Tolerance, in.	Diameter Tolerance, in.	Roundness TIR, in.	Camber, in./ft
1/16	+1 –0	+0.003 –0	0.002	2½ /8
1/8	+1 –0	+0.003 –0	0.002	2½ /8
3/16	+1 –0	+0.003 –0	0.002	2½ /8
1/4	+1 –0	+0.003 –0	0.002	2½ /8
3/8	+1 –0	+0.003 –0	0.002	2½ /8
1/2	+1 –0	+0.003 –0	0.002	2½ /8
5/8	+1 –0	+0.003 –0	0.002	2½ /8
3/4	+1 –0	+0.003 –0	0.002	2½ /8
7/8	+1 –0	+0.003 –0	0.002	2½ /8
1	+1 –0	+0.003 –0	0.002	1¼ /8
1⅛	+1 –0	+0.005 –0	0.005	1¼ /8
1¼	+1 –0	+0.005 –0	0.005	1¼ /8
1⅜	+1 –0	+0.005 –0	0.005	1¼ /8
1½	+1 –0	+0.005 –0	0.005	1¼ /8
1⅝	+1 –0	+0.005 –0	0.005	1¼ /8
1¾	+1 –0	+0.005 –0	0.005	1¼ /8
1⅞	+1 –0	+0.005 –0	0.005	1¼ /8
2	+1 –0	+0.005 –0	0.010	1¼ /8
2⅛ –2¾	+1 –0	+0.015 –0	0.030	1¼ /8
3–5	+1 –0	+0.250 –0	0.060	¼ /4
Over 5	+1 –0	+0.250 –0	0.060	¼ /4

[A]Based on dry-as-manufactured condition and proper product storage and handling.
[B]To convert inches to millimetres, multiply by 25.40.

3.2.2 *monomer-cast nylon, n*—nylon polymer prepared by polymerization of epsilon-caprolactam or lauryllactam monomer.

3.2.3 *oversize product (O), n*—product that meets only the designated dimensional criteria of Table 2 or Table 4.

3.2.4 *plate, n*—flat stock greater than ⅜ in. (9.5 mm).

3.2.5 *recycled-plastic shape, n*—a product made from up to 100 % post-consumer material.

3.2.6 *rod, n*—an extruded solid cylindrical shape with a minimum diameter of 1/16 in., or cast solid cylindrical shapes with a minimum diameter of 1 in. (25.4 mm).

3.2.7 *sheet, n*—flat stock less than and including ⅜ in. thickness.

3.2.8 *tubular bar, n*—extruded annular shapes with minimum inside diameter of ⅜ in. (9.5 mm) and minimum wall thickness of 1/16 in. (1.6 mm), or cast shapes with minimum inside diameter of ½ in. (12.7 mm), and minimum wall of ¼ in. (6.4 mm).

3.2.9 *unmodified virgin plastic shape, n*—a product produced from virgin plastic, as furnished by a manufacturer, with no additives or processing aids.

3.2.10 *virgin-plastic shape, n*—product that is produced from 100 % plastic resin that has not been subjected to subsequent melt processing.

TABLE S-PA Requirements for Nylon (Polyamide) Shapes, Dry-as-Manufactured (<0.2 % Moisture)

Type	Description	Class	Description	Grade	Applicable Classification System D6779 Callout[A]	Description	Ultimate Tensile Strength, min, psi (MPa)	Tensile Elongation, % at Break, min	Tensile Modulus, min, psi (MPa)	Dimensional Stability, %, max
01	Nylon 66	1	Unfilled	1	...	General purpose	10 000 (69)	25	350 000 (2400)	0.4
				2	...	Recycled	9000 (62)	15	350 000 (2400)	0.7
				3	PA 0114[B]	Unmodified virgin	10 000 (69)	25	350 000 (2400)	0.4
		2	MoS_2 filled	1	PA 0110L01	General purpose	11 000 (76)	15	450 000 (3100)	0.4
				2	...	Recycled	9000 (62)	5	350 000 (2400)	0.7
		3	Heat stabilized	1	PA 0124	General purpose	10 000 (69)	25	350 000 (2400)	0.4
		4	Weather resistant	1	PA 0180	General purpose	10 000 (69)	5	350 000 (2400)	0.4
		0	As specified	1	See Table 5	General purpose	...	...	...	...
				2	See Table 5	Recycled	...	...	...	...
				3	See Table 5	Unmodified virgin	...	...	...	...
02	Monomer Cast Nylon 6	1	Unfilled	1	...	General purpose	10 000 (69)	25	350 000 (2400)	0.4
		2	MoS_2 filled, 0.5–1.5 %	1	...	General purpose	10 000 (69)	15	350 000 (2400)	0.4
		3	Heat stabilized[C]	1	...	General purpose	10 000 (69)	25	350 000 (2400)	0.4
		4	Internally lubricated	1	...	General purpose	9000 (62)	25	320 000 (2100)	0.4
		5	Oil-filled	1	...	General purpose	9000 (62)	25	350 000 (2400)	0.4
		6	Highly plasticized	1	...	General purpose	8000 (53)	100	275 000 (1845)	0.4
		0	As specified	1	See Table 5	General purpose	...	...	...	...
03	Monomer Cast Nylon 612	1	Unfilled	1	...	General purpose	8000 (53)	40	300 000 (2000)	0.4
		0	As specified	1	See Table 5	General purpose	...		...	...
04	Nylon 6	1	Unfilled	1	...	General purpose	10 000 (69)	25	328 000 (2260)	0.4
		0	As specified	1	See Table 5	General purpose	...	...	...	...
05	Nylon 6/12	1	Unfilled	1	PA 0511/0512/0513	General purpose	8000 (53)	20	300 000 (2000)	0.4
		0	Unfilled	1	See Table 5	General purpose	...	...	...	...
00	Other	0	...	0	...	...	...	...	...	...

[A] Applicable Classification System D6779 resin type to be specified on purchase order.
[B]In accordance with Classification System D6779.
[C]Heat resistance requirement is 75 % retention of original tensile strength after aging 100 h at 300 ± 3.5°F. After heat aging, use Test Method D638 procedure.

TABLE 2 Dimensional Requirements for Monomer Cast Nylon Rod[A]

Size, in.[B]	Length Tolerance, in.	Diameter Tolerance, in.		Roundness TIR, in.		Camber, in./ft	
		Finished[C]	Oversize[D]	Finished[C]	Oversize[D]	Finished[C]	Oversize[D]
1	+1 -0	+0.015 –0	...	0.015	N/A[E]	¼ /4	N/A
1⅛	+1 -0	+0.015 –0	...	0.015	N/A	¼ /4	N/A
1¼	+1 -0	+0.015 –0	...	0.015	N/A	¼ /4	N/A
1⅜	+1 -0	+0.015 –0	+0.100 –0	0.015	N/A	¼ /4	N/A
1½	+1 -0	+0.015 –0	+0.100 –0	0.015	N/A	¼ /4	N/A
1⅝	+1 -0	+0.015 –0	+0.100 –0	0.015	N/A	¼ /4	N/A
1¾	+1 -0	+0.015 –0	+0.100 –0	0.015	N/A	¼ /4	N/A
1⅞	+1 -0	+0.015 –0	+0.100 –0	0.015	N/A	¼ /4	N/A
2–2¾	+1 -0	+0.015 –0	+0.125 –0	0.015	N/A	¼ /4	N/A
3–5	+1 -0	+0.250 –0	+0.250 –0	0.060	N/A	¼ /4	N/A
Over 5	+1 -0	+0.250 –0	+0.500 –0	N/A	N/A	N/A	N/A

[A]Based on dry-as-manufactured condition and proper product storage and handling.
[B]To convert inches to millimetres, multiply by 25.40.
[C]Finished product as defined in 3.2.1.
[D]Oversize product as defined in 3.2.3; roundness and camber not applicable.
[E]Not applicable.

TABLE 3 Dimensional Requirements for Extruded Nylon Sheets and Plates[A] (Squareness Requirement Listed in 11.4)

Size, in.[B]	Width Tolerance, in.	Thickness Tolerances, in.[C]	Length Camber, in./ft	Width Bow, in./ft
1/16	+0.5 –0	±0.005	¾ /4	3/16 /2
3/32	+0.5 –0	±0.005	¾ /4	3/16 /2
⅛	+0.5 –0	±0.005	¾ /4	3/16 /2
3/16	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
¼	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
5/16	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
⅜	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
7/16	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
½	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
⅝	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
¾	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
⅞	+0.5 –0	+0.025 –0	¾ /4	3/16 /2
1	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
1⅛	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
1¼	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
1⅜	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
1½	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
1⅝	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
1¾	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
1⅞	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
2	+0.5 –0	+0.025 –0	¼ /4	1/16 /2
Over 2	+0.5 –0	+0.050 –0	¼ /4	1/16 /2

[A]Based on dry-as-manufactured condition and proper product storage and handling.
[B]To convert inches to millimetres, multiply by 25.40.
[C]Length tolerance in inches for all sizes at 48-in. length is +1.001 –0 and at 144-in. length is +1.001 –0.

4. Classification and Material

4.1 Product shape and size as defined in the applicable purchase order.

4.2 This specification covers product extruded and cast as listed in Table S-PA. Products included in the designations reference Classification System D6779 callouts where applicable.

4.2.1 The type of nylon extruded product is categorized by type, grade and class depending on resin and filler compositions as defined in Table S-PA.

4.2.2 Each type of nylon shape is categorized into one of several grades as follows:

4.2.2.1 *Grade 1—General Purpose:*

(1) Extruded product made using virgin plastic plus up to 15 % maximum of an alternate virgin-nylon as a processing aid.

(2) Monomer-cast nylon made from epsilon-caprolactam or lauryllactam monomer.

4.2.2.2 *Grade 2—Recycled*—This specification allows for the use of nylon plastic materials that are recycled, reconstituted, recycled-regrind, recovered, or preprocessed, or combination thereof, provided that the requirements as stated in this specification are met. It is the responsibility of the supplier and the buyer of recycled, reconstituted recycled-regrind, recovered, or reprocessed Nylon plastic materials, or combination thereof, to ensure compliance. (See Guide D7209.)

(1) Extruded product made using any amount up to 100 % recycled nylon plastic.

(2) Does not apply to cast product.

4.2.2.3 *Grade 3—Unmodified Virgin:*

(1) Extruded product made using 100 % unmodified virgin plastic.

(2) Does not apply to cast product.

4.3 The type, class, and grade is further differentiated based on dimensional stability (elevated temperature excursion test), Table S-PA, and dimensional requirements. The suffix F is added to any Table S-PA description to specify finished product meeting the dimensional properties of the appropriate table of Tables 1-4. The suffix O is added to any Table S-PA description to excuse cast products from roundness, camber, or bow requirements (3.2.3)

4.4 *Property Tables:*

4.4.1 Table S-PA is used to describe extruded or cast products, except where it does not cover the product type being considered.

4.4.2 Table 5 is used to describe extruded or cast products for which properties are not included in Table S-PA. A cell callout that includes the applicable Table S-PA nylon type and specific properties in Table 5. These are called out using the appropriate numerical property designations in order (1 through 7) preceded by the number 5. See Example 5 for a possible callout.

TABLE 4 Dimensional Requirements for Monomer Cast Nylon Sheets and Plates[A] (Squareness Requirement Listed in 11.4)

Size, in.[B]	Width Tolerance, in.	Thickness Tolerances, in.		Length Camber, in./ft		Width Bow, in./ft	
		Finished[C]	Oversize[D]	Finished[C]	Oversize[D]	Finished[C]	Oversize[D]
3/16	+0.5 –0	+0.025 –0	...	1/4 /4	N/A[E]	1/16 /2	N/A
1/4	+0.5 –0	+0.025 –0	...	1/4 /4	N/A	1/16 /2	N/A
5/16	+0.5 –0	+0.025 –0	...	1/4 /4	N/A	1/16 /2	N/A
3/8	+0.5 –0	+0.025 –0	+0.080 –0	1/4 /4	N/A	1/16 /2	N/A
7/16	+0.5 –0	+0.025 –0	+0.080 –0	1/4 /4	N/A	1/16 /2	N/A
1/2	+0.5 –0	+0.025 –0	+0.080 –0	1/4 /4	N/A	1/16 /2	N/A
5/8	+0.5 –0	+0.025 –0	+0.080 –0	1/4 /4	N/A	1/16 /2	N/A
3/4	+0.5 –0	+0.025 –0	+0.080 –0	1/4 /4	N/A	1/16 /2	N/A
7/8	+0.5 –0	+0.025 –0	+0.080 –0	1/4 /4	N/A	1/16 /2	N/A
1	+0.5 –0	+0.025 –0	+0.100 –0	1/4 /4	N/A	1/16 /2	N/A
1 1/8	+0.5 –0	+0.025 –0	+0.100 –0	1/4 /4	N/A	1/16 /2	N/A
1 1/4	+0.5 –0	+0.025 –0	+0.100 –0	1/4 /4	N/A	1/16 /2	N/A
1 3/8	+0.5 –0	+0.025 –0	+0.100 –0	1/4 /4	N/A	1/16 /2	N/A
1 1/2	+0.5 –0	+0.025 –0	+0.100 –0	1/4 /4	N/A	1/16 /2	N/A
1 5/8	+0.5 –0	+0.025 –0	+0.100 –0	1/4 /4	N/A	1/16 /2	N/A
1 3/4	+0.5 –0	+0.025 –0	+0.100 –0	1/4 /4	N/A	1/16 /2	N/A
1 7/8	+0.5 –0	+0.025 –0	+0.100 –0	1/4 /4	N/A	1/16 /2	N/A
2–3 3/4	+0.5 –0	+0.025 –0	+0.200 –0	1/4 /4	N/A	1/16 /2	N/A
Over 3 3/4	+0.5 –0	+0.025 –0	N/A	1/4 /4	N/A	1/16 /2	N/A

[A]Based on dry-as-manufactured condition and proper product storage and handling.
[B]To convert inches to millimetres, multiply by 25.40.
[C]Finished product as defined in 3.2.1.
[D]Oversize product as defined in 3.2.3; camber and bow not applicable.
[E]Not applicable.

TABLE 5 Additional Detail Requirements—Reinforced/Unreinforced Extruded and Cast Nylons[A]

Designation Order Number	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, Test Method D638, min, psi (MPa)	Unspecified	6000 (41)	8000 (55)	10 000 (69)	12 000 (83)	14 000 (97)	16 000 (110)	20 000 (138)	25 000 (172)	Specify value
2	Elongation at break, Test Method D638, %, min	Unspecified	1	3	5	10	20	50	100	200	Specify value
3	Tensile modulus min, Test Method D638, min, psi (MPa)	Unspecified	100 000 (690)	200 000 (1379)	300 000 (2073)	400 000 (2760)	500 000 (3448)	600 000 (4137)	800 000 (5516)	1 000 000 (6895)	Specify value
4	Dimensional stability, % max, per 11.2	Unspecified	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.5	Specify value
5	Flexural modulus, Test Methods for D790, min, psi (MPa)	Unspecified	250 000 (1649)	350 000 (2400)	450 000 (3100)	550 000 (3792)	650 000 (4482)	750 000 (5171)	1 000 000 (6895)	1 500 000 (10 343)	Specify value
6	Izod impact, Test Method for D256, min, ft lbs/in. (J/m) of notch	Unspecified	0.4 (21)	0.6 (32)	0.8 (43)	1.0 (53)	2.0 (107)	3.0 (160)	4.5 (240)	6.0 (320)	Specify value
7	To be determined	Unspecified	...	...	...	...	...	...	...	...	

[A]The applicable Table 4 nylon type (including fillers in accordance with 4.4.4) must precede this table designation.

4.4.3 To facilitate the incorporation of future or special materials not covered by Table S-PA, the "as specified" category (00) for type is shown in the table with the basic properties to be obtained from Table 5, as they apply (see 4.5, Example 5).

4.4.4 *Reinforcements and Additive Materials*—A symbol (single-letter) shall be used for the major reinforcement or combination, or both, along with two numbers that indicate the

percentage of addition by mass with the tolerances as tabulated in the following table. This must be included in all 5 callouts (see 4.5, Example 5).

Symbol	Material	Tolerance (Based on the Total Mass)
C	Carbon and graphite fiber	±2 %
G	Glass	±2 %
L	Lubricants (for example, PTFE, graphite, silicone and molybdenum disulfide)	Depends upon material and process to be specified.
M	Mineral	±2 %
R	Combinations of reinforcements or fillers, or both	±3 % for the total reinforcement

4.5 *Callout Designation*—A one-line system shall be used to specify nylon materials covered by this specification. The system uses pre-defined cells to refer to specific aspects of this specification as illustrated in the following examples:

4.5.1 *Description:*

4.5.1.1 *Example 1*—Product made from general purpose nylon 66 natural:

CELL CALLOUT: S-PA 0111
S-PA01 = Product made from PA 66 per Table S-PA
1 = Unfilled class
1 = General purpose grade product

4.5.1.2 *Example 2*—Product made from nylon 66 recycle:

CELL CALLOUT: S-PA 0112
S-PA01 = Product made from PA 66 per Table S-PA
1 = Unfilled class
2 = Recycled grade product

4.5.1.3 *Example 3*—Product made from nylon 66 MoS_2 filled:

CELL CALLOUT: S-PA 0121
S-PA01 = Product made from PA 66 per Table S-PA
2 = MoS_2 filled class
1 = General purpose grade product

4.5.1.4 *Example 4*—Product made from unmodified virgin nylon 66 natural:

CELL CALLOUT: S-PA 0113
PA01 = Product made from PA 66 per Table S-PA
1 = Unfilled class
3 = Unmodified virgin grade product

4.5.1.5 *Example 5*—Product made from nylon 66, 33 % glass-reinforced:

CELL CALLOUT: S-PA 0101 G33 A57170720
S-PA0101 = Product made from PA 66 per Table S-PA as specified
G33 = 33 % glass
5 = Table 5 properties
7 = Tensile Strength (20 000 psi (137 895 kPa))
1 = Elongation at Break (1 %)
7 = Tensile Modulus (800 000 psi (5 515 800 kPa))
0 = Dimensional Stability (unspecified)
7 = Flexural Modulus (1 000 000 psi (6 894 800 kPa))
2 = Izod Impact (0.6 ft lb/in. (0.13 J/cm) of notch)
0 = Unspecified

4.5.1.6 *Example 6*—Product made from unfilled cast nylon 6:

CELL CALLOUT: S-PA 0211F
S-PA02 = Product made from PA 6 cast per Table S-PA
1 = Unfilled class
1 = General purpose grade product
F = Produced to meet all dimensional criteria of Table 2, cast rod, or Table 4, cast plate.

4.5.1.7 *Example 7*—Product made from oil-filled cast nylon 6:

CELL CALLOUT: S-PA 0251O
S-PA02 = Product made from PA 6 per Table S-PA
5 = Oil-filled
1 = General purpose grade product
O = Product exceeds dimensional criteria of Table 2, cast rod, or Table 4, cast plate.

4.5.2 These seven examples illustrate how a one-line, alphanumeric sequence can identify the product composition, commercial parameters and physical characteristics of extruded or cast product. A space shall be used as a separator between the specification number and the type designation. No separators are needed between type, class and grade. When special notes are to be included, such information should be preceded by a comma. Special tolerances must be noted at time of order and are inserted after the grade in parentheses and preceded by a comma.

5. Dimensional Requirements

5.1 The type, class, and grade is further differentiated based on dimensional stability (elevated temperature excursion test), Table S-PA, and dimensional requirements, Tables 1-4. Products shall be produced within commercial tolerances and with the lowest stress levels for machined parts as delineated in Table 1 and Table 3 for extruded products. For cast product, Table 2 and Table 4 contain dimensional tolerances for both finished (F) and oversize (O) product. The manner in which the tolerances are obtained is not relevant. This shall be designated in each callout as referenced in 4.5, Examples 6 and 7.

5.2 Tubular bar dimensions shall be supplied in the unfinished condition unless otherwise specified.

5.3 The maximum allowable camber or bow, or both, shall be within the limits referenced in Tables 1-4.

6. Workmanship, Finish, and Appearance

6.1 *Appearance*—The color of products shall be as published by the shapes manufacturer. They shall be uniform in color throughout the thickness. Specific colors and color-matching only as agreed to by order. Color sometimes affects physical properties.

6.2 *Finish*—All products shall be free of blisters, wrinkles, cracks, gouges and defects that restrict commercial use of the product. A special surface finish shall be supplied only when specified.

6.3 *Defects*—All products shall be free of voids, dirt, foreign material and embedded particles exceeding 1/32-in. (0.8-mm) maximum diameter as defined in 6.3.1.

6.3.1 The criteria for determining the internal cleanliness shall be external visual inspection. A maximum number of two internal defects per square foot of plate/sheet and 1-ft (0.3-m) length of rod and tubular bar shall be allowed. Clusters of defects less than 1/32-in. (0.8-mm) diameter are to be counted as a single defect.

7. Physical Property Requirements

7.1 The physical property values listed within this specification's tables are to be considered minimum specification values. Any requirement for specific test data for a given production lot is to be specified at the time of order. If physical

properties for products not yet included in Table S-PA are required, specify using Table 5 for extruded or cast products.

8. Sampling

8.1 The materials shall be sampled in accordance with a sampling procedure statistically adequate to satisfy the requirements of 12.1. A lot shall be considered as a unit of manufacture defined as a production run.

9. Number of Tests

9.1 Routine lot inspection shall consist of all the criteria specified in the applicable product tables.

9.2 The criteria listed in these product tables and definitions are sufficient to establish conformity of the sheet, plate, rod, or tubular bars to this specification. When the number of test specimens is not stated in the test method, a single determination is sufficient. If more than single determinations and separate portions of the same sample are made, the results shall be averaged. The final result shall conform to the requirements prescribed in this specification.

10. Test Conditions

10.1 *Conditioning of Specimens*—The specification values and dimensions are based on dry-as-manufactured specimens or the test specimens are dried at 150°F (65.5°C), 28- to 30-in. (71- to 76-cm) Hg vacuum to less than 0.2 % moisture.

10.2 *Standard Temperature*—The tests shall be conducted at the standard laboratory temperature of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 10 % relative humidity.

11. Test Methods

11.1 Test tensile strength at break, elongation at break, and tensile modulus (tangent) in accordance with Test Method D638, at the rate of 0.2 in./min:

11.1.1 All plate and sheet specimens in accordance with Test Method D638, Type I.

11.1.2 All rod specimens in accordance with Test Method D638.

11.1.3 All tubular bar specimens in accordance with Test Method D638.

11.2 *Dimensional Stability:*

11.2.1 *Specimen Preparation* (A minimum of three test samples required. The results shall be averaged. The final result shall conform to the requirements prescribed in this specification.)

11.2.1.1 *Rods and Tubular Bar*—Prepare each specimen by cutting a 1.5-in. (38-mm) long slice from the shape to be tested. Then machine the slice using a coolant and good machining practices to a length of 1.000 ± 0.005 in. (25.4 ± 0.01 mm). Each end of the specimen shall have a machined surface.

11.2.1.2 *Plate and Sheet*—This test is not applicable to sheet under 3/16-in. (4.8-mm) thick. Each specimen shall consist of a 2 in. (51-mm) diameter disc machined from the flat (the diameter shall equal the test specimen thickness with a minimum of 2.0 in. (51 mm)). The same care shall be used in the machining in accordance with 11.2.1.1. The thickness of the specimen shall be that of the original flat from which it was cut, no machining being done on the top or bottom faces.

11.2.2 *Testing Procedure*—Measure the outside diameter and thickness or length of the specimen as applicable at 73.4 ± 1.8°F (23 ± 1°C) to the nearest 0.0001 in. (0.003 mm). All measurements shall be done on the center line and 90° from the center line for plate. Also take measurements for thickness halfway to center and for diameter at mid-point. Place the specimen in an oil bath consisting of polyalkylene glycol or an air-circulating oven and heat to the applicable temperature for nylon type as noted in 11.2.2.1. After 6 h, allow the specimen to slowly cool to room temperature at a rate not to exceed 40°F (22°C)/h. Then measure the specimen at 73.4 ± 1.8°F (23 ± 1°C) and calculate the percent change in each dimension.

11.2.2.1 *Test Temperatures:*

Nylon 66 = 425 ± 5.4°F (218 ± 3°C)
Nylon 6 = 350 ± 5.4°F (177 ± 3°C)
Nylon 612 = 300 ± 5.4°F (149 ± 3°C)

11.3 *Lengthwise Camber and Widthwise Bow:*

11.3.1 Make all measurements for camber and bow using the maximum distance rod, sheet or plate deviates from the straight line extended from edge to edge when measured in accordance with 11.3.2. The shape shall be oriented such that the weight of the product does not influence the results.

11.3.2 *Rod, Sheet and Plate:*

11.3.2.1 *Rod*—Lay each rod on its side and measure it with the concave side facing the straight edge. Measure the camber from the straight edge to the maximum concave point on the rod. The camber is not to exceed the values of Table 1 for extruded or Table 2 for cast product.

11.3.2.2 *Sheet and Plate Up To and Including* 5/8-in. (16-mm) thick shall meet the requirements of Table 3 for extruded or Table 4 for cast product when measured with a straight edge, positioned in a lengthwise and widthwise direction, with the plate standing on its edge.

11.3.2.3 *Sheet and Plate Greater than* 5/8-in. (16-mm) Thick—Plate above 5/8-in. (16-mm) thick shall not exceed the requirements of Table 3 for extruded or Table 4 for cast product on the lengthwise ends and widthwise edges when laid on a flat surface (crown side up).

11.4 *Squareness (Based on a 4-ft (1.2-m) Nominal Length):*

11.4.1 Measure and compare diagonal lengths (corner to corner). Accept the product if the difference is 1/16 in. (1.6 mm) or less and the measured minimum diagonal meets the following requirements:

11.4.1.1 One foot wide is 49½ in. (1257 mm) minimum.

11.4.1.2 Two feet wide is 53¾ in. (1365 mm) minimum.

11.4.1.3 Four feet wide is 68 in. (173 mm) minimum.

11.4.2 If the diagonal difference exceeds 1/16 in. (1.6 mm), proceed to measure the gap (which is the deviation from a 2-ft (0.6-m) square). The maximum allowable gap shall not exceed 1/8 in. (3.2 mm) except for the 1-ft (0.3-m) wide sizes of sheet and plate, which should not exceed 1/16 in. (1.6 mm).

11.5 *Flexural Modulus*—Test in accordance with Test Methods D790, specimen 1/4-in. (6-mm) thick maximum, testing speed 0.11 in./min.

11.6 *Izod Impact*—Test in accordance with Test Method D256, Method A, Fig. 4, notched, 1/4-in. (6-mm) thick maximum specimen.

12. Certification

12.1 When requested, the purchaser shall be furnished a certification that the lot is made from the required nylon plastic (percent recycle, if applicable) and meets the requirements of this standard.

13. Packing, Packaging, and Marking

13.1 All packing, packaging, and marking provisions of Practice D3892 shall apply to this specification.

14. Ordering Information

14.1 All shapes covered by this specification shall be ordered using the proper callout designation (see 4.5).

15. Keywords

15.1 monomer cast; nylon; plates; recycled plastic; rod; shapes; sheet; tubular bar

APPENDIX

(Nonmandatory Information)

X1. PHYSICAL PROPERTY CROSS REFERENCES TO L-P-410A AND PS 50

Specification D5989	L-P-410A/PS 50
S-PA0111	Tables I and V
S-PA011	Tables I and V
S-PA 0121	Tables I, II and V
S-PA 0211	Tables I and V
S-PA 0221	Tables I, II and V
S-PA 0231	Tables I, II and V

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D5989 - 14a) that may impact the use of this standard. (August 1, 2018)

(1) In Table S-PA, corrected callout for S-PA 0511 to contain Applicable Classification System D6779 PA 0511/0512/0513.

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