



Designation: **D5989—14a D5989 – 18**

## Standard Specification for Extruded and Monomer Cast Shapes Made from Nylon (PA)<sup>1</sup>

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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

### 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:<sup>2</sup>

[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 \(Withdrawn 2015\)](#)<sup>3</sup>

##### 2.2 Federal Standard:<sup>4</sup>

[LP-410A Nylon Stock Shapes](#)

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee [D20](#) on Plastics and is the direct responsibility of Subcommittee [D20.15](#) on Thermoplastic Materials. Current edition approved July 1, 2014/Aug. 1, 2018. Published July 2014/August 2018. Originally approved in 1998. Last previous edition approved in 2014 as [D5989—14-D5989 – 14a](#). DOI: [10.1520/D5989-14A-10.1520/D5989-18](#).

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

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](#).

<sup>4</sup> 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

### 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.

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  $\frac{3}{8}$  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  $\frac{1}{16}$  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  $\frac{3}{8}$  in. thickness.

3.2.8 *tubular bar, n*—extruded annular shapes with minimum inside diameter of  $\frac{3}{8}$  in. (9.5 mm) and minimum wall thickness of  $\frac{1}{16}$  in. (1.6 mm), or cast shapes with minimum inside diameter of  $\frac{1}{2}$  in. (12.7 mm), and minimum wall of  $\frac{1}{4}$  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 <sup>A</sup>	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 <sup>B</sup>	Unmodified virgin	10 000 (69)	25	350 000 (2400)	0.4
2	MoS <sub>2</sub> filled	1		1	PA 0110L01	General purpose	11 000 (76)	15	450 000 (3100)	0.4

**TABLE 1 Dimensional Requirements for Extruded Nylon Rod<sup>A</sup>**

Size, in. <sup>B</sup>	Length Tolerance, in.	Diameter Tolerance, in.	Roundness TIR, in.	Camber, in./ft
$\frac{1}{16}$	+1 –0	+0.003 –0	0.002	2½ /8
$\frac{1}{8}$	+1 –0	+0.003 –0	0.002	2½ /8
$\frac{3}{16}$	+1 –0	+0.003 –0	0.002	2½ /8
$\frac{1}{4}$	+1 –0	+0.003 –0	0.002	2½ /8
$\frac{3}{8}$	+1 –0	+0.003 –0	0.002	2½ /8
$\frac{1}{2}$	+1 –0	+0.003 –0	0.002	2½ /8
$\frac{5}{8}$	+1 –0	+0.003 –0	0.002	2½ /8
$\frac{3}{4}$	+1 –0	+0.003 –0	0.002	2½ /8
$\frac{7}{8}$	+1 –0	+0.003 –0	0.002	2½ /8
1	+1 –0	+0.003 –0	0.002	1¼ /8
1½	+1 –0	+0.005 –0	0.005	1¼ /8
1¼	+1 –0	+0.005 –0	0.005	1¼ /8
1⅝	+1 –0	+0.005 –0	0.005	1¼ /8
1½	+1 –0	+0.005 –0	0.005	1¼ /8
1⅞	+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
2⅞ –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

<sup>A</sup>Based on dry-as-manufactured condition and proper product storage and handling.

<sup>B</sup>To convert inches to millimetres, multiply by 25.40.

TABLE 2 Dimensional Requirements for Monomer Cast Nylon Rod<sup>A</sup>

Size, in. <sup>B</sup>	Length Tolerance, in.	Diameter Tolerance, in.		Roundness TIR, in.		Camber, in./ft	
		Finished <sup>C</sup>	Oversize <sup>D</sup>	Finished <sup>C</sup>	Oversize <sup>D</sup>	Finished <sup>C</sup>	Oversize <sup>D</sup>
1	+1 -0	+0.015 -0	...	0.015	N/A <sup>E</sup>	¼ /4	N/A
1 1/8	+1 -0	+0.015 -0	...	0.015	N/A	¼ /4	N/A
1 1/4	+1 -0	+0.015 -0	...	0.015	N/A	¼ /4	N/A
1 3/8	+1 -0	+0.015 -0	+0.100 -0	0.015	N/A	¼ /4	N/A
1 1/2	+1 -0	+0.015 -0	+0.100 -0	0.015	N/A	¼ /4	N/A
1 5/8	+1 -0	+0.015 -0	+0.100 -0	0.015	N/A	¼ /4	N/A
1 3/4	+1 -0	+0.015 -0	+0.100 -0	0.015	N/A	¼ /4	N/A
1 7/8	+1 -0	+0.015 -0	+0.100 -0	0.015	N/A	¼ /4	N/A
2-2 3/4	+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

<sup>A</sup>Based on dry-as-manufactured condition and proper product storage and handling.

<sup>B</sup>To convert inches to millimetres, multiply by 25.40.

<sup>C</sup>Finished product as defined in 3.2.1.

<sup>D</sup>Oversize product as defined in 3.2.3; roundness and camber not applicable.

<sup>E</sup>Not applicable.

TABLE 3 Dimensional Requirements for Extruded Nylon Sheets and Plates<sup>A</sup> (Squareness Requirement Listed in 11.4)

Size, in. <sup>B</sup>	Width Tolerance, in.	Thickness Tolerances, in. <sup>C</sup>	Length Camber, in./ft	Width Bow, in./ft
1/16	+0.5 -0	±0.005	¾ /4	¾ /2
3/32	+0.5 -0	±0.005	¾ /4	¾ /2
1/8	+0.5 -0	±0.005	¾ /4	¾ /2
3/16	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1/4	+0.5 -0	+0.025 -0	¾ /4	¾ /2
5/16	+0.5 -0	+0.025 -0	¾ /4	¾ /2
3/8	+0.5 -0	+0.025 -0	¾ /4	¾ /2
7/16	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1/2	+0.5 -0	+0.025 -0	¾ /4	¾ /2
5/8	+0.5 -0	+0.025 -0	¾ /4	¾ /2
3/4	+0.5 -0	+0.025 -0	¾ /4	¾ /2
7/8	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1 1/8	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1 1/4	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1 3/8	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1 1/2	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1 5/8	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1 3/4	+0.5 -0	+0.025 -0	¾ /4	¾ /2
1 7/8	+0.5 -0	+0.025 -0	¾ /4	¾ /2
2	+0.5 -0	+0.025 -0	¾ /4	¾ /2
Over 2	+0.5 -0	+0.050 -0	¾ /4	¾ /2

<sup>A</sup>Based on dry-as-manufactured condition and proper product storage and handling.

<sup>B</sup>To convert inches to millimetres, multiply by 25.40.

<sup>C</sup>Length tolerance in inches for all sizes at 48-in. length is +1.001 -0 and at 144-in. length is +1.001 -0.

Type	Description	Class	Description	Grade	Applicable Classification System D6779 Callout <sup>A</sup>	Description	Ultimate Tensile Strength, min, psi (MPa)	Tensile Elongation, % at Break, min	Tensile Modulus, min, psi (MPa)	Dimensional Stability, %, max		
02	Monomer Cast Nylon 6	1	Unfilled	2	...	Recycled	9000 (62)	5	350 000 (2400)	0.7		
				3	PA 0124	General purpose	10 000 (69)	25	350 000 (2400)	0.4		
				4	PA 0180	General purpose	10 000 (69)	5	350 000 (2400)	0.4		
		2	MoS <sub>2</sub> filled, 0.5-1.5 %	0	As specified	1	See Table 5	General purpose	...	...	...	
				1	See Table 5	Recycled	...	...	...	...		
				2	See Table 5	Unmodified virgin	...	...	...	...		
		3	Heat stabilized <sup>C</sup>	1	...	1	...	General purpose	10 000 (69)	25	350 000 (2400)	0.4
				2	...	1	...	General purpose	10 000 (69)	25	350 000 (2400)	0.4
				3	...	1	...	General purpose	9000 (62)	25	320 000 (2100)	0.4
				4	...	1	...	General purpose	9000 (62)	25	350 000 (2400)	0.4
		6	Highly plasticized	1	...	1	...	General purpose	8000 (53)	100	275 000 (1845)	0.4

TABLE 4 Dimensional Requirements for Monomer Cast Nylon Sheets and Plates<sup>A</sup> (Squareness Requirement Listed in 11.4)

Size, in. <sup>B</sup>	Width Tolerance, in.	Thickness Tolerances, in.		Length Camber, in./ft		Width Bow, in./ft	
		Finished <sup>C</sup>	Oversize <sup>D</sup>	Finished <sup>C</sup>	Oversize <sup>D</sup>	Finished <sup>C</sup>	Oversize <sup>D</sup>
3/16	+0.5 -0	+0.025 -0	...	1/4 /4	N/A <sup>E</sup>	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

<sup>A</sup>Based on dry-as-manufactured condition and proper product storage and handling.

<sup>B</sup>To convert inches to millimetres, multiply by 25.40.

<sup>C</sup>Finished product as defined in 3.2.1.

<sup>D</sup>Oversize product as defined in 3.2.3; camber and bow not applicable.

<sup>E</sup>Not applicable.

Type	Description	Class	Description	Grade	Applicable Classification System D6779 Callout <sup>A</sup>	Description	Ultimate Tensile Strength, min, psi (MPa)	Tensile Elongation, % at Break, min	Tensile Modulus, min, psi (MPa)	Dimensional Stability, %, max
03	Monomer Cast Nylon 612	0	As specified	1	See Table 5	General purpose	...	...	...	...
		1	Unfilled	1	...	General purpose	8000 (53)	40	300 000 (2000)	0.4
04	Nylon 6	0	As specified	1	See Table 5	General purpose	...	...	...	...
		1	Unfilled	1	...	General purpose	10 000 (69)	25	328 000 (2260)	0.4
05	Nylon 6/12	0	As specified	1	See Table 5	General purpose	...	...	...	...
		1	Unfilled	1	PA 0612/0613	General purpose	8000 (53)	20	300 000 (2000)	0.4
05	Nylon 6/12	1	Unfilled	1	PA 0511/0512/0513	General purpose	8000 (53)	20	300 000 (2000)	0.4
00	Other	0	Unfilled	1	See Table 5	General purpose	...	...	...	...
		0	...	0	...	...	...	...	...	...

TABLE 5 Additional Detail Requirements—Reinforced/Unreinforced Extruded and Cast Nylons<sup>A</sup>

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	...	...	...	...	...	...	...	...	...

<sup>A</sup>The applicable Table 4 nylon type (including fillers in accordance with 4.4.4) must precede this table designation.

<sup>A</sup> Applicable Classification System **D6779** resin type to be specified on purchase order.

<sup>B</sup> In accordance with Classification System **D6779**.

<sup>C</sup> 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.

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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.

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).

<https://standards.iteh.ai/catalog/standards/sist/591b3-104b-443d-9901-dd7a741f7700/astm-d5989-18>

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<sub>2</sub> filled:

CELL CALLOUT: S-PA 0121  
 S-PA01 = Product made from PA 66 per Table S-PA  
 2 = MoS<sub>2</sub> filled class  
 1 = General purpose grade product