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Designation: D 4066 – 00a

An American National Standard

Standard Classification System for Nylon Injection and Extrusion Materials (PA)[1]

This standard is issued under the fixed designation D 4066; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope *

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

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

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

1.4 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 11, of this classification system. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—This classification system is similar to ISO 1874-1/-2 1993, although the technical content is significantly different.

NOTE 2—This classification system is being revised to include international 4-mm specimens and test procedures as the standard for compliance. The 3.2-mm specimens; test methods; and Tables PA, A, and B are included in Appendix X3 as a reference for those wishing to use them. It is recommended that the material manufacturer be consulted on all callouts against this classification system.

2. Referenced Documents

2.1 *ASTM Standards:*

D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies[2]

D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials[2]

D 256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics[3]

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials[2]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[3]

D 638 Test Method for Tensile Properties of Plastics[3]

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load[3]

D 789 Test Methods for Determination of Relative Viscosity, Melting Point, and Moisture Content of Polyamide (PA)[3]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[3]

D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement[3]

D 883 Terminology Relating to Plastics[4]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[3]

D 1898 Practice for Sampling of Plastics[3]

D 1999 Guide for Selection of Specimens and Test Parameters for International Commerce[3]

D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis[5]

D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials[5]

D 3892 Practice for Packaging/Packing of Plastics[5]

D 4000 Classification System for Specifying Plastic Materials[5]

[1] This classification system is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials (Section D20.15.09).

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[2] *Annual Book of ASTM Standards*, Vol 10.01.

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

[4] Discontinued; see *1997 Annual Book of ASTM Standards*, Vol 08.01.

[5] *Annual Book of ASTM Standards*, Vol 08.02.

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

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D 5630 Test Method for Ash Content in Thermoplastics[6]
E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[7]

2.2 *Military and Federal Specifications and Standards:*[8]
L-P-410 Plastic, Polyamide (Nylon) Rigid: Rods, Tubes, Flats, Molded and Cast Parts
VV-I-530 Insulating Oil, Electrical (for Transformers, Switches, and Circuit Breakers)

2.3 *ISO Standards:*[9]
ISO 75-1:1993 Plastics—Determination of Temperature of Deflection Under Load—Part 1: General Test Methods
ISO 75-2:1993 Plastics—Determination of Temperature of Deflection Under Load—Part 2: Plastic and Ebonite
ISO 178:1993 Plastics—Determination of Flexural Properties
ISO 180:1993 Plastics—Determination of Izod Impact Strength
ISO/DIS 294-1:1995 Plastics—Injection Moulding of Test Specimens of Thermoplastic Materials—Part 1: General Principles, Multipurpose-Test Specimens (ISO Mould Type A) and Bars (ISO Mould Type B)
ISO 307 Determination of Viscosity Number of Polyamides In Dilute Solutions
ISO 527-1:1993 Plastics—Determination of Tensile Properties—Part 1: General Principles
ISO 527-2:1993 Plastics—Determination of Tensile Properties—Part 2: Testing Conditions
ISO 960:1969 Plastics—Determination of the Water Content in Polyamides
ISO 1183:1987 Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics
ISO 1874-1:1992 Plastics—Polyamide (PA) Homopolymers and Copolymers for Moulding and Extrusion Part 1: Designation
ISO/DIS 1874-2.2:1995 Plastics—Polyamide (PA) Homopolymers for Moulding and Extrusion—Part 2: Preparation of Test Specimens and Determination of Properties
ISO 3146: Plastics—Determination of Melting Behaviour (Melting Temperature or Melting Range) of Semi-Crystalline Polymers
ISO 3167 Plastics, Multipurpose Test Specimens
ISO 3451-4:1994 Plastics—Determination of Ash—Part 4: Polyamides

3. Terminology

3.1 The terminology used in this classification system is in accordance with Terminologies D 883 and D 1600.

4. Classification

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

NOTE 3—An example of this classification system for unreinforced nylon is given as follows: The designation PA0123 indicates the following:

PA	=	polyamide (nylon) as found in Terminology D 1600,
01 (group)	=	66 nylon,
2 (class)	=	heat stabilized, and
3 (grade)	=	with a minimum viscosity number of 210 and the requirements given in Table PA.

NOTE 4—An example of this classification system for reinforced nylon is given as follows: The designation PA012G35 indicates the following:

PA	=	polyamide (nylon) as found in Terminology D 1600,
01 (group)	=	66 nylon,
2 (class)	=	heat stabilized, and
G35 (grade)	=	nominal 35 % glass with the requirements given in Table PA.

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

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

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

NOTE 6—Materials containing reinforcements or fillers, or both, at nominal levels not in multiples of 5 are included in the nearest PA grade designation. For example, a material with a nominal material level of 28 % is included with Grade M30.

NOTE 7—An example of this classification system for a 33 % glass-reinforced nylon is given as follows. The designation PA011G35 indicates the following:

PA	=	polyamide (nylon) as found in Terminology D 1600,
01 (group)	=	66 nylon,
1 (class)	=	general purpose, and
G35 (grade)	=	with requirements given in Table PA.

NOTE 8—Ash content of filled or reinforced materials may be determined using Test Method D 5630.

[6] *Annual Book of ASTM Standards*, Vol 08.03.
[7] *Annual Book of ASTM Standards*, Vol 14.02.
[8] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.
[9] Available from American National Standards Institute, 11 West 42nd St., 13th Floor, New York, NY 10036.

TABLE PA Requirements for Nylons Dry-as-Molded[A,B]

Group	Description	Class	Description	Grade	Description[C]	Viscosity Number, ISO 307, min, mL/g	Density, ISO 1183, g/cm^3	Tensile Strength,[D] ISO 527-1 and ISO 527-2, min, MPa	Flexural Modulus, ISO 178, min, MPa	Izod Impact Resistance, ISO 180/1A, min, kJ/m^2	Deflection Temperature at 1.82 MPa,[E] ISO 75-1 and ISO 75-2 min, °C
01	66 Nylon	1	General-purpose	1		135	1.13–1.15	70	2 300	3.3	60
				2		165	1.13–1.15	70	2 300	3.3	60
				3		210	1.13–1.15	70	2 300	3.3	60
				4		270	1.13–1.15	70	2 300	3.3	60
				5	recycled	115	1.13–1.15	70	2 300	3.3	60
				6	recycled	135	1.13–1.15	70	2 300	3.3	60
				0	other						
				G15	15 % glass	. . .	1.20–1.26	100	4 000	3.0	215
				G20	20 % glass	. . .	1.25–1.33	115	5 000	4.0	220
				G25	25 % glass	. . .	1.29–1.37	140	6 000	5.0	225
				G35	35 % glass	. . .	1.35–1.45	170	8 000	7.0	235
				G40	40 % glass	. . .	1.42–1.52	175	9 000	8.0	235
				G45	45 % glass	. . .	1.45–1.55	180	10 000	9.0	240
				M40	40 % mineral	. . .	1.45–1.55	80	5 000	2.0	150
		2	Heat-stabilized	1		135	1.13–1.15	70	2 300	3.0	60
				2		165	1.13–1.15	70	2 300	3.0	60
				3		210	1.13–1.15	70	2 300	3.0	60
				4		270	1.13–1.15	70	2 300	3.0	60
				5	recycled	115	1.13–1.15	70	2 300	3.0	60
				6	recycled	135	1.13–1.15	70	2 300	3.0	60
				0	other						
				G15	15 % glass	. . .	1.20–1.26	100	4 000	3.0	220
				G25	25 % glass	. . .	1.29–1.37	140	6 000	5.0	225
				G30	30 % glass	. . .	1.32–1.42	160	7 000	6.0	230
				G35	35 % glass	. . .	1.35–1.45	170	8 000	7.0	235
				G40	40 % glass	. . .	1.43–1.53	175	9 000	8.0	235
				G45	45 % glass	. . .	1.45–1.55	180	10 000	9.0	240
				M40	40 % mineral	. . .	1.45–1.55	80	5 000	2.0	150
				R20	20 % filler	. . .	1.23–1.31	70	3 200	1.5	. . .
				R40	40 % filler	. . .	1.43–1.53	100	5 500	2.5	200
		3	Nucleated	1		135	1.13–1.15	80	2 500	2.8	60
				2		165	1.13–1.15	80	2 500	2.8	60
				3		210	1.13–1.15	80	2 500	2.8	60
				4		270	1.13–1.15	80	2 500	2.8	60
				5	recycled	115	1.13–1.15	80	2 500	2.8	60
				6	recycled	135	1.13–1.15	80	2 500	2.8	60
				0	other						
		4	Nucleated, heat-stabilized	1							
				2							
				3			Requirements the same as corresponding grades under Group 01, Class 3.				
				4							
				0	other						
		5	Impact-modified	1		. . .	1.06–1.12	52	1 700	9.0	50
				2	recycled	. . .	1.06–1.12	50	1 600	8.0	50
				0	other						
				G15	15 % glass	. . .	1.15–1.23	85	3 000	6.0	210
				G35	35 % glass	. . .	1.31–1.41	110	5 500	6.0	225
		6	Impact-modified, heat-stabilized	1		. . .	1.08–1.12	52	1 700	9.0	50
				2	recycled	. . .	1.08–1.12	50	1 600	8.0	50
				0	other						
				G15	15 % glass	. . .	1.15–1.23	85	3 000	6.0	210
				G35	35 % glass	. . .	1.31–1.41	110	5 500	6.0	225
				M40	40 % mineral	. . .	1.45–1.55	75	4 500	4.0	. . .
				R35	35 % filler	. . .	1.38–1.48	80	5 500	3.0	200
		7	Toughened	1		. . .	1.06–1.10	42	1 500	40	45
				2	recycled	. . .	1.05–1.11	40	1 300	35	45
				0	other						
				G15	15 % glass	. . .	1.15–1.23	70	2 800	9.0	180
				G35	35 % glass	. . .	1.28–1.38	110	5 500	11	220
		8	Toughened, heat-stabilized	1		. . .	1.06–1.10	42	1 500	40	45
				2	recycled	. . .	1.05–1.11	40	1 300	35	45
				0	other						
				G15	15 % glass	. . .	1.15–1.23	70	2 800	9.0	180

TABLE PA Requirements for Nylons Dry-as-Molded[A,B]

Group	Description	Class	Description	Grade	Description[C]	Viscosity Number, ISO 307, min, mL/g	Density, ISO 1183, g/cm^3	Tensile Strength,[D] ISO 527-1 and ISO 527-2, min, MPa	Flexural Modulus, ISO 178, min, MPa	Izod Impact Resistance, ISO 180/1A, min, kJ/m^2	Deflection Temperature at 1.82 MPa,[E] ISO 75-1 and ISO 75-2 min, °C
				G35	35 % glass	. . .	1.28–1.38	110	5 500	11	220
				G45	45 % glass	. . .	1.39–1.49	130	8 000	10	230
				M35	35 % mineral	. . .	1.37–1.47	70	3 800	6.0	. . .
		9	Weather-stabilized[F]	1		135	1.13–1.17	80	2 400	2.5	60
				2	recycled	115	1.13–1.17	65	2 200	2.0	60
				0	other						
		0	Other	0	other						
02	6 Nylon	1	General-purpose	1		135	1.12–1.14				
				2		175	1.12–1.14	70	2 200	3	50
				3		200	1.12–1.15	70	2 200	3	50
				4		230	1.12–1.15				
				0	other						
				G15	15 % glass		1.20–1.28	110	4 500	4.5	170
				G25	25 % glass		1.28–1.36	140	6 500	6.5	180
				G30	30 % glass		1.32–1.40	150	7 000	7.5	180
				G35	35 % glass		1.38–1.44	155	7 500	8	180
				M30	30 % mineral		1.30–1.40	70	3 200	2.4	50
				R40	40 % glass/ mineral		1.42–1.50	100	6 000	3	180
		2	Heat-stabilized	1		135	1.12–1.14				
				2		175	1.12–1.14	70	2 200	3	50
				3		200	1.12–1.15	70	2 200	3	50
				4		230	1.12–1.15				
				0	other						
				G15	15 % glass		1.20–1.28	110	4 500	4.5	180
				G25	25 % glass		1.28–1.36	140	6 500	6.5	190
				G30	30 % glass		1.32–1.40	150	7 000	7.5	190
				G35	35 % glass		1.38–1.44	155	7 500	8	190
				M30	30 % mineral		1.30–1.40	70	3 200	2.4	60
				M40	40 % mineral		1.44–1.52	75	4 500	4.5	70
				R40	40 % glass/ mineral		1.42–1.50	100	6 000	3	190
		3	Nucleated and lubricated	1		135	1.12–1.14				
				2		175	1.12–1.14	70	2 300	2.5	50
				3		200	1.12–1.15	75	2 300	2.5	50
				4		230	1.12–1.15	80	2 300	2.5	50
				0	other						
		4	Nucleated and heat-stabilized	1		135					
				2		175	1.12–1.14	70	2 300	2.5	55
				3		200	1.12–1.15	75	2 300	2.5	55
				4		230	1.12–1.15	80	2 300	2.5	55
				0	other						
		5	Impact-modified	1			1.05–1.12	45	1 700	30	45
				2			1.05–1.18	60	2 000	6	50
				3			1.05–1.18	60	2 000	6	50
				0	other						
				G30	30 % glass		1.32–1.40	135	6 500	15	180
		6	Impact-modified, heat-stabilized	1			1.05–1.12	45	1 700	30	45
				2			1.05–1.18	60	2 000	6	50
				3			1.05–1.18	60	2 000	6	50
				0	other						
				G30	30 % glass		1.32–1.40	135	6 500	15	190
		8	Flexural-modified, heat-stabilized	2	injection molding		1.05–1.16	55	2 375max	10	45
				3	extrusion		1.05–1.16	30	2 000max	70	25
				4	blends		1.05–1.10	35	1 700max	4.5	35
				0	other						
		0	Other	0	other						
03[G]	11 Nylon	1	General purpose	1		221	1.03–1.06				
				2		234	1.03–1.06	45	1000	4.0	35
				3		252	1.03–1.06				

TABLE PA Requirements for Nylons Dry-as-Molded[A,B]

Group	Description	Class	Description	Grade	Description[C]	Viscosity Number, ISO 307, min, mL/g	Density, ISO 1183, g/cm^3	Tensile Strength,[D] ISO 527-1 and ISO 527-2, min, MPa	Flexural Modulus, ISO 178, min, MPa	Izod Impact Resistance, ISO 180/1A, min, kJ/m^2	Deflection Temperature at 1.82 MPa,[E] ISO 75-1 and ISO 75-2 min, °C
				4		291	1.03–1.06				
				5	hydrolysis-resistant		1.03–1.06				
				0	other						
		2	Heat-stabilized	1		234	1.03–1.06				
				2		252	1.03–1.06	45	900	2.0	35
				3		291	1.03–1.06				
				4	hydrolysis-resistant		1.03–1.06				
				0	other						
			Highly plasticized	1			1.03–1.06				
				2			1.03–1.06				
				3			1.03–1.06				
				4			1.03–1.06				
				0	other						
		4	Highly plasticized, heat stabilized	1			1.03–1.06				
				2			1.03–1.06				
				3			1.03–1.06				
				4			1.03–1.06				
				0	other						
		5	Moderately plasticized	1			1.03–1.06				
				2			1.03–1.06				
				3			1.03–1.06				
				4			1.03–1.06				
				5			1.03–1.06				
				0	other						
		6	Moderately plasticized, heat-stabilized	1			1.03–1.06				
				2			1.03–1.06				
				3			1.03–1.06				
				4			1.03–1.06				
				5			1.03–1.06				
				0	other						
		0	Other	0	other						
04	12 Nylon		General purpose	1		100–210	1.00–1.06	30	800	2.5	35
				2		100–210	1.00–1.06	35	1 000	2.5	35
				3		211–270	1.00–1.06	35	1 000	2.5	35
				4		271–340	1.00–1.06	35	1 000	2.5	35
				0	other						
		2	Heat-stabilized	1		100–150	1.00–1.06	35	800	2.5	35
				2		151–210	1.00–1.06	35	800	2.5	35
				3		211–280	1.00–1.06	35	1 000	2.5	35
				0	other						
				G15	15 % glass		1.10–1.20	75	3 000	10	160
				G25	25 % glass		1.10–1.25	90	3 000	15	160
				G30	30 % glass		1.15–1.30	95	4 000	15	160
				G40	40 % glass		1.30–1.45	100	4 500	15	160
				R30	30 % filler		1.22–1.28	55	3 500	5.0	100
		3	Nucleated	1		100–180	1.00–1.06	35	800	1.0	35
				2		181–250	1.00–1.06	35	800	1.0	35
				0	other						
		4	Plasticized	1		100–280	1.00–1.06	30	300–550	15	. . .
				2		100–280	1.00–1.06	30	450–750	10	. . .
				0	other						
		5	Plasticized, heat-stabilized	1		100–280	1.00–1.06	20	200–350	20	. . .
				2		100–280	1.00–1.06	30	300–550	15	. . .
				3		100–280	1.00–1.06	30	450–750	10	. . .
				4		100–280	1.00–1.06	35	550–950	5.0	. . .
				0	other						
		0	Other	0	other						
05	69 Nylon	1	General purpose	1			1.07–1.09				

TABLE PA Requirements for Nylons Dry-as-Molded[A,B]

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				2			1.07–1.09				
				3			1.07–1.09				
				0	other						
		2	Heat-stabilized	1			1.07–1.09				
				2			1.07–1.09				
				3			1.07–1.09				
				0	other						
		0	Other	0	other						
06	612 Nylon	1	General purpose	1		100–139	1.05–1.07	50	1 800	2.0	45
				2		140–199	1.05–1.07	50	1 800	2.5	45
				3		200	1.05–1.07	50	1 800	3.0	45
				0	other						
				G35	35 % glass	. . .	1.28–1.38	140	7 000	9.0	175
				G45	45 % glass	. . .	1.38–1.48	150	8 500	11	180
		2	Heat-stabilized	1		140	1.05–1.07	50	1 800	2.0	45
				0	other						
				G30	30 % glass	. . .	1.25–1.33	120	5 500	5.0	170
				G35	35 % glass	. . .	1.28–1.38	140	7 000	9.0	175
		3	Weather-stabilized[F]	1		140	1.05–1.07	50	1 800	1.5	45
				0	other						
		0	Other	0	other						
07	610 Nylon	1	General purpose	1			1.05–1.09				
				2			1.05–1.09				
				3			1.05–1.09				
				0	other						
		2	Heat-stabilized	1			1.05–1.09				
				2			1.05–1.09				
				0	other						
		0	Other	0	other						
08	Special	1	n-alkoxy-alkyl 6:6	1			1.09–1.12				
				0	other						
		0	Other	0	other						
09	46 Nylon	1	General-purpose	1							
				2		170	1.16–1.20	85	2 300	6.0	140
				3		195	1.16–1.20	85	2 300	6.0	140
				0	other						
		2	Heat-stabilized	1							
				2		165	1.16–1.20	85	2 300	6.0	140
				3		195	1.16–1.20	85	2 300	6.0	140
				0	other						
				G15	15 % glass	. . .	1.25–1.31	125	5 000	3.6	240
				G30	30 % glass	. . .	1.38–1.42	175	8 000	7.5	280
				G40	40 % glass	. . .	1.48–1.53	195	10 000	10.0	280
				G50	50 % glass	. . .	1.58–1.63	210	12 000	12.0	280
				R50	50 % filler	. . .	1.60–1.67	140	9 000	4.0	280
		3	Flame-retardant,[G] heat-stabilized	1							
				2		. . .	1.32–1.36	45	2 250	4.0	140
				0	other						
				G15	15 % glass	. . .	1.55–1.59	115	6 000	4.5	270
				G30	30 % glass	. . .	1.63–1.69	155	10 000	7.5	280
				G40	40 % glass	. . .	1.76–1.80	145	11 000	8.0	280
				G45	45 % glass	. . .	1.75–1.79	165	12 000	8.0	280
		4	Impact-modified, heat-stabilized	1							
				2		. . .	1.08–1.12	40	1 500	50	70
				0	other						
		5	Wear-resistant heat-stabilized	1							
				2		. . .	1.16–1.20	75	2 200	3.0	140
				0	other						

TABLE PA Requirements for Nylons Dry-as-Molded[A,B]

Group	Description	Class	Description	Grade	Description[C]	Viscosity Number, ISO 307, min, mL/g	Density, ISO 1183, g/cm^3	Tensile Strength,[D] ISO 527-1 and ISO 527-2, min, MPa	Flexural Modulus, ISO 178, min, MPa	Izod Impact Resistance, ISO 180/1A, min, kJ/m^2	Deflection Temperature at 1.82 MPa,[E] ISO 75-1 and ISO 75-2 min, °C
		0	Other	0	other						
10	6T/MPMDT nylon	1	General-purpose	0	other						
		2	Heat-stabilized	G35	35 % glass	. . .	1.42–1.52	200	10 000	8.0	250
				G45	45 % glass	. . .	1.53–1.63	210	12 000	8.0	250
		0	Other	0	other						
11	66 nylon copolymers + blends	1	66/6	G15	15 % glass	. . .	1.20–1.26	90	3 500	3.0	180
			General-purpose	G35	35 % glass	. . .	1.35–1.45	160	7 500	8.0	190
				G45	45 % glass	. . .	1.45–1.55	180	8 500	10	200
		2	66/6	G15	15 % glass	. . .	1.20–1.26	90	3 500	3.0	180
			Heat-stabilized	G25	25 % glass	. . .	1.29–1.37	115	4 500	6.5	190
				G35	35 % glass	. . .	1.35–1.45	160	7 500	8.0	190
				G45	45 % glass	. . .	1.45–1.55	180	8 500	10	200
				M20	20 % mineral	. . .	1.25–1.33	70	3 000	4.0	. . .
				M30	30 % mineral	. . .	1.35–1.45	75	4 000	3.0	. . .
				M40	40 % mineral	. . .	1.45–1.55	75	4 000	3.0	. . .
		3	66 + 6	G15	15 % glass	. . .	1.20–1.26	100	4 000	3.0	200
			General purpose	G35	35 % glass	. . .	1.35–1.45	170	8 000	9.0	210
				G45	45 % glass	. . .	1.45–1.55	190	10 000	10	220
		4	66 + 6	M20	20 % mineral	. . .	1.25–1.33	70	3 000	3.0	. . .
			Heat-stabilized	M40	40 % mineral	. . .	1.45–1.55	75	4 500	3.0	. . .
		0	Other	0	other						
12	6 nylon copolymer + blends	1	6 + polypropylene blend	1		. . .	1.00–1.05	50	2 000	7.0	50
				0	other						
			Heat-stabilized	G35	35 % glass	. . .	1.23–1.33	150	8 500	9.0	200
				R35	35 % filler	. . .	1.28–1.38	53	6 000	2.0	135
		0	Other	0	other						
13	6T/66 nylon	1	General-purpose	0	other						
		2	Heat–stabilized	G35		. . .	1.41–1.51	175	9 000	6.0	270
				0	other						
		0	Other	0	other						
00	Other	0	Other	0	other						

[A] Data on 4-mm test specimens may be limited, and the minimum values may be changed in a later revision after a statistical data base of sufficient size is generated.
[B] Refer to 9.1 for source of test pieces.
[C] No descriptions are listed unless needed to describe a special grade under the class. All other grades are listed by requirements.
[D] Crosshead speed shall be 50 mm/min ± 10 % unless the specimen exhibits brittle failure (no yield point) and strain at break of <10 % in which case crosshead speed shall be 5 mm/min ± 25 %.
[E] Deflection temperature shall be determined with the specimen in the flatwise position (Method A_f).
[F] Carbon black content and absorbance must be 1.90 to 2.25 % and 0.230 minimum respectively as determined in accordance with methods found in Federal Specification L-P-410a. It is possible, by agreement between the buyer and the seller, that materials incorporating other segments or soluble stabilizers, or both, may prove adequate for particular applications.
[G] Relative Viscosities for Group 03 were generated from a correlation with Test Method D 789, utilizing an Ubbelohde viscometer, and m-Cresol as the solvent. Refer to Table X3.1, Note B for more specific information.

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

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

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

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

NOTE 9—An example of this classification system for a reinforced nylon material is given as follows. The designation PA0110G30A22450

would indicate the following material requirements:

PA0110	=	66 nylon, from Table PA,
G30	=	glass reinforced at 30 % nominal,
A	=	Table A property requirements,
2	=	70-MPa tensile strength, min,
2	=	4 500-MPa flexural modulus, min,
4	=	10.0-kJ/m^2 Izod impact, min,
5	=	160°C deflection temperature at 1.82 MPa, min, and
0	=	unspecified.

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

NOTE 10—When a grade of polyamide is not fully identified by a standard callout, it is possible to specify all table properties by the use of an addition of Classification D 4000 suffixes. Suffix values will override the PA table values.

An example of an unreinforced nylon material is given as follows: PA0212UM023. This example is a general purpose, low viscosity nylon 6 material where U denotes flexural modulus. M denotes ISO 178 as the test method, and 023 denotes a value of 2300 MPa. This value for flexural modulus overrides the normal table value.

This example can be applied to replace all table values, that is, tensile stress, notched Izod impact, and heat deflection temperature.

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

NOTE 11—Pigmented or colored nylons can differ significantly from the natural polymers in mechanical properties depending on the choice of colorants and concentrations. The main property affected is ductility, as illustrated by a reduction in Izod impact and elongation values. In a typical white pigmented nylon, elongation losses of up to 50 % and Izod impact losses of up to 30 % are common. If specific properties of pigmented materials are necessary, Table B may be employed to specify property requirements.

NOTE 12—An example of a special material using this classification system is as follows: The designation PA0220B54220 would indicate the following material requirements from Table B:

PA0220	=	6 nylon, heat stabilized, from Table PA,
B	=	Table B property requirements,
5	=	70-MPa tensile strength, min,
4	=	2400-MPa flexural modulus, min,
2	=	4.0-kJ/m^2 Izod impact, min,
2	=	55°C deflection temperature at 1.82 MPa, min, and
0	=	unspecified.

TABLE A Detail Requirements[A,B] Reinforced Nylons

Designation Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ISO 527, min, MPa[C]	unspecified	35	70	105	140	175	210	245	280	specify[D] value
2	Flexural modulus, ISO 178, min, MPa	unspecified	1 500	4 500	7 500	10 500	13 500	16 500	19 500	22 500	specify[D] value
3	Izod impact, ISO 180/1A, min, kJ/m^2	unspecified	2.5	5.0	7.5	10.0	12.5	15.0	22.5	30.0	specify[D] value
4	Deflection temperature, ISO 75, Method A, 1.82 MPa, min, °C[E]	unspecified	50	85	110	135	160	185	200	235	specify[D] value
5	To be determined	unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	

[A]It is recognized that detailed test values, particularly Izod impact, may not predict nor even correlate with performance of parts molded of these materials.
[B]Refer to 9.1 for source of test specimens.
[C]Crosshead speed shall be 50 mm/min ± 10 % unless the specimen exhibits brittle failure (no yield point) and a strain at break of <10 % in which case crosshead speed shall be 5 mm/min± 25 %.
[D]If a specific value is required, it must appear on the drawing or contract, or both.
[E]Deflection temperature shall be determined with the specimen in the flatwise position (Method A_f).

TABLE B Detail Requirements[A,B] Unreinforced Nylons

Designation Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ISO 527, min, MPa[C]	unspecified	10	25	40	55	70	85	100	115	specify[D] value
2	Flexural modulus, ISO 178, min, MPa	unspecified	300	1 000	1 700	2 400	3 100	3 800	4 500	5 200	specify[D] value
3	Izod impact, ISO 180/1A, min, kJ/m^2	unspecified	2.0	4.0	6.0	10.0	14.0	18.0	24.0	30.0	specify[D] value
4	Deflection temperature, ISO 75, Method A, 1.82 MPa, min, °C[E]	unspecified	40	55	70	85	100	115	130	145	specify[D] value
5	To be determined	unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	

[A]It is recognized that detailed test values, particularly Izod impact, may not predict nor even correlate with performance of parts molded of these materials.
[B]Refer to 9.1 for source of test specimens.
[C]Crosshead speed shall be 50 mm/min ± 10 % unless the specimen exhibits brittle failure (no yield point) and a strain at break of <10 % in which case crosshead speed shall be 5 mm/min± 25 %.
[D]If a specific value is required, it must appear on the drawing or contract, or both.
[E]Deflection temperature shall be determined with the specimen in the flatwise position (Method A_f).

5. Suffixes

5.1 When additional requirements are needed that are not covered by the basic requirements or cell-table requirements, they shall be indicated through the use of suffixes.

5.1.1 When using the callout for the materials covered by this classification system, the following suffixes may be used for specific requirements for the material for the application intended. In general, the suffix letter gives the general requirements needed and the first number (digit) gives the test condition, with the second number (digit) giving the specific requirement.

Suffixes:

E = Electrical requirements as designated by the following digits:

First Digit

0 = to be specified by user.
1 = specimens tested dry-as-molded.
2 = specimens tested conditions 96 h at 23°C and 50 % relative humidity.

Second Digit

0 = to be specified by user.
1 = insulation resistance, dielectric strength, dielectric constant, and dissipation factor meet property limits as shown in Table 1. These are electrical limits applied to unreinforced nylons when control of their electrical properties is required.
2 = dielectric strength, dielectric constant, and dissipation factor meet property limits as shown in Table 2. These are electrical limits applied to reinforced nylons when control of their electrical properties is required.
Z = Other special requirement characteristics, that is, color, not covered by existing call-out capabilities may be assigned by the user. These will be spelled out in detail and identified in sequence, that is, 01, 02, 03, etc.

NOTE 13—A further list of suffixes can be found in Classification D 4000 and may be used for additional requirements as appropriate.

5.2 A list of suffixes can be found in Classification System D 4000 (Table 3) and may be used for additional requirements as appropriate. Additional suffixes will be added to that

TABLE 1 Electrical Properties of Unreinforced Nylons

	ASTM Test Method	Requirement
Insulation resistance, min, MΩ	D 257 (Note 13)	5×10^6
Dielectric strength step-by-step test, min, kV/mm	D 149 (Note 14)	14.8 (Note 20)
Dielectric constant at 1 MHz, max	D 150 (Note 15)	4.0
Dissipation factor at 1 MHz, max	D 150 (Note 15)	0.11

TABLE 2 Electrical Properties of Reinforced Nylons

	ASTM Test Method	Requirement
Dielectric strength step-by-step test, min, kV/mm	D 149 (Note 14)	14.8 (Note 20)
Dielectric constant at 1 MHz, max	D 150 (Note 15)	4.2
Dissipation factor at 1 MHz, max	D 150 (Note 15)	0.025

classification system as test methods and requirements are developed and requested.

NOTE 14—As modified by the following: Electrodes shall be American Standard No. 3 tapered pins 3 in. (76.2 mm) long having a diameter at the large end of 5.56 mm and tapering 6.35 mm/305 mm. The specimen shall be of sufficient size so that two 4.75-mm diameter holes centrally located, 25.4 mm apart, center-to-center, and perpendicular to the faces of the specimen, may be drilled. The holes shall be drilled as above and then reamed, using a standard-tapered pin reamer, to a sufficient depth to allow the pins to extend approximately 31.75 mm beyond the small end of the hole. The electrodes shall be inserted after the specimens have been conditioned. These specimens shall be tested.

NOTE 15—As modified by the following: The test specimen shall be a disk 101.6 mm in diameter and 3.18 mm thick. Step-by-step testing shall be done after a short-time test where voltage is increased uniformly at the rate of 500 V/s. Voltage increments for the step-by-step test shall be determined from short-time test results as follows:

Breakdown by short-time test, kV	Increment for step-by-step test, kV
12.5 or less	0.5
Over 12.5 to 25, incl	1.0
Over 25 to 50, incl	2.5
Over 50 to 100, incl	5.0
Over 100	10.0

Dielectric strength testing shall be run under oil conforming to Federal Specification VV-I-530 at a frequency not exceeding 100 Hz. Step-by-step testing shall be carried out using five test specimens.

NOTE 16—As modified by the following: The test specimen is a disk 50.8 or 101.6 mm in diameter by 3.18 mm thick. The dissipation factor is the cotangent of the dielectric phase angle or the tangent of the dielectric loss angle. Five specimens shall be tested. After the humidity conditioning specified by the first digit following the E suffix, test specimens are immersed in distilled water at 50°C for 48 h followed by immersion in distilled water at 23°C for ½ h. Start the test within 2 min after removing the specimen and wiping with a dry cloth.

NOTE 17—kV/mm × 25.4 = V/mil.

6. General Requirements

6.1 Basic requirements from the property tables or cell tables are always in effect unless superseded by specific suffix requirements, which always take precedence.

6.2 The plastics composition shall be uniform and shall conform to the requirements specified herein.

7. Detail Requirements

7.1 The material shall conform to the requirements prescribed in Tables PA, A, and B, and suffix requirements as they apply.

7.2 For purposes of determining conformance, all specified limits for classification (line callout based on this classification system are *absolute limits*, as defined in Practice E 29).

7.2.1 With the absolute method, an observed value or a calculated value is not rounded, but is to be compared directly with the specified limiting value. Conformance or nonconformance is based on this comparison.

8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of 12.4.

8.2 A batch or lot shall be constituted as a unit of manufacture as prepared for shipment, and may consist of a blend of two or more "production runs."

9. Specimen Preparation

9.1 Test pieces for relevant test methods shall be based on the injection molded ISO 3167 type multipurpose test specimen. All tests shall be conducted on as-molded (not annealed) specimens conditioned dry-as-molded. The following pieces are to be used for the listed relevant test methods:

Test Piece	Relevant Test Method
ISO 3167 Type 1A bar	tensile strength by ISO 527
80 ± 2 mm by 10 ± 9.2 mm by 4 ± 0.2 mm cut from the center portion of ISO 3167 Type 1A bar	flexural modulus by ISO 178. izod impact resistance by ISO 180/1A deflection temperature by ISO 75/Method A_f
Specimen approximately 10 by 10 by 4 mm cut from center of ISO 3167 Type 1A bar	Density by ISO 1183

9.2 The test specimens shall be prepared by an injection molding process as specified in ISO 294 and Practice D 3641. Recommended processing temperatures are shown in Table 3.

NOTE 18—Test specimens of PA 6 and PA 66 copolymers and blends may be prepared at the same process temperatures as specified for their homopolymers, without significant property loss. Selection of process temperature is made based on the major polymer component.

TABLE 3 Process Temperatures for Injection Molding of Specimens

Polyamide		Plastic Melt Temperature, °C	Mold Surface Temperature, °C
PA 6	unfilled	260	80
	filled	290	80
PA 46	unfilled	305	80
	filled	305	80
PA 66	unfilled	290	80
	filled	290	80
PA 69, PA 610, PA 612, PA 11, PA 12	unfilled	270	80
	filled	230	80
PA 6T/MPMDT	filled	325	140

NOTE 19—Consult ISO 1874-2.2, Table 1, for a more comprehensive listing of the Conditions for Injection Moulding of Test Specimens.

9.3 Molding material-granules of the molding material used in preparation of test specimens shall contain no more than 0.2 % moisture, with the exception of PA 46 which will contain no more than 0.05 % moisture.

NOTE 20—If the moisture content exceeds the limits stated above, the material may be dried by a variety of methods such as, a temperature of 80 to 100°C in vacuum or a stream, or both, of dry nitrogen or a desiccant bed dryer, or both, until the moisture content is within stated limits.

10. Conditioning

10.1 *Conditioning*—Test data shall be obtained using dry-as-molded specimens, defined as those specimens that immediately upon removal from mold are sealed in containers that are impermeable to water vapor. Maximum moisture content of specimens shall be 0.2 %. No moisture shall be intentionally added to reach this level. Condition specimens a minimum of 24 h in sealed containers at 23 ± 2°C.

NOTE 21—Physical properties of most nylon resins are highly dependent upon the moisture content of the molded item. The user is referred to the manufacturer's literature for details.

10.2 *Test Conditions*—Conduct tests, other than solution viscosity or those tests conducted at elevated temperature, in the standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity. Individual specimens shall not be removed from sealed containers until immediately before testing.

11. Test Methods

11.1 Determine the properties enumerated in this classification system by means of the test methods referenced in Section 2.

11.1.1 The number of tests shall be consistent with the requirements of Section 8 and 12.4.

12. Inspection and Certification

12.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

12.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of the tests listed as they apply:

(1) Relative viscosity, or viscosity number, or both,

(2) Moisture content,

(3) Reinforcement content,

(4) Carbon black content (weather-stabilized materials), and

(5) Heat stabilizer content (heat-stabilized materials, supplier's test showing positive presence).

12.3 Periodic-check inspection with reference to a specific based upon this classification system shall consist of the tests specified for all requirements of the material under this classification system. Inspection frequency shall be adequate to ensure the material is certifiable in accordance with 12.4.

12.4 Certification shall be that the material was manufactured by a process in statistical control, sampled, tested, and inspected in accordance with this classification system and that the average values for the lot meet the requirements of the specification (line callout).

12.5 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 the results of the most recent periodic-check inspection.

13. Packing, Packaging, and Marking

13.1 The provisions of Practice D 3892 apply to packaging, packing, and marking of containers for plastic materials.

14. Keywords

14.1 classification; classification system; line callout; plastic materials

APPENDIXES

(Nonmandatory Information)

X1. VISCOSITY CONVERSION: ASTM TEST METHODS D 789 and ISO 307

X1.1 The relation between relative viscosity in 90 % HCOOH (test Methods D 789) and viscosity number in 96 % $H2SO_4$ (ISO 307) was developed in an interlaboratory round-robin study by ISO TC-61 Subcommittee 9/Work Group 8 (Plastic Materials/Polyamides). Seven laboratories, including 3 U.S. laboratories (Allied, DuPont, and Monsanto), participated in the work. A 95 ± 9 % between-laboratory confidence interval was predicted for the measurements.

X1.2 For convenience, a conversion table and graph (Fig. X1.1) are provided using the following established relationship:

$$VN = A + B \times \ln (RV) \quad \text{(X1.1)}$$

where:

VN = viscosity number (ISO 307),
RV = relative viscosity (Test Methods D 789),
A = –206.52124, and
B = 90.23355.

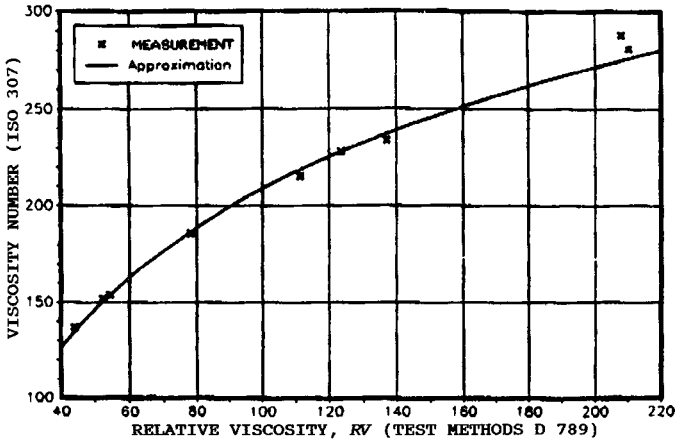

FIG. X1.1 Nylon 6 and Nylon 66 Viscosity Correlation Relative Viscosity in 90 % HCOOH (Test Methods D 789) versus Viscosity Number in 96 % $H2SO_4$ (ISO 307)

X2. MELTING POINT

X2.1 The melting point range of the various polyamide polymers shown in Table PA are listed as follows:

X2.2 The melting point shall be determined using ISO 3146, Method C2, with a heating rate of 10°C/min. The melting point, Tm, is obtained from the second melting curve.

Group	Description	Tm, °C
01	66 nylon	262
02	6 nylon	222
03	11 nylon	190
04	12 nylon	178
05	69 nylon	215
06	612 nylon	212
07	610 nylon	218
08	special	150
09	46 nylon	290
10	6T/MPMDT	300

X3. REFERENCE TO PREVIOUS EDITIONS

X3.1 Referenced Documents

X3.1.1 *ASTM Standards:*

D 256 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials

D 638 Test Method for Tensile Properties of Plastics

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load

D 789 Test Methods for Determination of Relative Viscosity, Melting Point, and Moisture Content of Polyamide (PA)

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D 792 Test Method for Specific Gravity (Relative Density) of Plastics by Displacement

D 3418 Test Method for Transition Temperature of Polymers by Thermal Analysis

TABLE X3.1 Requirements for Nylons Dry-as-Molded (Table PA, Specification D 4066–94b)

Group	Description	Class	Description	Grade	Description[A]	Relative Viscosity,[B] min, ASTM D 789	Melt Point, °C, ASTM D 3418, DTA or DSC[C,D]	Specific Gravity, ASTM D 792	Tensile Strength,[E] ASTM D 638, min, MPa	Elongation[E] (ultimate), ASTM D 638, min, %	Flexural Modulus,[F] ASTM D 790, min, MPa	Izod Impact Resistance,[G] ASTM D 2256, min, J/m	Deflection Temperature,[H] °C, min, ASTM D 648 at 1.82 MPa	Moisture[I] "as received," ASTM D 789, max, %
01	66 Nylon	1	General-purpose	1		45	250–265	1.13–1.15	76	50	2 600	50	63	0.25
				2		60	250–265	1.13–1.15	76	50	2 600	50	63	0.20
				3		100	250–265	1.13–1.15	76	50	2 600	50	63	0.15
				4		200	250–265	1.13–1.15	76	100	2 600	50	63	0.15
				5	recycled	35	250–265	1.13–1.15	76	10	2 600	50	63	0.30
				6	recycled	45	250–265	1.13–1.15	76	25	2 600	50	63	0.25
				7	recycled	45	250–265	1.13–1.15	76	50	2 600	50	63	0.25
				0	other									

TABLE X3.1 *Continued*

Group	Description	Class	Description	Grade	Description[A]	Relative Viscosity,[B] min, ASTM D 789	Melt Point, °C, ASTM D 3418, DTA or DSC[C,D]	Specific Gravity, ASTM D 792	Tensile Strength,[E] ASTM D 638, min, MPa	Elongation[E] (ultimate), ASTM D 638, min, %	Flexural Modulus,[F] ASTM D 790, min, MPa	Izod Impact Resistance,[G] ASTM D 2256, min, J/m	Deflection Temperature,[H] °C, min, ASTM D 648 at 1.82 MPa	Moisture[I] "as received," ASTM D 789, max, %
		2	Heat-stabilized	1		45	250–265	1.13–1.15	76	40	2 600	40	63	0.25
				2		60	250–265	1.13–1.15	76	40	2 600	40	63	0.20
				3		100	250–265	1.13–1.15	76	40	2 600	40	63	0.15
				4		200	250–265	1.13–1.15	76	100	2 600	40	63	0.15
				5	recycled	35	250–265	1.13–1.15	76	10	2 600	40	63	0.30
				6	recycled	45	250–265	1.13–1.15	76	20	2 600	40	63	0.25
				7	recycled	45	250–265	1.13–1.15	76	40	2 600	40	63	0.25
				0	other									
		3	Nucleated	1		45	250–265	1.13–1.15	83	20	2 800	40	63	0.25
				2		60	250–265	1.13–1.15	83	20	2 800	40	63	0.20
				3		100	250–265	1.13–1.15	83	20	2 800	40	63	0.15
				4		200	250–265	1.13–1.15	83	20	2 800	40	63	0.15
				5	recycled	45	250–265	1.13–1.15	83	15	2 600	40	63	0.25
				6	recycled	45	250–265	1.13–1.15	83	20	2 600	40	63	0.25
				0	other									
		4	Nucleated, heat-stabilized	1										
				2					Requirements the same as corresponding grades under Group 1 Class 3					
				3										
				4										
				0	other									
		5	Highly nucleated	1		45	250–265	1.13–1.15	90	5	2 900	40	63	0.25
				2		60	250–265	1.13–1.15	90	5	2 900	40	63	0.20
				3		100	250–265	1.13–1.15	90	5	2 900	40	63	0.15
				4		200	250–265	1.13–1.15	90	5	2 900	40	63	0.15
				0	other									
		5	Impact-modified	1		. . .	250–265	1.09–1.11	58	55	1 700	150	. . .	0.20
				2		. . .	250–265	1.06–1.09	48	50	1 500	800	. . .	0.20
				3	recycled	. . .	250–265	1.09–1.11	50	40	1 600	80	60	0.20
				0	other									
		7	Impact-modified, heat-stabilized	1		. . .	250–265	1.09–1.11	58	55	1 700	150	60	0.20
				2		. . .	250–265	1.06–1.09	48	50	1 500	800	63	0.20
				3	recycled	. . .	250–265	1.09–1.11	50	40	1 600	90	60	0.20
				0	other									
		8	Weather-stabilized[J]	1		45	250–265	1.14–1.16	83	20	2 700	40	65	0.20
				2	recycled	. . .	250–265	1.14–1.16	65	10	2 500	30	. . .	0.20
				0	other									
		9	Flexural-modified, heat-stabilized	1		80	190–220	1.12–1.16	45	250	525 max	150	. .	0.20
				0	other									
02	6 Nylon	1	General-purpose	1		30	210–225	1.12–1.14	76	40	2 600	40	58	0.20
				2		40	210–225	1.12–1.14	76	40	2 600	50	58	0.20
				3		50	210–225	1.12–1.14	76	100	2 600	50	58	0.20
				4		95	210–225	1.12–1.14	76	150	2 600	55	58	0.20
				5		200	210–225	1.12–1.14	76	200	2 600	55	58	0.20
				6	recycled	30	210–225	1.12–1.14	68	25	2 600	40	58	0.20
				7	recycled	40	210–225	1.12–1.14	68	35	2 600	40	58	0.20
				8	recycled	40	210–225	1.12–1.14	76	40	2 600	40	58	0.20
				0	other									
		2	Heat-stabilized	1		30	210–225	1.12–1.14	76	40	2 600	40	58	0.20
				2		40	210–225	1.12–1.14	76	40	2 600	50	58	0.20
				3		50	210–225	1.12–1.14	76	100	2 600	50	58	0.20

TABLE X3.1 *Continued*

Group Description	Class	Description	Grade	Description[A]	Relative Viscosity,[B] min, ASTM D 789	Melt Point, °C, ASTM D 3418, DTA or DSC[C,D]	Specific Gravity, ASTM D 792	Tensile Strength,[E] ASTM D 638, min, MPa	Elongation[E] (ultimate), ASTM D 638, min, %	Flexural Modulus,[F] ASTM D 790, min, MPa	Izod Impact Resistance,[G] ASTM D 2256, min, J/m	Deflection Temperature,[H] °C, min, ASTM D 648 at 1.82 MPa	Moisture[I] "as received," ASTM D 789, max, %
			4		95	210–225	1.12–1.14	76	150	2 600	55	58	0.20
			5		200	210–225	1.12–1.14	68	25	2 600	40	58	0.20
			6	recycled	30	210–225	1.12–1.14	68	25	2 600	40	58	0.20
			7	recycled	40	210–225	1.12–1.14	68	35	2 600	40	58	0.20
			8	recycled	40	210–225	1.12–1.14	76	40	2 600	40	58	0.20
			0	other									
			G10	10 % glass	. . .	. . .	. . .	70	. . .	3 200	25	135	. . .
			G15	15 % glass	. . .	. . .	. . .	105	. . .	4 500	40	185	. . .
			G30	30 % glass	. . .	. . .	. . .	140	. . .	7 500	75	200	. . .
			G45	45 % glass	. . .	. . .	. . .	175	. . .	10 500	100	200	. . .
			G00	other									
			M35	35 % mineral	. . .	. . .	. . .	63	. . .	3 600	50	. . .	. . .
			M40	40 % mineral	. . .	. . .	. . .	80	. . .	4 100	25	85	. . .
			M00	other									
			R20	20 % filler	. . .	. . .	. . .	90	. . .	4 200	25	185	. . .
			R40	40 % filler	. . .	. . .	. . .	105	. . .	6 200	25	185	. . .
			R00	other									
	3	Nucleated	1		30	210–225	1.12–1.15	82	10	2 800	35	63	0.20
			2		40	210–225	1.12–1.15	82	10	2 800	40	63	0.20
			3		50	210–225	1.12–1.15	82	50	2 800	40	63	0.20
			4		95	210–225	1.12–1.15	82	100	2 800	45	63	0.20
			5		200	210–225	1.12–1.15	82	100	2 800	45	63	0.20
			6	recycled	30	210–225	1.12–1.15	70	10	2 800	35	63	0.20
			7	recycled	40	210–225	1.12–1.15	70	10	2 800	40	63	0.20
			8	recycled	40	210–225	1.12–1.15	82	10	2 800	40	63	0.20
			0	other									
	4	Nucleated, heat-stabilized	1										
			2										
			3										
			4										
			5				Requirements the same as corresponding grades under Group 2 Class 3						
			6										
			7										
			8										
			0	other									
	5	Flexural-modified	1		. . .	185–225	1.05–1.16	27	50	700 max	80	33	0.20
			2		. . .	185–225	1.05–1.16	34	50	1 400 max	80	35	0.20
			3		. . .	185–225	1.05–1.16	41	50	2 100 max	80	38	0.20
			4		. . .	185–225	1.05–1.16	55	50	2 800 max	80	44	0.20
			0	other									
	6	Flexural-modified, heat-stabilized	1										
			2				Requirements the same as corresponding grades under Group 2 Class 5						
			3										
			4										
			0	other									
		Impact-modified	1		. . .	185–225	1.05–1.16	55	50	1 890	55	44	0.20
			2		. . .	185–225	1.05–1.16	27	50	690	105	33	0.20
			3		. . .	185–225	1.05–1.16	27	50	550	265	33	0.20
			4		. . .	185–225	1.05–1.16	27	50	275	425	33	0.20
			5	recycled	. . .	210–225	1.05–1.16	55	30	1 890	69	65	0.20
			0	other									
	8	Impact-modified, heat-stabilized	1										
			2				Requirements the same as corresponding grades under Group 2 Class 7						
			3										
			4										

TABLE X3.1 *Continued*

Group	Description	Class	Description	Grade	Description[A]	Relative Viscosity,[B] min, ASTM D 789	Melt Point, °C, ASTM D 3418, DTA or DSC[C,D]	Specific Gravity, ASTM D 792	Tensile Strength,[E] ASTM D 638, min, MPa	Elongation[E] (ultimate), ASTM D 638, min, %	Flexural Modulus,[F] ASTM D 790, min, MPa	Izod Impact Resistance,[G] ASTM D 2256, min, J/m	Deflection Temperature,[H] °C, min, ASTM D 648 at 1.82 MPa	Moisture[I] "as received," ASTM D 789, max, %
				0	other									
		0	Other	0	other									
03	11 Nylon	1	General-purpose	1		1.53–1.58	185–195	1.03–1.06	41	200	900	55	35	0.15
				2		1.59–1.67	185–195	1.03–1.06	45	200	900	55	40	0.12
				3		1.67–1.82	185–195	1.03–1.06	45	200	900	55	40	0.10
				4		1.83–2.00	185–195	1.03–1.06	48	200	900	55	40	0.08
				5	hydrolysis-resistant[K]	1.83–2.00	185–195	1.03–1.06	48	200	900	55	40	0.08
				0	other									
		2	Heat-stabilized	1		1.59–1.67	185–195	1.03–1.06	45	200	900	55	40	0.12
				2		1.67–1.82	185–195	1.03–1.06	45	200	900	55	40	0.10
				3		1.83–2.00	185–195	1.03–1.06	48	200	900	55	40	0.08
				4	hydrolysis-resistant	1.83–2.00	185–195	1.03–1.06	48	200	900	55	40	0.08
				0	other									
		3	Highly plasticized	1		1.59–1.67	185–195	1.03–1.06	45	250	300	80	35	0.10
				2		1.67–1.82	185–195	1.03–1.06	52	250	300	80	35	0.08
				3		1.83–2.00	185–195	1.03–1.06	52	250	300	80	35	0.08
				4		2.00 min	185–195	1.03–1.06	52	250	300	80	35	0.08
				0	other									
		4	Highly plasticized, heat-stabilized	1										
				2										
				3										
				4										
				0	other									
		5	Moderately plasticized	1		1.59–1.67	185–195	1.03–1.06	45	250	350	80	35	0.10
				2		1.83–2.00	185–195	1.03–1.06	52	250	350	80	35	0.08
				3		1.59–1.67	185–195	1.03–1.06	45	225	450	80	35	0.08
				4		1.83–2.00	185–195	1.03–1.06	52	225	450	80	35	0.08
				5		1.83–2.00	185–195	1.03–1.06	52	225	600	80	35	0.08
				0	other									
		6	Moderately plasticized, heat-stabilized	1										
				2										
				3										
				4										
				5										
				0	other									
		0	Other	0	other									
04	12 Nylon	1	General-purpose	1		1.50–2.05	170–185	1.01–1.06	30	140	800	25[L]	35[M]	0.10
				2		1.50–2.05	170–185	1.01–1.06	35	150	1 000	25	35	0.10
				3		2.06–2.35	170–185	1.01–1.06	35	150	1 000	25	35	0.10
				4		2.36–2.70	170–185	1.01–1.06	35	150	1 000	25	35	0.10
				0	other									
		2	Heat-stabilized	1		1.50–1.75	170–185	1.00–1.06	35	150	800	25[L]	35[M]	0.10
				2		1.76–2.05	170–185	1.00–1.06	35	150	800	25	35	0.10
				3		2.06–2.40	170–185	1.00–1.06	35	150	1 000	25	35	0.10
				0	other									
		3	Nucleated	1		1.50–1.90	170–185	1.00–1.06	35	100	800	10[L]	35[M]	0.10
				2		1.91–2.25	170-185	1.00–1.06	35	100	800	25	35	0.10
				0	other									

Requirements the same as corresponding grades under Group 3 Class 3

Requirements the same as corresponding grades under Group 3 Class 5

TABLE X3.1 *Continued*

Group	Description	Class	Description	Grade	Description[A]	Relative Viscosity,[B] min, ASTM D 789	Melt Point, °C, ASTM D 3418, DTA or DSC[C,D]	Specific Gravity, ASTM D 792	Tensile Strength,[E] ASTM D 638, min, MPa	Elongation[E] (ultimate), ASTM D 638, min, %	Flexural Modulus,[F] ASTM D 790, min, MPa	Izod Impact Resistance,[G] ASTM D 2256, min, J/m	Deflection Temperature,[H] °C, min, ASTM D 648 at 1.82 MPa	Moisture[I] "as received," ASTM D 789, max, %
		4	Plasticized	1		1.50–2.40	165–180	1.00–1.06	30	180	300–550	200[L]	. . .	0.10
				2		1.50–2.40	165–180	1.00–1.06	30	200	300–550	200	. . .	0.10
				3		1.50–2.40	170–185	1.00–1.06	30	200	450–750	100	. . .	0.10
				0	other									
		5	Plasticized, heat-stabilized	1		1.50–2.40	160–175	1.00–1.06	20	200	200–350	200[L]	. . .	0.10
				2		1.50–2.40	165–180	1.00–1.06	30	180	300–550	200	. . .	0.10
				3		1.50–2.40	165–180	1.00–1.06	30	200	300–550	200	. . .	0.10
				4		1.50–2.40	170–185	1.00–1.06	30	200	450–750	100	. . .	0.10
				5		1.50–2.40	170–185	1.00–1.06	35	200	550–950	50	. . .	0.10
				0	other									
		0	Other	0	other									
05	69 Nylon	1	General-purpose	1		30	208–220	1.07–1.09	60	50	1 900	40	47	0.20
				2		45	208–220	1.07–1.09	60	50	1 900	40	47	0.20
				3		100	208–220	1.07–1.09	60	508	1 900	40	47	0.20
				0	other									
		2	Heat-stabilized	1		30	208–220	1.07–1.09	60	50	1 900	40	47	0.20
				2		45	208–220	1.07–1.09	60	50	1 900	40	47	0.20
				3		100	208–220	1.07–1.09	60	50	1 900	40	47	0.20
				0	other									
		0	Other	0	other									
06	612 Nylon	1	General-purpose	1		0.90[N]	208–220	1.05–1.07	55	50	1 900	30	65	0.30
				2		1.1[N]	208–220	1.05–1.07	55	100	1 900	40	65	0.25
				3		1.3[N]	208–220	1.05–1.07	55	100	1 900	40	60	0.15
				0	other									
		2	Heat-stabilized	1		1.1[N]	208–220	1.05–1.07	55	50	1 900	35	60	0.30
				0	other									
		3	Weather-stabilized[J]	1		1.1[N]	208–220	1.05–1.07	. . .	. . .	. . .	40	60	0.30
				0	other									
		0	Other	0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
07[O]	610 Nylon	1	General-purpose	1		25	210–222	1.05–1.09	50	50	1 850	40	60	0.25
				2		40	210–222	1.05–1.09	60	70	1 850	45	60	0.22
				3		60	210–222	1.05–1.09	65	70	1 850	45	60	0.22
				0	other									
		2	Heat-stabilized	1		25	210–222	1.05–1.09	50	50	1 850	40	60	0.25
				2		40	210–222	1.05–1.09	60	70	1 850	45	60	0.22
				0	other									
		0	Other	0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
08	Special	1	*n*-Alkoxy-alkyl 6:6	1		40	143–158	1.09–1.12	20	250	200	N/B[G]	. . .	0.20
				0	other									
		0	Other	0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
09	46 Nylon	1	General-purpose	1		45	285–295	1.16–1.20	90	25	2 600	50	140	0.05
				2		80	285–295	1.16–1.20	90	25	2 600	50	140	0.05
				3		125	285–295	1.16–1.20	90	25	2 600	50	140	0.05
				0	other									
		2	Heat-stabilized	1		45	285–295	1.16–1.20	90	25	2 600	50	140	0.05
				2		80	285–295	1.16–1.20	90	25	2 600	50	140	0.05
				3		125	285–295	1.16–1.20	90	25	2 600	50	140	0.05
				0	other									

TABLE X3.1 *Continued*

Group	Description	Class	Description	Grade	Description[A]	Relative Viscosity,[B] min, ASTM D 789	Melt Point, °C, ASTM D 3418, DTA or DSC[C,D]	Specific Gravity, ASTM D 792	Tensile Strength,[E] ASTM D 638, min, MPa	Elongation[E] (ultimate), ASTM D 638, min, %	Flexural Modulus,[F] ASTM D 790, min, MPa	Izod Impact Resistance,[G] ASTM D 2256, min, J/m	Deflection Temperature,[H] °C, min, ASTM D 648 at 1.82 MPa	Moisture[I] "as received," ASTM D 789, max, %
		0	Other	0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
19	Reinforced/Filled 46 Nylon[P]	1	Glass-reinforced, heat-stabilized	2	15 % glass	. . .	. . .	1.28[Q]	145[R]	. . .	4 500	35	275	. . .
				5	30 % glass	. . .	. . .	1.41[Q]	190[R]	. . .	7 700	80	280	. . .
				7	40 % glass	. . .	. . .	1.51[Q]	210[R]	. . .	9 000	85	280	. . .
				9	50 % glass	. . .	. . .	1.62[Q]	235[R]	. . .	12 000	85	280	. . .
				0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
		2	Glass-reinforced, heat-stabilized, flame-retardant[S]	2	15 % glass	. . .	. . .	1.53[Q]	140[R]	. . .	4 700	25	270	. . .
				5	30 % glass	. . .	. . .	1.68[Q]	180[R]	. . .	8 000	55	280	. . .
				0	other									
		3	Mineral-filled, heat-stabilized	7	40 % mineral	. . .	. . .	1.49[Q]	100[R]	. . .	5 000	25	240	. . .
				0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	
		4	Mineral/glass-filled, heat-stabilized	5	30 % filler	. . .	. . .	1.40[Q]	120[R]	. . .	5 500	30	270	. . .
				7	40 % filler	. . .	. . .	1.50[Q]	140[R]	. . .	6 000	30	270	. . .
				0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
		0	Other	0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
0	Other	0	Other	0	other	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .

[A] No descriptions are listed unless needed to describe a special grade under the class. All other grades are listed by requirements.

[B] Viscosities for Groups 03, 04, 06, and 08 are measured as described as follows. Refer to Specification D 789 for general directions and for the calculation of relative viscosities. Relative viscosities of Groups 03 and 04 shall be measured on 0.5 g of polymer dissolved in 99.5 g of *m*-cresol at 25.0 ± 0.1°C in a Cannon-Fenske No. 200 viscometer. Inherent viscosity of Group 06 shall be measured on 0.5 g of polymer dissolved in 100 mL of *m*-cresol at 25.0± 0.1°C in a Cannon-Fenske No. 200 viscometer. The inherent viscosity is calculated as follows:

$$\text{Inherent viscosity} = \frac{\ln(t_s/t_c)}{C}$$

t_s = average efflux time for sample solution,
t_c = average efflux time for solvent, and
C = concentration, g/100 mL.

Relative viscosity of Group 08 shall be measured on 9.44 g of polymer dissolved in 100 mL of *m*-cresol at 25.0 ± 0.1°C in a Cannon-Fensky No. 450 viscometer. Details of these methods will be included in a future revision of Specification D 789.

[C] Heating rate—10°C/min.

[D] The results of an international round robin (ISO-USA, Germany, Japan, Poland, and Italy) showed DSC melt point to be the method having the best reproducibility of results when compared to other available methods (ref. ISO 3146).

[E] Tensile strength and elongation shall be determined on Test Method D 638 test specimens 3.2 ± 0.4 mm thick. The speed of testing shall be 50 mm/min (±10 %) unless otherwise agreed upon.

[F] Flexural modulus shall be determined on Test Method D 790 test specimens 3.2 by 12.7 by 127 mm with a crosshead speed of 1.3 mm/min (±50 %), Procedure A.

[G] Izod impact for these materials shall be conducted on specimens with a 12.7-mm depth and a notch radius of 0.25 mm. The specimens tested are 3.17 mm in width. N/B = No Break.

[H] Requirements are based on unannealed test specimens 3.17 mm in width. Annealed specimens tend to give higher results because of the elimination of the effect of molding stresses when annealed in accordance with the supplier's recommendation.

[I] Groups 03 and 04 materials use Specification D 789 except sample to be immersed in a heat bath for 45 min at 180 ± 2°C.

[J] Carbon black content and absorbance must be 1.90 to 2.25 % and 0.230 minimum, respectively, as determined in accordance with methods found in Federal Specification L-P-410a. It is possible, by agreement between the buyer and the seller, that materials incorporating other pigments or soluble stabilizers, or both, may prove adequate for particular applications.

[K] Hydrolysis-resistance test. To be agreed upon between the user and the supplier.

[L] Izod impact requirements for Group 04 materials based on specimens with a 12.7-mm depth, 3.17-mm width, and a notch radius of 0.25 mm.

[M] Deflection temperature requirements for Group 04 materials are based on unannealed test specimens 3.17 mm in width.

[N] Inherent viscosities (dL/g).

[O] Group 07 nylons are presently used commercially only as reinforced materials.

[P] Moisture of material" as received" shall be 0.05 % max (Test Method D 789).

[Q] For general information (not a requirement).

[R] Tensile strength and elongation shall be determined on Test Method D 638 test specimens 3.2 ± 0.4 mm thick. The speed of testing shall be 5 mm/min (±10 %) unless otherwise agreed upon.

[S] For specific flammability requirement use the proper suffix from Classification D 4000, for example, FL310 = (UL 94) VO at 0.8 mm.

TABLE X3.2 Detail Requirements[A] Reinforced Nylons (Table A, Specification D 4066–94b)

Designation Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ASTM D 638, min, MPa[B,C]	unspecified	35	70	105	140	175	210	245	280	Specify[D] value
2	Flexural modulus, ASTM D 790, min, MPa[B,E]	unspecified	1 500	4 500	7 500	10 500	13 500	16 500	19 500	22 500	Specify[D] value
3	Izod impact, ASTM D 256, min, J/m[F]	unspecified	25	50	75	100	125	150	225	300	Specify[D] value
4	Deflection temperature, ASTM D 648, 1820 kPa, °C, min[G]	unspecified	50	85	110	135	160	185	200	235	Specify[D] value
5	To be determined	unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	

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

[B] MPA × 145 = psi.

[C] Tensile strength and elongation shall be determined on Test Method D 638 test specimens 3.2 ± 0.4 mm thick. The speed of testing shall be 5 mm/min (±25 %) unless otherwise agreed upon.

[D] If specific value is required, it must appear on drawing or contract, or both.

[E] Flexural modulus shall be determined on Test Methods D 790 test specimens 6.4 by 13 by 130 mm with a crosshead speed of 2.8 mm/min (±50 %), Procedure A.

[F] J/m × 18.73 × 10^{-3} = ft · lbf/in.

[G] Requirements are based on unannealed test specimens 3.17 mm in width. Annealed specimens tend to give higher results because of the elimination of the effect of molding stresses when annealed in accordance with the supplier's recommendation.

TABLE X3.3 Detail Requirements[A] Unreinforced Nylons (Table B, Specification D 4066–94b)

Designation Order No.	Property	0	1	2	3	4	5	6	7	8	9
1	Tensile strength, ASTM D 638, min, MPa[B,C]	unspecified	10	25	40	55	70	85	100	115	Specify[D] value
2	Flexural modulus, ASTM D 790, min, MPa[B,E]	unspecified	300	1 000	1 700	2 400	3 100	3 800	4 500	5 200	Specify[D] value
3	Izod impact, ASTM D 256, min, J/m[C,F]	unspecified	20	40	60	100	140	180	240	300	Specify[D] value
4	Deflection temperature, ASTM D 648, 1820 kPa, °C, min[G]	unspecified	40	55	70	85	100	115	130	145	Specify[D] value
5	To be determined	unspecified	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .	

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

[B] MPA × 145 = psi.

[C] Tensile strength and elongation shall be determined on Test Method D 638 test specimens 3.2 ± 0.4 mm thick. The speed of testing shall be 50 mm/min (±25 %) unless otherwise agreed upon.

[D] If specific value is required, it must appear on drawing or contract, or both.

[E] Flexural modulus shall be determined on Test Methods D 790 test specimens 6.4 by 13 by 130 mm with a crosshead speed of 2.8 mm/min (±50 %), Procedure A.

[F] J/m × 18.73 × 10^{-3} = ft · lbf/in.

[G] Requirements are based on unannealed test specimens 3.17 mm in width. Annealed specimens tend to give higher results because of the elimination of the effect of molding stresses when annealed in accordance with the supplier's recommendation.

SUMMARY OF CHANGES

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

D 4066 – 96:
(*1*) This edition includes the addition of international test specimens and procedures, and additional grades to Table PA; the removal of melting point, specific gravity, elongation, and moisture content from Table PA; and the addition of melting point to the appendix.
D 4066 – 96a:
(*1*) This edition includes revised Nylon 6 data in Table PA.
(*2*) Table X3.1 was corrected to reflect Table PA of Classification System D 4066 – 94b.
D 4066 – 98:
(*1*) A new Note 10 was added to 4.2 to explain the use of Classification D 4000 suffixes, and all subsequent notes were renumbered.
D 4066 – 99:
(*1*) Table PA was expanded to include Group 03 11 Nylon data.
D 4066 – 00:
(*1*) Revised Nylon 46 data in Table PA.
D 4066 – 00a:
(*1*) Added Group 13 (PA 6T/66) and Group 00 to Table PA.
(*2*) Removed reinforcement Grades G00, M00, and R00 from Table PA.

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