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Plastics — Polyamide (PA) moulding and extrusion materials —

Part 1: Designation

*Plastiques — Matériaux polyamides (PA) pour moulage et extrusion —
Partie 1: Désignation*



Reference number
ISO 1874-1:1992(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 1874-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Sub-Committee SC 9, *Thermoplastic materials*.

This second edition cancels and replaces the first edition (ISO 1874-1:1985), the scope of which has been extended to include not only homopolymers but also copolymers.

ISO 1874 consists of the following parts, under the general title *Plastics — Polyamide (PA) moulding and extrusion materials*:

- *Part 1: Designation*
- *Part 2: Preparation of test specimens and determination of properties*

Annex A forms an integral part of this part of ISO 1874.

Plastics — Polyamide (PA) moulding and extrusion materials —

Part 1: Designation

1 Scope

1.1 This part of ISO 1874 establishes a system of designation for polyamide (PA) thermoplastic materials, which may be used as the basis for specifications.

It covers polyamide homopolymers for moulding and extrusion based on PA 6, PA 66, PA 69, PA 610, PA 612, PA 11, PA 12, PA MXD6, PA 46, PA 1212 and copolyamides of various compositions for moulding and extrusion.

1.2 The types of polyamide plastic are differentiated from each other by a classification system based on appropriate levels of the designatory properties

- a) viscosity number,
- b) tensile modulus of elasticity and
- c) presence of nucleating agent,

and on information about chemical structure, intended application, method of processing, important properties, additives, colour, fillers and reinforcing materials.

1.3 The designation system is applicable to all polyamide homopolymers and copolymers. It applies to materials ready for normal use, unmodified and modified by colorants, additives, fillers, reinforcing materials, polymer modifiers, etc.

This part of ISO 1874 does not apply to monomer casting-type polyamides of PA 6 and PA 12.

1.4 It is not intended to imply that materials having the same designation give necessarily the same performance. This part of ISO 1874 does not provide engineering data, performance data or data on processing conditions which may be required to specify a material for a particular application and/or method of processing.

If such additional properties are required, they shall be determined in accordance with the test methods specified in part 2 of ISO 1874, if suitable.

1.5 In order to specify a thermoplastic material for a particular application or reproducible processing, additional requirements may be given in Data Block 5 (see clause 3).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 1874. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 1874 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 307:1984, *Plastics — Polyamides — Determination of viscosity number*.

ISO/R 527:1966, *Plastics — Determination of tensile properties*.

ISO 1043-1:1987, *Plastics — Symbols — Part 1: Basic polymers and their special characteristics*.

ISO 1043-2:1988, *Plastics — Symbols — Part 2: Fillers and reinforcing materials*.

ISO 1874-2:1987, *Plastics — Polyamide (PA) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*.

ISO 3451-4:1986, *Plastics — Determination of ash — Part 4: Polyamides*.

3 Designation system

The designation system for thermoplastics is based on the standardized pattern given in figure 1.

The designation consists of an optional Description Block, reading "Thermoplastics", and an Identity Block comprising the International Standard number and an Individual Item Block. For unambiguous designation, the Individual Item Block is subdivided into four data blocks comprising the following information:

- | | |
|---------------|---|
| Data Block 1: | Identification of the plastic by its symbol (PA), in accordance with ISO 1043-1, and information about chemical structure and composition (see 3.1). |
| Data Block 2: | Position 1: Intended application or method of processing (see 3.2).
Positions 2 to 8: Important properties, additives and supplementary information (see 3.2). |
| Data Block 3: | Designatory properties (see 3.3). |
| Data Block 4: | Fillers or reinforcing materials and their nominal content (see 3.4). |

For the purpose of specifications, a fifth data block may be added containing additional information. The kind of information and the code-letters used are not the subject of this part of ISO 1874.

The first character of the Individual Item Block shall be a hyphen.

The four data blocks shall be separated from each other by a comma.

If a data block is not used, this shall be indicated by doubling the separation sign, i.e. by two commas (,,).

3.1 Data Block 1

In this data block, after the hyphen, the polyamide plastic is identified using the symbols and designations listed in tables 1 and 2.

Polyamides containing a plasticizer may be designated by adding the letter P after the symbol, separated from it by a hyphen (example: PA 610-P).

Polyamides containing an impact modifier may be designated by adding the letters HI after the symbol, separated from it by a hyphen (example: PA6-HI).

Designation						
Description Block (optional)	Identify Block					
	International Standard Block	Individual Item Block				
		Data Block 1	Data Block 2	Data Block 3	Data Block 4	Data Block 5

Figure 1 — Data block designation system

Table 1 — Symbols indicating the chemical structure of polyamide materials in Data Block 1

Symbol	Name and chemical structure
PA 6	Polyamide 6; homopolymer based on ϵ -caprolactam
PA 66	Polyamide 66; homopolycondensate based on hexamethylenediamine and adipic acid
PA 69	Polyamide 69; homopolycondensate based on hexamethylenediamine and azelaic acid
PA 610	Polyamide 610; homopolycondensate based on hexamethylenediamine and sebacic acid
PA 612	Polyamide 612; homopolycondensate based on hexamethylenediamine and dodecanedioic acid ¹⁾
PA 11	Polyamide 11; homopolymer based on 11-aminoundecanoic acid
PA 12	Polyamide 12; homopolymer based on ω -aminododecanoic acid or on laurilactam
PA MXD6	Polyamide MXD6; homopolycondensate based on <i>m</i> -xylylenediamine and adipic acid
PA 46	Polyamide 46; homopolymer based on tetramethylenediamine and adipic acid
PA 1212	Polyamide 1212; homopolymer based on dodecanediamine and dodecanedioic acid ¹⁾

1) 1,10-Decanedicarboxylic acid.

Table 2 — Symbols indicating the chemical structure of copolyamide materials in Data Block 1 (examples)

Symbol	Chemical structure
PA 66/610	Polyamide copolymers based on hexamethylenediamine, adipic acid and sebacic acid
PA 6/12	Polyamide copolymers based on ϵ -caprolactam and laurilactam
PA 6T/6I	Polyamide copolymers based on hexamethylenediamine, terephthalic acid and isophthalic acid
PA 6/66/PACM 6	Polyamide ternary copolymers of ϵ -caprolactam, hexamethylenediamine, adipic acid, bis(<i>p</i> -aminocyclohexyl)methane and adipic acid
PA 12/IPDC	Polyamide copolymers of laurilactam, isophorone diamine and isophthalic acid
The following two designations include an indication of the mass content ratio:	
PA 66/6 (90/10)	Polyamide copolymers based on 90 % (<i>m/m</i>) hexamethylenediamine and adipic acid and 10 % (<i>m/m</i>) ϵ -caprolactam
PA 66/6 (20/80)	Polyamide copolymers based on 20 % (<i>m/m</i>) hexamethylenediamine and adipic acid and 80 % (<i>m/m</i>) ϵ -caprolactam

3.2 Data Block 2

In this data block, information about intended application or method of processing is given in position 1 and information about important properties, additives and colour in positions 2 to 8. The code-letters are specified in table 3.

If information is presented in positions 2 to 8 and no specific information is given in position 1, the letter X shall be inserted in position 1.

Table 3 — Codes used in Data Block 2

Code-letter	Position 1	Positions 2 to 8
A	Blow moulding	Processing stabilized
B		Antiblocking
C1		Coloured, transparent
C2		Coloured, non-transparent
D		Powder; dry blend
E	Extrusion of pipes, profiles and sheets	Expandable
F		Special burning characteristics
G	Extrusion of film and thin sheeting	Pellets; granules
H	General use	Heat-ageing stabilized
K	Coating	Light and/or weather stabilized
L	Cable and wire coating	
M	Monofilament extrusion	
N	Injection moulding	Natural (not coloured)
R	Rotational moulding	Moulding release agent
S	Powder coating or sintering	Lubricated
T	Tape manufacture	Improved transparency
W		Stabilized against hydrolysis
X	No indication	Antistatic
Z		

3.3 Data Block 3

In this data block, the viscosity number is represented by a two-figure code-number (see 3.3.1) and the tensile modulus of elasticity by a three-figure code-number (see 3.3.2). The two codes are separated from each other by a hyphen.

Nucleated polyamides may be designated by the letter N in the very last position of Data Block 3.

If a property value falls on or near a range limit, the manufacturer shall state which range will designate the material. If subsequent individual test values lie on, or either side of, the range limit because of manufacturing tolerances, the designation is not affected.

NOTE 1 Not all combinations of the values of the designatory properties are provided by currently available materials.

3.3.1 Viscosity number

The viscosity number shall be determined in accordance with ISO 307, using the solvent specified in table 4. The average value of the viscosity number is represented by a two-figure code-number as specified in table 4.

For copolyamides, 96 % (m/m) sulfuric acid should preferably be used as solvent, but some copolyamides dissolve better in *m*-cresol. Information concerning the most suitable solvent can be obtained from the supplier of copolyamides and homopolyamides which are not covered by the last column of table 4.

Table 4 — Code-numbers used for viscosity number in Data Block 3

Code-number	Range of viscosity number ml/g		Applicable to
	Solvent: 96 % (m/m) sulfuric acid	Solvent: <i>m</i> -cresol	
09	≤ 90		PA 6
10	> 90 to 110		PA 66
12	> 110 to 130		PA 69
14	> 130 to 160		PA 610
18	> 160 to 200		PA 612
22	> 200 to 240		PA MXD6
27	> 240 to 290		Copolyamides
32	> 290 to 340		
34	> 340		
11		≤ 110	PA 1212
12		> 110 to 130	PA 11
14		> 130 to 150	PA 12
16		> 150 to 170	Copolyamides
18		> 170 to 200	
22		> 200 to 240	
24		> 240	

NOTE 2 Viscosity numbers determined with 90 % (m/m) formic acid as solvent can be converted into viscosity numbers determined in 96 % (m/m) sulfuric acid using the following equations:

For PA 6

$$\ln y = 0,416\ 1 + 0,927\ 6 \ln x$$

For PA 66

$$\ln y = 0,454\ 1 + 0,926\ 1 \ln x$$

For PA 69

$$\ln y = 0,463\ 4 + 0,909\ 5 \ln x$$

For PA 610

$$\ln y = 0,982\ 3 + 0,793\ 2 \ln x$$

where

x is the viscosity number in 90 % (m/m) formic acid;

y is the viscosity number in 96 % (m/m) sulfuric acid.

For the viscosity number of PA 612, which may be determined in accordance with ISO 307 in either *m*-cresol or 96 % (m/m) sulfuric acid, the following conversion formula applies:

$$\ln y = 0,285\ 7 + 0,985\ 9 \ln x$$

where

x is the viscosity number in 96 % (m/m) sulfuric acid;

y is the viscosity number in *m*-cresol.

The above conversion formulae have been calculated from the results of an interlaboratory investigation carried out in 1982 (see ISO 307:1984, clause 13). The accuracy of the conversions depends on both the size of the viscosity number and the type of PA, the latter resulting from the fact that different numbers of the different PA-types were included in the investigation. The 95 % confidence intervals for the values of the nominal viscosity number in 96 % (m/m) sulfuric acid, converted from different values of the nominal viscosity number in the other solvent, are given in table 5.

Table 5 — Confidence intervals

Nominal viscosity number ¹⁾	95 % confidence intervals for converted nominal viscosity numbers in 96 % (m/m) sulfuric acid				
	PA 6	PA 66	PA 69	PA 610	PA 612
100	±0,8	±1,6	±2,0	±4,7	±4,4
140	±0,8	±1,4	±1,9	±4,1	±4,9
180	±0,7	±1,2	±2,9	±5,8	±10,2
220	±0,7	±1,3	±4,7	±9,0	±17,6
260	±0,8	±1,7	±6,9	±12,9	±26,0
300	±1,0	±2,4	±9,3	±17,2	±35,3
340	±1,3	±3,3	±11,9	±21,8	±45,3

1) Solvents: 90 % (m/m) formic acid for PA 6, PA 66, PA 69 and PA 610; *m*-cresol for PA 612.

3.3.2 Tensile modulus of elasticity

The tensile modulus of elasticity shall be determined in the dry state in accordance with ISO/R 527 under the test conditions specified in ISO 1874-2. The average value of the tensile modulus of elasticity is represented by a three-figure code-number as specified in table 6.

Table 6 — Codes used for tensile modulus of elasticity in Data Block 3

Tensile modulus of elasticity	
Code-number	Range MPa
001	≤ 150
002	> 150 to 250
003	> 250 to 350
004	> 350 to 450
005	> 450 to 600
007	> 600 to 800
010	> 800 to 1 500
020	> 1 500 to 2 500
030	> 2 500 to 3 500
040	> 3 500 to 4 500
050	> 4 500 to 5 500
060	> 5 500 to 6 500
070	> 6 500 to 7 500
080	> 7 500 to 8 500
090	> 8 500 to 9 500
100	> 9 500 to 10 500
110	> 10 500 to 11 500
120	> 11 500 to 13 000
140	> 13 000 to 15 000
160	> 15 000 to 17 000
190	> 17 000 to 20 000
220	> 20 000 to 23 000
250	> 23 000

3.4 Data Block 4

In this data block, the type of filler or reinforcing material is represented by one code-letter in position 1 and its physical form by a second code-letter in position 2 (see table 7 and ISO 1043-2). Subsequently (without a space), the mass content may be given by a two-figure code-number in positions 3 and 4.

Mixtures of materials or forms may be indicated in parentheses by combining the relevant codes using the sign "+". For example, a mixture of 25 % (*m/m*) glass fibre (GF) and 10 % (*m/m*) mineral powder (MD) would be indicated by (GF25+MD10).

Table 7 — Coding system for fillers and reinforcing materials in Data Block 4

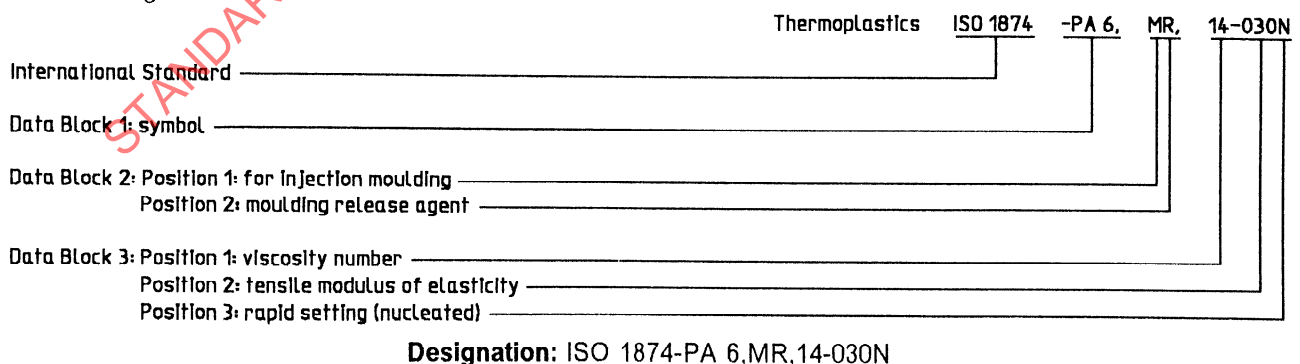
Code-letter	Material (Position 1)	Form (Position 2)
B	Boron	Balls; beads; spheres
C	Carbon ¹⁾	
D		Powder; dry blend
F		Fibre
G	Glass	Granules; ground
H		Whiskers
K	Chalk (CaCO ₃)	
M	Mineral ¹⁾ ; metal ²⁾	
S	Organic; synthetic ¹⁾	
T	Talcum	
X	Not specified	Not specified
Z	Others ¹⁾	Others

1) These materials may be defined after position 4 of the data block, for example by chemical symbol or additional codes to be agreed upon.

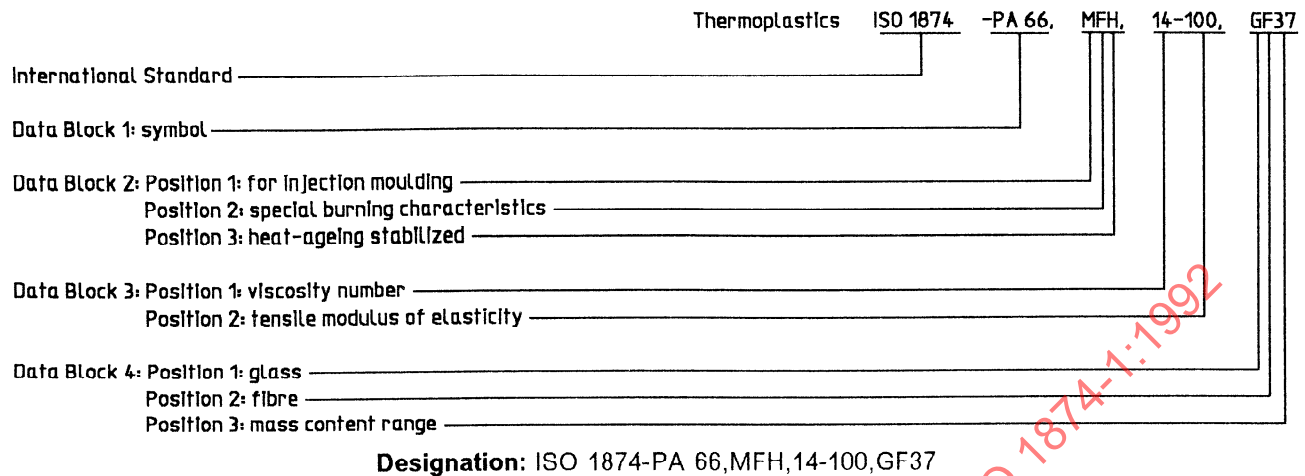
2) Metal filler shall identified by the chemical symbol (in capital letters) after the mass content. For example, steel whiskers may be designated "MH05FE".

4 Examples of designations

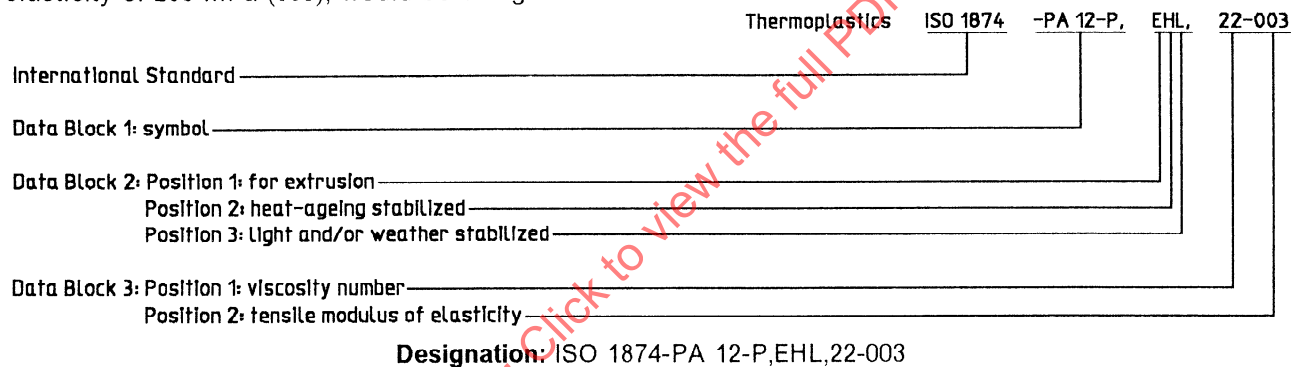
4.1 A polyamide material (PA 6) for injection moulding (M), with moulding release agent (R), having a viscosity of 150 ml/g (14) and a tensile modulus of elasticity of 2 700 MPa (030), and with a nucleating additive (N), would be designated:



4.2 A polyamide material (PA 66) for injection moulding (M), with special burning characteristics (F) and a heat-ageing stabilizer (H), having a viscosity number of 140 ml/g (14) and a tensile modulus of elasticity of 10 200 MPa (100), and reinforced with 37 % of glass fibre (GF), would be designated:



4.3 A polyamide material containing plasticizer (PA 12-P), for extrusion (E), with a heat-ageing stabilizer (H) and a light and weather stabilizer (L), and having a viscosity number of 210 ml/g (22) and a tensile modulus of elasticity of 280 MPa (003), would be designated:



Annex A

(normative)

Definition and designation of aliphatic polyamides

Polyamide materials are thermoplastic materials that contain carboxylic amide groups, $-\text{CONH}-$, at regular intervals in the linear polymer chain.

Polyamide homopolymers may be built up from a single starting material (an aminocarboxylic acid or its lactam); in this case, they are designated by a number corresponding to the number of carbon atoms in the starting material (see table A.1).

Table A.1 — Designation of linear aliphatic polyamides of general formula $-\text{[NH}-(\text{CH}_2)_x-\text{CO}]_n-$

Symbol	Value of x	Number of C atoms in the starting material
PA 6	5	6
PA 11	10	11
PA 12	11	12

However, polyamide homopolymers may also be built up from one starting material with amino groups plus one starting material with carboxylic acid groups. These polyamides, based on diamines and dicarboxylic acids, are designated by a two-digit, three-digit or four-digit number, respectively. In the case of the four-digit number, the first digit (or the first and second digits) corresponds to the number of C atoms in the linear aliphatic diamine and the second digit (or with some materials the second and third or the third and fourth digits) corresponds to the number of C atoms in the linear aliphatic dicarboxylic acid (see table A.2).

Table A.2 — Designation of linear aliphatic polyamides of general formula

$-\text{[NH}-(\text{CH}_2)_x-\text{NH-CO}-(\text{CH}_2)_y-\text{CO}]_{n/2}-$

Symbol	Value of	
	x	y
PA 66	6	4
PA 610	6	8
PA 612	6	10
PA 46	4	4
PA 1212	12	10

Copolymer polyamides, also called copolyamides, may be built up from various starting materials (lactams, aminocarboxylic acids, equimolar amounts of diamines and dicarboxylic acids). These copolyamides are designated PA plus numbers representing the components of the copolyamide, the numbers being separated by an oblique stroke (see ISO 1043-1:1987, annex A, clause A.6). But copolyamides with the same numbers or symbols can have quite different properties, depending on the ratio of the starting materials. Therefore, if there is a need for a more exact designation, the mass content ratio shall be included. If it is necessary to indicate this ratio, the two figures, separated by an oblique stroke, may be placed in parentheses at the end of the designation (see table 2).

Starting materials (monomers) for copolyamides, as well as for homopolyamides, include not only linear aliphatic compounds, but also branched aliphatic, aliphatic-aromatic, cyclo-aliphatic and aromatic compounds. The monomer units of these non-linear aliphatic compounds may be derived from the substances listed, together with their designations, in table A.3.

Because of the large number of possible combinations of copolyamides, only a few examples have been listed in table 2.

Table A.3 — Symbols of non-linear aliphatic monomer units

Symbol of monomer unit	Monomer unit derived from
T	Terephthalic acid (CAS No. 100-21-0)
I	Isophthalic acid (CAS No. 121-95-5)
N	2,6-Naphthalenedicarboxylic acid (CAS No. 1141-38-4)
PACP	2,2-Bis(<i>p</i> -aminocyclohexyl)propane (CAS No. 3377-24-0)
MACM	3,3'-Dimethyl-4,4'-diaminodicyclohexylmethane (CAS No. 6864-37-5)
PACM	Bis(<i>p</i> -aminocyclohexyl)methane (CAS No. 1761-71-3)
IPD	Isophorone diamine (CAS No. 2855-13-2)
ND	1,6-Diamino-2,2,4-trimethylhexane (CAS No. 3236-53-1)
IND	1,6-Diamino-2,4,4-trimethylhexane (CAS No. 3236-54-2)
PPGD	Polypropylene glycoldiamine (CAS No. 9046-10-0)
PBGD	Polybutylene glycoldiamine (CAS No. 27417-83-0)
MXD	<i>m</i> -Xylylene diamine (CAS No. 1477-55-0)
PTD	<i>p</i> -Toluylene diamine (CAS No. 95-70-5)
MTD	<i>m</i> -Toluylene diamine (CAS No. 95-80-7)
PABM	Diphenylmethane-4,4'-diamine (CAS No. 101-77-9)
MC	1,3-Bis(aminomethyl)cyclohexane (CAS No. 2579-20-6)
X	Not specified

NOTE — The designations ND and IND are derived from the chemical names nonyldiamine and isononyldiamine to avoid having to include numbers in the designations.