INTERNATIONAL STANDARD

NORME INTERNATIONALE

IEC
CEI
60404-8-6

1999

AMENDMENT 1
AMENDEMENT 1
2007-04

Amendment 1

Magnetic materials –

Part 8-6:
Specifications for individual materials –
Soft magnetic metallic materials

Amendement 1

Matériaux magnétiques –

Partie 8-6:
Spécifications pour matériaux particuliers –
Matériaux métalliques magnétiquement doux

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FOREWORD

This amendment has been prepared by IEC technical committee 68: Magnetic alloys and steels.

The text of this amendment is based on the following documents:

CDV	Report on voting
68/325A/CDV	68/328/RVC

Full information on the voting for the approval of this amendment can be found in the report on voting indicated in the above table.

The committee has decided that the contents of this amendment and the base publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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4.3 Alloy class E (nickel-iron)

Replace the whole text with the following sentence:

“These alloys are classified according to the shape of the hysteresis loop and the minimum amplitude permeability in an a.c. measurement (50 Hz or 60 Hz), under sine flux conditions, with a S.W. specimen made of material with a thickness of 0,10 mm.”

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7.1 Magnetic properties

Replace paragraph 2 with the following text:

“The properties shall meet the magnetic requirements specified in Tables 2 to 4 for the alloy, the magnetic grade and the thickness specified in the order. For intermediate thicknesses not given in the table, the values for the next thicker group shall apply. When a.c. magnetic testing is used to demonstrate conformance of the alloy to this standard, either amplitude permeability measurements (Table 2a) or serial inductance permeability measurements (Table 2b) can be used. It is not a requirement of this standard that both methods must be used. The method used shall be subject to agreement between the manufacturer and the purchaser.“

Delete paragraphs 3 and 4.

7.2.1.4 Edge camber

Replace items a) to c) with the following sentence:

"The edge camber shall be as agreed between the manufacturer and the purchaser."

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8.3.2 Magnetic testing, a.c. methods

Replace the text the with following sentences:

"Measurement of a.c. flux density and permeability shall be in accordance with IEC 60404-2 and IEC 60404-6. Unless otherwise specified, a test frequency of 50 Hz or 60 Hz shall be used. When amplitude permeability measurements are made, the test conditions shall conform to sine flux (sine B). When inductance permeability measurements are made, the serial inductance permeability shall be measured."

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Table 1

Replace the existing table with the following new table:

Table 1 – Chemical composition of the alloy classes in accordance with IEC 60404-1

Alloy class	Constituents in accordance with IEC 60404-1	Typical compositions[a] Mass fraction in %						
		Co	**Cr**	**Cu**	**Mo**	**Ni**	**Si**	**V**
A	100 Fe	–	–	–	–	–	–	–
C1	0 – 5 Si	–	–	–	–	–	2 – 4,5	–
C21	0,4 – 5 Si	–	–	–	–	–	1 – 4,5	–
C22	3 Si	–	–	–	–	–	2,5 – 3,5	–
E1	70 – 85 Ni	–	2 – 3	1 – 6	–	75 – 80	–	–
		–	–	1 – 6	3 – 5	75 – 80	–	–
		–	–	–	3,5 – 6	79 – 82	–	–
E2	54 – 68 Ni	–	–	–	–	53 – 65	–	–
E3	41 – 51 Ni	–	–	–	–	42 – 49	–	–
E4	35 – 40 Ni	–	–	–	–	36 – 40	–	–
F1	47 – 50 Co	47,5 – 50	–	–	–	–	–	1,7 – 2,5
F2	35 Co	34,5 – 36	–	–	–	–	–	–
F3	23 –27 Co	23 – 28	–	–	–	–	–	–

Typical compositions of each alloy class are shown as the examples and other compositions are acceptable if the magnetic property requirements in this standard are satisfied.

[a] Remainder: iron.

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Table 2

Replace the existing table with the following new tables:

Table 2 – Minimum permeability requirements

Table 2a – Minimum amplitude permeability requirements for sheet and strip - AC measurement (50 Hz or 60 Hz), sine flux conditions, thickness 0,05 mm to 0,38 mm

Alloy class[a]	Magnetic grade	Measuring point $\hat{H}$(A / m)	Specimen	Minimum amplitude permeability for a thickness, in millimetres, of			
				0,35	**0,20**		
A		As agreed between manufacturer and purchaser					
C1		As agreed between manufacturer and purchaser					
C21	–9	1,6	L.R.	900	750		
C22	–13			1 300	—		

Alloy class[a]	Magnetic grade	Measuring point $\hat{H}$(A / m)	Specimen	Minimum amplitude permeability for a thickness, in millimetres, of			
				0,30 – 0,38	**0,15 – 0,20**	**0,10**	**0,05**
E11	–30	0,4	L.R.	20 000	20 000	18 000	16 000
	–60			40 000	40 000	35 000	30 000
	–100			50 000	60 000	60 000	50 000
	–200			100 000	120 000	120 000	100 000
E31	–4	0,4		4 000	4 000	4 000	4 000
	–6			6 000	6 000	6 000	6 000
	–10			10 000	10 000	8 000	8 000
E41	–2	0,8		2 200	2 200	2 200	2 200
	–3			2 900	2 900	2 900	2 500
E11	–30	0,4	S.W.	b	30 000	30 000	30 000
	–60			b	60 000	60 000	60 000
	–100			b	80 000	100 000	100 000
	–200			b	160 000	200 000	200 000
E31	–4	0,4		b	4 000	4 000	4 000
	–6			b	6 000	6 000	6 000
	–10			b	10 000	10 000	10 000
E41	–2	0,8		b	2 200	2 200	2 200
	–3			b	2 900	2 900	2 500
E21		As agreed between the manufacturer and the purchaser					
E32							
F1		As agreed between the manufacturer and the purchaser					
F2							
F3							

[a] The second digit of the alloy class stands for the shape of the hysteresis loop:

1 = round (non-oriented);

2 = rectangular (oriented).

[b] Type S.W. should not be used in this thickness range.

Table 2b – Minimum serial inductance permeability requirements for sheet and strip – AC measurement (0,3 kHz, 1 kHz, 3 kHz, 10 kHz and 30 kHz), thickness 0,025 mm to 0,35 mm

Alloy class[a]	Magnetic grade	Measuring point $\hat{H}$ (A/m)	Specimen	Measuring frequency kHz	Minimum a.c. inductance permeability for a thickness, in millimetres, of					
					0,35	0,20	0,15	0,10	0,05	0,025
E11	–100	0,4	L.R. or S.W.	0,3	12 000	24 000	27 000	30 000	–	–
				1	4 800	10 000	12 000	20 000	25 000	30 000
				3	–	–	–	9 000	–	–
				10	–	–	–	–	9 000	18 000
				30	–	–	–	–	–	9 000
	–200	0,4	L.R. or S.W.	0,3	–	–	–	40 000	–	–
				1	–	–	–	25 000	40 000	40 000
				3	–	–	–	10 000	–	–
				10	–	–	–	–	9 000	20 000
				30	–	–	–	–	–	12 000
E31	–6	0,4	L.R. or S.W.	0,3	3 000	3 600	–	–	–	–
				1	2 200	2 400	–	3 000	–	–
				3	–	–	–	2 500	–	–
	–10	0,4	L.R. or S.W.	0,3	3 600	4 000	–	5 000	–	–
E41	–2	0,4	L.R. or S.W.	0,3	1 900	2 000	–	–	–	–
				1	1 800	1 900	–	1 900	–	–
				3	–	–	–	1 800	–	–
	–3	0,4	L.R. or S.W.	0,3	3 500	3 800	–	–	–	–
				1	3 000	3 300	–	3 600	–	–
				3	–	–	–	3 000	–	–

[a] The second digit of the alloy class stands for the shape of the hysteresis loop:

1 = round (non-oriented);

2 = rectangular (oriented).

NOTE There is no corresponding measurement procedure in the IEC 60404-6 up to now. However, 60404-6 is under revision, and will be amended correspondingly.

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Table 3

Replace the existing table with the following new table:

Table 3 – DC magnetic property requirements for bar, billet, rod, sheet, strip and wire, thickness or diameter greater than 0,05 mm[a] – S.R., L.R. or E.S. specimen

Alloy class[b]	Magnetic grade		Maximum coercivity A/m	Minimum magnetic polarization in teslas for $\hat{H}$ in amperes per metre					
				100	200	300	500	1 000	4 000
A	–240		240	–	–	1,15	1,30	–	1,60
	–120		120	–	–	1,15	1,30	1,45	1,60
	–80		80	–	1,10	1,20	1,30	1,45	1,60
	–60		60	–	1,15	1,25	1,35	1,45	1,60
	–20		20	1,15	1,25	1,30	1,40	1,45	1,60
	–12		12	1,15	1,25	1,30	1,40	1,45	1,60
C1	–48		48	0,60	–	1,10	1,20	–	1,50
	–24		24	1,20	–	1,30	1,35	–	1,50
	–12		12	1,20	–	1,30	1,35	–	1,50

Alloy class[b]	Magnetic grade	Measuring point $\hat{H}$ A/m	Minimum permeability for a thickness, in millimetres, of		Maximum coercivity in amperes per metre for a thickness, in millimetres, of		Minimum magnetic polarization in teslas for $\hat{H}$ in amperes per metre					
			0,05-1,5	>1,5	0,05-1,5	>1,5	20	50	100	500	800	
E11	–30	0,4	30 000	15 000	4	4	0,40	0,55	0,60	0,63	0,65	
	–60		60 000	30 000	2	4						
	–100		100 000	50 000	1	2	0,50	0,65	0,70	0,73	0,73	
E31	–4	0,4	4 000	3 000	12	12	0,50	0,90	1,00	1,30	1,40	
	–6		6 000	5 000	10	10						
	–10		10 000	7 000	6	6	0,50	0,90	1,10	1,35	1,40	
E41	–3	0,8	2 500	2 500	24	24	0,20	0,45	0,70	1,00	1,10	
E21		As agreed between the manufacturer and the purchaser										
E32												

Alloy class[b]	Magnetic grade	Supplied form	Dimensions mm	Maximum coercivity A/m	Minimum magnetic polarization in teslas for $\hat{H}$ in amperes per metre					
					300	800	1 600	2 800	4 000	8 000
F11	–240	Bulk material, hot–rolled	> 6	240	1,40	1,70	1,90	2,00	2,06	2,15
	–120	Rod, wire	$d \leq 6$	120	1,70	2,00	2,10	2,15	2,20	2,25
		Sheet, strip	$0,05 \leq t \leq 2,0$	120	–	–	–	–	–	–
	–60	Sheet, strip	$0,05 \leq t \leq 2,0$	60	1,80	2,10	2,20	2,23	2,25	2,25
F12	–30	S.W.	$0,05 \leq t \leq 1,5$	30	As agreed between the manufacturer and the purchaser					
F21	–300	Bulk material	> 6	300	–	1,20	1,30	1,35	–	–
		Sheet, strip	$0,05 \leq t \leq 2,0$	300	–	1,50	1,60	1,80	2,00	2,20
F31	–300	Bulk material	> 6	300	–	–	–	–	1,10	1,75
		Sheet, strip	$0,05 \leq t \leq 2,0$	300	–	–	–	–	1,85	2,00

[a] The properties for 0,05 mm to 2 mm thicknesses refer to sheet and strip only. For bar, billet, rod and wire with small cross-sections, magnetic polarization shall be determined on S.R. specimens taken at an earlier stage of manufacture.

[b] The second digit of the alloy class stands for the shape of the hysteresis loop:

1 = round (non-oriented);

2 = rectangular (oriented by texture or thermomagnetic treatment).

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Table 4

Replace the existing table with the following new table:

Table 4 – Maximum permeability rise factor for sheet and strip – L.R. test specimen, a.c. measurement (50 Hz or 60 Hz)

Alloy class	Magnetic grade	$\delta_{0,4}$[a] 10^{-2} m/A	δ_8[b] 10^{-2} m/A
E41	–2	4,7	3,1
C21	–9	–	15,7
C22	–13	–	15,7

[a] $\delta_{0,4} = (\mu_{1,6} - \mu_{0,4})/(\mu_{0,4} \cdot \Delta H) = 0{,}833(\mu_{1,6} - \mu_{0,4})/\mu_{0,4}\,(\mathrm{m/A})$

[b] $\delta_8 = (\mu_8 - \mu_{1,6})/(\mu_{1,6} \cdot \Delta H) = 0{,}156(\mu_8 - \mu_{1,6})/\mu_{1,6}\,(\mathrm{m/A})$

The indices denote the field strength, in amperes per metre (A/m).

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Table 5

Replace the existing table with the following new table:

Table 5 – Dimensional requirements for toroidal strip-wound cores

Ratio of dimensions	Alloy class	
	E11 – E41	E32
Outside/inside diameter (d_1/d_2)	1,2 – 1,6	1,2 – 1,6
Height/inside diameter (h/d_2)	0,2 – 1,1	0,2 – 1,1
Inside diameter/strip thickness (d_2/t)	> 100	> 100