

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Magnetic materials – Part 8-10: Specifications for individual materials – Magnetic materials (iron and steel) for use in relays**

**Matériaux magnétiques – Partie 8-10: Spécifications pour matériaux particuliers – Matériaux magnétiques (fer et acier) pour relais**



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3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
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# INTERNATIONAL STANDARD

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**MAGNETIC MATERIALS –****Part 8-10: Specifications for individual materials –  
Magnetic materials (iron and steel)  
for use in relays**

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International Standard IEC 60404-8-10 has been prepared by IEC technical committee 68: Magnetic alloys and steels, in collaboration with ISO technical committee 17: Steel.

This second edition cancels and replaces the first edition published in 1994 and constitutes a technical revision. The main modifications from the previous edition of the standard are as follows:

- introduction of the ferritic stainless steels and the fully-processed state in the scope of the standard (see Clause 1);
- modification of the designation with the letter R at the beginning and the condition and state at the end (see Clause 5);
- introduction of the new grades R160 and R320 (see Table 2);
- modification of the requirements for the heat treatment of test specimens for semi-processed material (see Subclause 8.3.1);

- indication in Bibliography of standards referred to in this standard as an information.

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

FDIS	Report on voting
68/387/FDIS	68/391/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 60404 series, under the general title *Magnetic materials*, can be found on the IEC website.

The committee has decided that the contents of this 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

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- replaced by a revised edition, or
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## MAGNETIC MATERIALS –

### Part 8-10: Specifications for individual materials – Magnetic materials (iron and steel) for use in relays

#### 1 Scope

This International Standard specifies the general requirements, magnetic properties, geometric characteristics and tolerances as well as inspection procedures for magnetic materials used primarily for relays.

This standard applies to pure iron, non-alloyed and alloyed steel and ferritic stainless steel products usually delivered in either the semi-processed or fully-processed state.

These materials correspond to classes A, B, C and D.3 of IEC 60404-1.

#### 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-121, *International Electrotechnical Vocabulary – Part 121: Electromagnetism*  
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IEC 60050-221, *International Electrotechnical Vocabulary – Chapter 221: Magnetic materials and components*

IEC 60404-1, *Magnetic materials – Part 1: Classification*

IEC 60404-7, *Magnetic materials – Part 7: Method of measurement of the coercivity of magnetic materials in an open magnetic circuit*

IEC 60404-9, *Magnetic materials – Part 9: Methods of determination of the geometrical characteristics of magnetic steel sheet and strip*

ISO 286-1, *ISO system of limits and fits – Part 1: Bases of tolerances, deviations and fits*

ISO 404, *Steel and steel products – General technical delivery requirements*

ISO 10474, *Steel and steel products – Inspection documents*

#### 3 Terms and definitions

For the purpose of this document, the definitions of the principal terms related to magnetic properties given in IEC 60050-121, IEC 60050-221 and IEC 60404-9 apply, as well as the following definitions:

##### 3.1

##### sheet and plate

flat rolled product with a minimum width of 600 mm



NOTE 1 The edges may be as rolled, mechanically sheared or flame cut.

NOTE 2 The distinction between sheet and plate is principally in terms of thickness tolerances (see Tables 3 and 4). Further information can be found in ISO 6929.

### 3.2

#### **strip**

flat rolled product which, immediately after the final rolling pass or after pickling or continuous annealing, is wound into a regular coil

NOTE As rolled, strip has slightly convex edges; strip may also be supplied with sheared edges or slit from wider strip.

### 3.3

#### **flat**

bar of rectangular cross-section, rolled on the four faces, whose thickness is generally 5 mm or greater and whose width is not greater than 150 mm

### 3.4

#### **round**

bar having a circular cross-section whose diameter is generally 8 mm or greater

### 3.5

#### **square**

bar having a square cross-section whose side dimension is generally 8 mm or greater

### 3.6

#### **wire rod**

hot-rolled long product whose nominal size is generally 5 mm or greater, wound into irregular coils

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NOTE The cross-section may be round, oval, square, rectangular, hexagonal, octagonal, half-round or of any similar shape.

### 3.7

#### **wire**

product of constant full cross-section along its length, obtained by cold-drawing which can be wound into irregular or regular coils

NOTE It is obtained by cold-drawing wire rod through a reducing die or passing it under pressure between rollers and rewinding the drawn product.

## 4 Classification

The materials covered by this standard are classified according to the maximum value of coercivity, the shape and dimensions of the material and its final condition and state. Not all materials are available in the cold-rolled condition throughout the thickness range.

## 5 Designation

The conventional designation of the material comprises the following in the order given:

- a) the letter R;
- b) the specified maximum value of coercivity in A/m;
- c) one of the following symbols:
  - F: for pure iron;
  - S: for ferritic stainless steel;
  - T: for alloyed steel;

- U: for non-alloyed steel;
- d) the condition as indicated below:
- H: hot-rolled;
  - C: cold-rolled or cold-drawn;
- e) the state as indicated below:
- S: semi-processed;
  - F: fully-processed.

EXAMPLE R80THF: alloyed steel having a specified maximum coercivity of 80 A/m supplied in the hot-rolled condition and the fully-processed state.

## 6 General requirements

### 6.1 Production process

The production process of the materials specified by this standard is left to the discretion of the manufacturer.

### 6.2 Form of supply

#### 6.2.1 Strip

The products can be supplied in the hot-rolled or cold-rolled condition and in the semi-processed or fully-processed state.

The products shall be delivered as strip in coils (with a minimum internal diameter not less than 500 mm) or in cut lengths.

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Strip supplied in coils shall be of constant width and wound in such a manner that the edges are superimposed in a regular manner and that the side faces of the coil are substantially flat.

Coils shall be sufficiently tightly wound that they do not collapse under their own weight.

Strip can occasionally exhibit welds or interleaves resulting from the removal of defective zones, subject to prior agreement between the manufacturer and the purchaser. The value of the additional thickness due to the weld is subject to special agreement. If necessary, the marking of welds or interleaves may form the subject of a special agreement.

For coils containing repair welds or interleaves, each part of the strip shall be of the same quality material.

The edges of parts welded together shall not be so much out of alignment as to affect the further processing of the material.

The mass of coils shall be agreed upon at the time of ordering.

#### 6.2.2 Sheet and plate

Sheets can be supplied in the hot-rolled or cold-rolled condition; plates are supplied in the hot-rolled condition. Sheets and plates can be supplied in the semi-processed or fully-processed state.

The edges of the sheet or plate, parallel to the rolling direction shall be as rolled, mechanically sheared or flame cut.

### 6.2.3 Flats and bars

The products can be supplied in the hot-rolled, cold-rolled or cold-drawn condition and in the semi-processed or fully-processed state.

### 6.2.4 Wire rod and wire

Wire rod and wire are supplied respectively in the hot-rolled condition and in the cold-drawn condition. Wire rod and wire are supplied in the semi-processed state.

The products are delivered in the form of coils, the mass of which shall be specified at the time of ordering.

## 6.3 Delivery condition and state

The different types of delivery condition and state are given in Table 1.

**Table 1 – Types of delivery condition and state**

Type of product	Condition			State	
	Hot-rolled	Cold-rolled	Cold-drawn	Semi-processed	Fully-processed
Strip	X	X		X	X
Sheet	X	X		X	X
Plate	X			X	X
Flats and bars	X	X	X	X	X
Wire rod	X			X	
Wire			X	X	

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### 6.4 Surface condition

The surface of the product shall be smooth and clean, free from grease and rust.

Isolated imperfections such as scratches, blisters, etc. can be tolerated if the thickness remains within the tolerance limits.

The nature of the surface condition will depend on the final treatment. For material in the hot-rolled condition, the material exhibits a hot mill scale. Hot-rolled material can be supplied with the scale removed by mechanical means or pickling if so specified at the time of ordering.

## 7 Technical requirements

### 7.1 Magnetic properties

The specified maximum value of coercivity shall be as given in Table 2 where the availability of grades is indicated.

**Table 2 – Coercivity and availability of grades**

Grade	Maximum value of coercivity A/m	Pure iron, alloyed steel, non-alloyed steel	Ferritic stainless steel <sup>a</sup>	Free machining ferritic stainless steel <sup>b</sup>
R40	40	X		
R60	60	X		
R80	80	X	X	
R120	120	X		
R160	160		X	X
R240	240	X	X	X
R320	320			X

<sup>a</sup> Ferritic stainless steels correspond to grades D31-01, D31-03 and D31-05 according to IEC 60404-1.  
<sup>b</sup> Free machining ferritic stainless steels correspond to grades D31-02, D31-04 and D31-06 according to IEC 60404-1.

If characteristics in the aged state are necessary, they shall be the subject of prior agreement between the manufacturer and the purchaser together with the conditions of the ageing treatment.

**7.2 Geometric characteristics and tolerances**

**7.2.1 Thickness of flat products**

The tolerances on thickness for hot-rolled flat products shall be as given in Table 3 for strip and sheet and in Table 4 for plates.

**Table 3 – Tolerances on thickness for hot-rolled strip and sheet**

Nominal thickness mm	Tolerances, in mm, for a nominal width, in mm, of:			
	≥ 600 ≤ 1 200	> 1 200 ≤ 1 500	> 1 500 ≤ 1 800	> 1 800
≤ 2,00	± 0,17	± 0,19	± 0,21	–
> 2,00 ≤ 2,50	± 0,18	± 0,21	± 0,23	± 0,25
> 2,50 ≤ 3,00	± 0,20	± 0,22	± 0,24	± 0,26
> 3,00 ≤ 4,00	± 0,22	± 0,24	± 0,26	± 0,27
> 4,00 ≤ 5,00	± 0,24	± 0,26	± 0,28	± 0,29
> 5,00 ≤ 6,00	± 0,26	± 0,28	± 0,29	± 0,31
> 6,00 ≤ 8,00	± 0,29	± 0,30	± 0,31	± 0,35
> 8,00 ≤ 10,00	± 0,32	± 0,33	± 0,34	± 0,40
> 10,00 ≤ 12,50	± 0,35	± 0,36	± 0,37	± 0,43
> 12,50 ≤ 15,00	± 0,37	± 0,38	± 0,40	± 0,46
> 15,00 ≤ 25,00	± 0,40	± 0,42	± 0,45	± 0,50

NOTE The specified tolerances are in accordance with EN 10051:1997, category A.

**Table 4 – Tolerances on thickness for hot-rolled plate**

Nominal thickness mm	Tolerances on the nominal thickness mm	Maximum thickness difference, in mm, within a plate for a nominal plate width, in mm, of:					
		≥ 600 ≤ 2 000	> 2 000 ≤ 2 500	> 2 500 ≤ 3 000	> 3 000 ≤ 3 500	> 3 500 ≤ 4 000	> 4 000
≥ 3 < 5	± 0,6	0,8	0,9	0,9	–	–	–
≥ 5 < 8	± 0,75	0,9	0,9	1,0	1,0	–	–
≥ 8 < 15	± 0,85	0,9	1,0	1,0	1,1	1,1	1,2
≥ 15 < 25	± 0,95	1,0	1,1	1,2	1,2	1,3	1,4
≥ 25 < 40	± 1,1	1,1	1,2	1,2	1,3	1,3	1,4
≥ 40 < 80	± 1,2	1,2	1,3	1,4	1,4	1,5	1,6
≥ 80 < 150	± 1,6	1,3	1,4	1,5	1,5	1,6	1,7
≥ 150 ≤ 200	± 1,8	1,4	1,5	1,6	1,6	1,7	–

NOTE The specified tolerances are in accordance with EN 10029:1991.

The tolerances on thickness for cold-rolled flat products shall be as given in Table 5.

**Table 5 – Tolerances on thickness for cold-rolled flat products**

Nominal thickness mm	Normal tolerances, in mm, for nominal width, in mm, of:			Special tolerances, in mm, for nominal width, in mm, of:		
	≤ 1 200	> 1 200 ≤ 1 500	> 1 500	≤ 1 200	> 1 200 ≤ 1 500	> 1 500
≥ 0,35 ≤ 0,40	± 0,04	± 0,05	± 0,06	± 0,025	± 0,030	–
> 0,40 ≤ 0,60	± 0,04	± 0,05	± 0,06	± 0,030	± 0,035	± 0,05
> 0,60 ≤ 0,80	± 0,05	± 0,06	± 0,07	± 0,035	± 0,040	± 0,05
> 0,80 ≤ 1,00	± 0,06	± 0,07	± 0,08	± 0,040	± 0,06	± 0,06
> 1,00 ≤ 1,20	± 0,07	± 0,08	± 0,10	± 0,050	± 0,07	± 0,07
> 1,20 ≤ 1,60	± 0,09	± 0,11	± 0,12	± 0,060	± 0,08	± 0,08
> 1,60 ≤ 2,00	± 0,12	± 0,13	± 0,14	± 0,070	± 0,09	± 0,09
> 2,00 ≤ 2,50	± 0,14	± 0,15	± 0,16	± 0,100	± 0,11	± 0,11
> 2,50 ≤ 3,00	± 0,17	± 0,18	± 0,18	± 0,120	± 0,12	± 0,12

NOTE The specified tolerances are in accordance with the requirements of EN 10131:2006 for steels with specified yield strength  $260 \text{ MPa} \leq R_e < 340 \text{ MPa}$ .

The tolerances on thickness for hot-rolled flats shall be as given in Table 6.

**Table 6 – Tolerances on thickness for hot-rolled flats**

Nominal thickness mm	Tolerance mm
≤ 20	± 0,5
> 20 ≤ 40	± 1
> 40	± 1,5

NOTE The specified tolerances are in accordance with EN 10058:2003.