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Plastics — Industrial laminated sheets based on thermosetting resins — Specification

*Plastiques — Stratifiés industriels en planches à base de résines thermodurcissables —
Spécification*

Withdrawn

Reference number
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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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 1642 was prepared by Technical Committee ISO/TC 61, *Plastics*.

This third edition cancels and replaces the second edition (ISO 1642 : 1979), of which it constitutes a minor revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Plastics — Industrial laminated sheets based on thermosetting resins — Specification

1 Scope and field of application

This International Standard specifies the characteristics of industrial laminated sheets made with any one of the following resins as the binder : epoxide (epoxy), melamine, phenolic, polyester (unsaturated), and silicone. The sheets covered are flat and the preferred nominal thicknesses are listed in table 3.

NOTE — The scope of this International Standard may subsequently be extended to cover additional commercially established types of industrial laminated sheets of similar basic composition.

2 References

ISO 62, *Plastics — Determination of water absorption.*

ISO 178, *Plastics — Determination of flexural properties of rigid plastics.*

ISO 179, *Plastics — Determination of the Charpy impact strength of rigid materials.*

ISO 180, *Plastics — Determination of the Izod impact strength of rigid materials.*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 472, *Plastics — Vocabulary.*

ISO 604, *Plastics — Determination of compressive properties.*

ISO 1043, *Plastics — Symbols.*

ISO 1183, *Plastics — Methods for determining the density and relative density (specific gravity) of plastics excluding cellular plastics.*¹⁾

ISO 2578, *Plastics — Determination of time-temperature limits after exposure to prolonged action of heat.*

IEC Publication 112, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*

IEC Publication 167, *Methods of test for the determination of the insulation resistance of solid insulating materials.*

IEC Publication 243, *Recommended methods of test for electric strength of solid insulating materials at power frequencies.*

IEC Publication 249, *Metal-clad base materials for printed circuits.*

IEC Publication 250, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.*

IEC Publication 587, *Test method for evaluating resistance to tracking and erosion of electrical insulating materials used under severe ambient conditions.*

IEC Publication 707, *Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source.*

3 Classification

3.1 Designation

The sheets covered by this specification are classified into types which differ in the resin and reinforcement employed and in the distinguishing properties.

Individual types are designated by

- a two-letter abbreviation denoting the resin;
- a second two-letter abbreviation, denoting the reinforcement;
- a serial number.

The abbreviations are given in 3.2.

Example : Type EP GC 3 is the third type in the group of types based on epoxide resin reinforced with woven glass cloth.

1) At present at the stage of draft. (Revision of ISO/R 1183 : 1970.)

3.2 Abbreviations

Resins	Abbreviation
Epoxide (epoxy)	EP
Melamine	MF
Phenolic	PF
Polyester (unsaturated)	UP
Silicone	SI

Reinforcement	Abbreviation
Cellulose paper	CP
Woven cotton cloth	CC
Wood veneer	WV
Asbestos paper	AP
Woven asbestos cloth	AC
Asbestos felt (mat)	AM
Woven glass cloth	GC
Glass mat	GM

3.3 Type

The combinations of resins and reinforcements that constitute the types covered by this International Standard, together with applications and distinguishing properties, are given in table 1.

Table 1 — Types

Type ¹⁾			Applications and distinguishing properties
Resin	Reinforcement	Serial number	
EP	CP	1	Electronic applications. Good stability of electrical properties under high humidity. Of defined burning characteristics.
	GC	1	Mechanical, electrical, and electronic applications. Extremely high mechanical strength at moderate temperature. Very good stability of electrical properties under high humidity.
		2	Similar to Type EP GC 1. of defined flammability.
		3	Similar to Type EP GC 1. High mechanical strength at elevated temperature.
		4	Similar to Type EP GC 3. Of defined flammability.
		5	Similar to Type EP GC 3, but with roving cloth in very coarse weave.
	GM	1	Mechanical and electrical applications. Extremely high mechanical strength at ambient temperature. Very good electrical properties under high humidity.
		2	Similar to EP GM 1. Of defined flammability.
		3	Similar to EP GM 1. High mechanical strength at elevated temperature.
		4	Similar to EP GM 3. Of defined flammability.
MF	CC	1	Mechanical and electrical applications (coarse weave ³⁾). Arc and tracking resistant.
	GC	1	Mechanical and electrical applications. High mechanical strength. Arc and tracking resistant. Of defined flammability.
PF	CP	1	Mechanical applications. Mechanical properties better than other PF CP types. Poor electrical properties under normal humidity. Also available in hot-punching versions.
	CP	2	High voltage applications at power frequencies. High electric strength under oil. Good electric strength in air under normal humidity.

Table 1 (concluded)

Type ¹⁾			Applications and distinguishing properties
Resin	Reinforce- ment	Serial number	
PF	CP	3	Electrical and mechanical applications. Good electrical properties under normal humidity. Also available in hot-punching versions.
	CP	4	Electrical and electronic applications. Good stability of electrical properties under high humidity. Also available in cold- or hot-punching versions.
	CP	5	Similar to Type PF CP 4, but of defined flammability.
	CP	6	Electrical and mechanical applications. Good electrical properties under high humidity. Also available in hot-punching versions.
	CP	7	Similar to Type PF CP 1, but with improved punching characteristics at lower temperatures.
	CC	1	Mechanical applications (coarse weave ³⁾). Good mechanical properties.
	CC	2	Mechanical and electrical applications (coarse weave ³⁾).
	CC	3	Mechanical applications (fine weave ³⁾). Recommended for small parts.
	CC	4	Mechanical and electrical applications (fine weave ³⁾). Recommended for small parts.
	WV	1	Mechanical applications. Good mechanical properties.
	WV	2	Mechanical and electrical applications. Good electrical properties under normal humidity.
	AP ²⁾	1	Mechanical applications. Heat resistant.
	AC ²⁾	1	Mechanical applications. Mechanically better than Type PF AP 1. Heat resistant.
	AM ²⁾	1	Mechanical applications. Heat resistant.
	GC	1	Mechanical and electrical applications. High mechanical strength and good electrical properties under normal humidity. Heat resistant.
UP	GM	1	Mechanical and electrical applications. Good stability of electrical properties under high humidity.
	GM	2	Mechanical and electrical applications. Similar to Type UP GM 1. Of defined flammability.
	GM	3	Mechanical and electrical applications. Similar to Type UP GM 2, but with improved resistance to arcing and tracking.
	GM	4	Mechanical and electrical applications. Very high mechanical properties at ambient temperature. Good mechanical properties at elevated temperature.
	GM	5	Mechanical and electrical applications. Similar to Type UP GM 4 of defined flammability.
SI	GC	1	Electronic and other electrical applications. Extremely good dielectric properties under dry conditions; still good properties under humidity.
	GC	2	Mechanical and electrical applications at elevated temperature. Good heat resistance.

1) It should not be inferred from table 1 that laminates of any particular type are necessarily unsuitable for applications other than those listed for them, or that specific laminates will be suitable for all applications within the wide descriptions given.

2) In some countries, the use of asbestos products is regulated by legislation. In such cases, national regulations must be observed.

3) Characteristics of the base material

Mass per unit area, g/m² Thread count per cm

Coarse weave > 130 < 30
Fine weave < 130 > 30

These values are given for information only; they are not to be considered specification values. In general, the finer weave materials give the better machining characteristics.

4 Definitions

Definitions of terms used in this International Standard are given in ISO 472.

5 Appearance

Sheets shall be free from blisters, wrinkles and cracks and reasonably free from other defects, for example scratches, dents and discoloration. A small amount of mottle is permissible.

6 Flatness

When any sheet of nominal thickness 3 mm or more is placed without restraint, concave side up, on a flat surface, the departure at any point of the upper surface of the sheet from a light straightedge laid in any direction upon it shall not exceed either of the appropriate values given in table 2.

7 Tolerances on thickness and width

7.1 The deviation from nominal thickness of a sheet at any point shall not exceed the value shown in table 3 for the

appropriate type and thickness. The diameter of the anvil of the measuring device shall be 6 to 8 mm.

7.2 When material is supplied in the form of cut strips, the deviation from the nominal width at any point shall not exceed the appropriate values shown in table 4.

8 Physical properties

When determined by the appropriate test methods, the physical properties shall be as given in table 5. In all cases, test results shall be rounded to the same degree of precision as the limiting values.

Annex K gives tables of typical values for other properties. These typical values are intended to give only general guidance and are not to be considered as requirements of this International Standard.

Table 2 — Maximum permissible departure of surface of sheet from straightedge

Values in millimetres

Material	Thickness d	Length of straightedge	
		1 000	500
PF AG 1 } SI GC 1 } SI GC 2 }	$1,6 < d < 3$	See note	
	$3 < d < 6$	15	4
	$6 < d < 8$	12	3
	$8 < d$	10	2,5
PF WV 1 } PF WV 2 }	$12 < d$	9	2
All other types	$1,6 < d < 3$	See note	
	$3 < d < 6$	10	2,5
	$6 < d < 8$	8	2,0
	$8 < d$	6	1,5

NOTE — Limiting values for sheets of nominal thickness from 1,6 mm up to but excluding 3 mm are under consideration and will be included in the next revision of this International Standard.

Table 3 — Tolerances on thickness ($\pm$ mm)¹⁾

Nominal thickness ²⁾ mm	EP				MF		PF											UP	SI	
	CP	GC		GM	CC	GC	CP		CC				WV	AP	AC	AM	GC	GM	GC	
	1	1, 2, 3, 4	5	1, 2, 3, 4	1	1	1, 2, 3, 4, 6	5, 7	1	2	3	4	1, 2	1	1	1	1	1, 2, 3, 4	1, 2	
0,4	0,07	0,10	—	—	—	0,10	0,07	0,07	—	—	0,12	—	—	—	—	—	0,10	—	0,10	
0,5	0,08	0,12	—	—	—	0,12	0,08	0,08	—	—	0,13	0,13	—	—	—	—	0,12	—	0,12	
0,6	0,09	0,13	—	—	—	0,13	0,09	0,09	—	—	0,14	0,14	—	0,19	—	—	0,13	—	0,13	
0,8	0,10	0,16	—	—	—	0,16	0,10	0,10	0,19	0,19	0,15	0,15	—	0,19	—	—	0,16	—	0,16	
1,0	0,12	0,18	—	—	—	0,18	0,12	0,12	0,20	0,20	0,16	0,16	—	0,20	—	—	0,18	—	0,18	
1,2	0,14	0,20	—	—	—	0,21	0,14	0,14	0,22	0,22	0,17	0,17	—	0,22	—	—	0,21	—	0,21	
1,6	0,16	0,24	—	0,23	0,24	0,24	0,16	0,16	0,24	0,24	0,19	0,19	—	0,24	0,63	0,63	0,24	0,23	0,24	
2,0	0,19	0,28	—	0,25	0,26	0,28	0,19	0,19	0,26	0,26	0,21	0,21	—	0,26	0,65	0,65	0,28	0,25	0,28	
2,5	0,22	0,33	—	0,30	0,29	0,33	0,22	0,22	0,29	0,29	0,24	0,24	—	0,29	0,68	0,68	0,33	0,30	0,33	
3,0	0,25	0,37	0,50	0,35	0,31	0,37	0,25	0,25	0,31	0,31	0,26	0,26	—	0,31	0,70	0,70	0,37	0,35	0,37	
4,0	0,30	0,45	0,60	0,40	0,36	0,45	0,30	—	0,36	0,36	0,32	0,32	—	0,36	0,75	0,75	0,45	0,40	0,45	
5,0	0,34	0,52	0,70	0,55	0,42	0,52	0,34	—	0,42	0,42	0,36	0,36	—	0,42	0,79	0,79	0,52	0,55	0,52	
			Plus only						Plus only		Plus only									
6,0	0,37	0,60	1,60	0,60	0,46	0,60	0,37	—	0,92	0,46	0,80	0,40	—	0,46	0,85	0,85	0,60	0,60	0,60	
8,0	0,47	0,72	1,90	0,70	0,55	0,72	0,47	—	1,10	0,55	0,98	0,49	—	0,55	1,00	1,00	0,72	0,70	0,72	
10,0	—	0,82	2,20	0,80	0,63	0,82	0,55	—	1,26	0,63	1,12	0,56	—	0,63	1,14	1,14	0,82	0,80	0,82	
12,0	—	0,94	2,40	0,90	0,70	0,94	0,62	—	1,40	0,70	1,28	0,64	1,25	0,70	1,28	1,28	0,94	0,90	0,94	
14,0	—	1,02	2,60	1,00	0,78	1,02	0,69	—	1,56	0,78	1,40	0,70	1,35	0,78	1,42	1,42	1,02	1,00	1,02	
16,0	—	1,12	2,80	1,10	0,85	1,12	0,75	—	1,70	0,85	1,52	0,76	1,45	0,85	1,57	1,57	1,12	1,10	1,12	
20,0	—	1,30	3,00	1,30	0,95	1,30	0,86	—	1,90	0,95	1,74	0,87	1,60	0,95	1,85	1,85	1,30	1,30	1,30	
25,0	—	1,50	3,50	1,40	1,10	1,50	1,00	—	2,20	1,10	2,04	1,02	1,80	1,10	2,18	2,18	1,50	1,40	1,50	
30,0	—	1,70	4,00	—	1,22	1,70	1,15	—	2,44	1,22	2,24	1,12	2,00	1,22	2,54	2,54	1,70	—	1,70	
35,0	—	1,95	4,40	—	1,43	1,95	1,25	—	2,68	1,34	2,48	1,24	2,10	1,34	2,89	2,89	1,95	—	1,95	
40,0	—	2,10	4,80	—	1,45	2,10	1,35	—	2,90	1,45	2,70	1,35	2,25	1,45	3,24	3,24	2,10	—	2,10	
45,0	—	2,30	5,10	—	1,55	2,30	1,45	—	3,10	1,55	2,90	1,45	2,40	1,55	3,59	3,59	2,30	—	1,17	
50,0	—	2,45	5,40	—	1,65	2,45	1,55	—	3,30	1,65	3,10	1,55	2,50	1,65	3,91	3,91	2,45	—	2,45	
60,0	—	—	5,80	—	—	—	—	—	3,70	—	3,50	—	2,80	—	—	—	—	—	—	
70,0	—	—	6,20	—	—	—	—	—	4,00	—	3,80	—	3,00	—	—	—	—	—	—	
80,0	—	—	6,60	—	—	—	—	—	4,40	—	4,20	—	3,25	—	—	—	—	—	—	
90,0	—	—	6,80	—	—	—	—	—	4,70	—	4,50	—	3,50	—	—	—	—	—	—	
100,0	—	—	7,00	—	—	—	—	—	5,00	—	4,80	—	3,75	—	—	—	—	—	—	

1) Other tolerances may be agreed between the vendor and the purchaser (for example, those given in IEC 249).

2) Where the nominal thickness is not one of the preferred thicknesses listed, then the tolerance for the next higher preferred nominal thickness shall apply.

Table 4 — Tolerances on width of cut strips (mm; minus only)

Nominal thickness	Nominal width (mm); all types					
	Above 3 up to 50	Above 50 up to 100	Above 100 up to 160	Above 160 up to 300	Above 300 up to 500	Above 500 up to 600
0,4	0,5	0,5	0,5	0,6	1,0	1,5
0,5	0,5	0,5	0,5	0,6	1,0	1,5
0,6	0,5	0,5	0,5	0,6	1,0	1,5
0,8	0,5	0,5	0,5	0,6	1,0	1,0
1,0	0,5	0,5	0,5	0,6	1,0	1,0
1,2	0,5	0,5	0,5	1,0	1,2	1,2
1,6	0,5	0,5	0,5	1,0	1,2	1,2
2,0	0,5	0,5	0,5	1,0	1,2	1,5
2,5	0,5	1,0	1,0	1,5	2,0	2,5
3,0	0,5	1,0	1,0	1,5	2,0	2,5
4,0	0,5	2,0	2,0	3,0	4,0	5,0
5,0	0,5	2,0	2,0	3,0	4,0	5,0

NOTE — In all cases, the measured width of the strip shall not be more than the specified nominal width. The values given in table 4 are unilateral, all-negative tolerances.

Table 5 — Physical properties

A. Epoxide resin EP														
Property	Method of test	Unit	Max. or min.	Max. or min. nominal thickness of sheet to which test is applied	Types									
					EP CP 1	EP GC 1	EP GC 2	EP GC 3	EP GC 4	EP GC 5	EP GM 1	EP GM 2	EP GM 3	EP GM 4
Flexural stress at rupture, perpendicular to laminations	Annex A	MPa	min.	1,5 mm min.	110	340	340	340 ¹⁾	340 ¹⁾	340 ¹⁾	320	320	320 ¹⁾	320 ¹⁾
Impact strength (notched specimen tested parallel to laminations) a) Charpy ²⁾ b) Izod ²⁾	Annex B Annex C	kJ/m ² J per mm of notch	min.	5 mm min.	—	33	33	33	33	50	50	50	50	
			min.	5 mm min.	—	0,35	0,35	0,35	0,35	0,55	0,55	0,55	0,55	
Electric strength at 90 °C in oil, perpendicular to laminations	Annex D	MV/m	min.	3 mm max. ³⁾	See table 7.									
Electric strength at 90 °C in oil, parallel to laminations ⁴⁾ a) 20 s step-by-step test b) 1 min proof test	Annex D Annex D	kV	min.	3 mm min. ⁵⁾	20	35	35	35	35	35	35	35	35	
		kV	min.	3 mm min. ⁵⁾	20	35	35	35	35	35	35	35	35	
Insulation resistance after immersion in water	Annex E	MΩ	min.	25 mm max.	1 × 10 ⁴	5 × 10 ⁴	5 × 10 ⁴	5 × 10 ⁴	5 × 10 ⁴	1 × 10 ⁴	5 × 10 ³	5 × 10 ³	5 × 10 ³	
Dissipation factor at 1 MHz	Annex F	—	max.	3 mm max.	0,05	0,04	0,04	0,04	0,04	0,04	—	—	—	
Permittivity at 1 MHz	Annex F	—	max.	3 mm max.	5,0	5,5	5,5	5,5	5,5	5,5	—	—	—	
Flammability	Annex J	—	max.	1,6 mm min.	FVO	—	FVO	—	FVO	—	FVO	—	FVO	
Water absorption	Annex H	mg	max.	All thickness	See table 6.									

See notes at the end of the table (page 11).