

INTERNATIONAL
STANDARD

ISO
16893

First edition
2016-01-15

Corrected version
2016-03-15

Wood-based panels — Particleboard

Panneaux à base de bois — Panneaux de particules



Reference number
ISO 16893:2016(E)

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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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is ISO/TC 89, *Wood-based panels*, Subcommittee SC 2, *Particle boards*.

This first edition cancels and replaces ISO 16893-1:2008 and ISO 16893-2:2010, which have been technically revised.

This corrected version of ISO 16893:2016 incorporates the following corrections.

The revision statement has been corrected in the Foreword, correctly identifying the documents which this International Standard cancels and replaces.

The footer ^a in Table 4 has been amended and changed to NOTE 2.

The expression of thickness ranges have been corrected in the headers in Tables 5 to 16.

Wood-based panels — Particleboard

1 Scope

This International Standard specifies a classification matrix and the related mandatory tests and thickness ranges to be applied to wood-based particleboard for general purposes, furniture, load-bearing applications and heavy-duty load-bearing applications. It then provides the manufacturing property requirements for these types of uncoated particleboard.

The values listed in this International Standard relate to product properties used to classify particleboards into one of four grades (P-GP, P-FN, P-LB or P-HLB, see [Clause 3](#)), for use in three service conditions (REG, MR1 and MR2). The values are not characteristic values to be used for design purposes.

2 Normative references

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

ISO 3340, *Fibre building boards — Determination of sand content*

ISO 9426, *Wood-based panels — Determination of dimensions of panels*

ISO 9427, *Wood-based panels — Determination of density*

ISO 12460-1, *Wood-based panels — Determination of formaldehyde release — Part 1: Formaldehyde emission by the 1-cubic-metre chamber method*

ISO 12460-3, *Wood-based panels — Determination of formaldehyde release — Part 3: Gas analysis method*

ISO 12460-4, *Wood-based panels — Determination of formaldehyde release — Part 4: Desiccator method*

ISO 12460-5, *Wood-based panels — Determination of formaldehyde release — Part 5: Extraction method (called the perforator method)*

ISO 16572, *Timber structures — Wood-based panels — Test methods for structural properties*

ISO 16978, *Wood-based panels — Determination of modulus of elasticity in bending and of bending strength*

ISO 16979, *Wood-based panels — Determination of moisture content*

ISO 16981, *Wood-based panels — Determination of surface soundness*

ISO 16983, *Wood-based panels — Determination of swelling in thickness after immersion in water*

ISO 16984, *Wood-based panels — Determination of tensile strength perpendicular to the plane of the panel*

ISO 16985, *Wood-based panels — Determination of dimensional changes associated with changes in relative humidity*

ISO 16987, *Wood-based panels — Determination of moisture resistance under cyclic test conditions*

ISO 16998, *Wood-based panels — Determination of moisture resistance — Boil test*

ISO 17064, *Wood-based panels — Fibreboard, particleboard and oriented strand board (OSB) — Vocabulary*

ISO 20585:2005, *Wood-based panels — Determination of wet bending strength after immersion in water at 70 degrees C or 100 degrees C (boiling temperature)*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17064 apply.

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

EXT	exterior
F	fungi resistant
FN	furniture
FR	fire retardant
GP	general purpose
HLB	heavy-duty load bearing
I	insect resistant
LB	load bearing
MR1	moisture resistant — temperate
MR2	moisture resistant — tropical
P	particleboard
REG	regular
δ	thickness

4 Classifications

4.1 Classification matrices

An overall classification matrix, which includes all major classes available at the time of publication, is shown in [Table 1](#). [Table 1](#) allows for future classes to be included as they become available on international markets.

Not all products in the matrix are currently available or under development. For example, there are no existing exterior condition products. Realistic property tables can only be developed for existing products. The remainder are potential future products and property tables will be developed when necessary.

Table 1 — Classification matrix for particleboard

Type	Service conditions			High humid and exterior conditions
	Dry conditions (regular)	Humid conditions — temperate	Humid conditions — tropical	
P-GP	REG general purpose	MR1 general purpose	MR2 general purpose	No existing product
Application examples	General uses, veneer grade	General uses	General uses	
P-FN	REG furniture grade	MR1 furniture grade	MR2 furniture grade	No existing product
Application examples	Carcass, furniture, cabinets, substrate for any decorative finish	Carcass, furniture, cabinets for kitchen and bathroom, toilet partitions, substrate for any decorative finish	Cabinets for kitchen and bathroom; moulded chair and table	
P-LB	REG load bearing	MR1 load bearing	MR2 load bearing	No existing product
Application examples	Domestic flooring, shelving, general construction	Domestic flooring, shelving, roof decking, wall sheathing, general construction	Domestic flooring, shelving, roof decking, wall sheathing, general construction	
P-HLB	REG heavy-duty load bearing	MR1 heavy-duty load bearing	MR2 heavy-duty load bearing	No existing product
Application examples	Industrial flooring, shelving	Industrial flooring, shelving, beams	Industrial flooring, shelving	

4.2 Uses

Products specified in this document have the following applications.

regular	REG	dry conditions only
moisture resistant — temperate	MR1	temperate humid conditions
moisture resistant — tropical	MR2	tropical humid conditions
exterior	EXT	exposed to weather conditions, above ground
load bearing	LB	structural or load bearing
heavy-duty load bearing	HLB	heavy structural or load bearing
general purpose	GP	applications not requiring the specific properties of furniture or load-bearing grades
furniture	FN	in furniture manufacture, cabinet making, fitments, joinery, bases for surface decorative treatment

4.3 Additional classifications

If additional attribute classifications are used, such as fire retardant (FR), insect resistant (I) and fungi resistant (F), claimed performance shall be confirmed by appropriate testing.

NOTE Relevant tests and performance requirements can be specified by national standards and codes.

4.4 Structural grades

When a product is used in a load-bearing or structural application, additional information shall be available in the form of characteristic values derived from structural testing (ISO 16572), experimental test results or history of use to validate its performance under the proposed conditions.

It should be noted that engineering design methods do not provide for design for high humid service conditions. The inclusion of P-LB and P-HLB grades in the high humid section of the classification matrix (Table 1) is on the basis that performance is validated by experimental test results or history of use.

5 Tests related to each class of particleboard

5.1 Mandatory tests

The mandatory tests shown in Table 2 shall be applied to the various particleboard grades identified in Table 1. All property requirements shall be met at dispatch from factory.

Table 2 — Tests related to particleboard grades

Property	Method	P-GP	P-FN	P-LB	P-HLB
Density variation	ISO 9427	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2
Dimensions	ISO 9426	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2
Formaldehyde emission	ISO 12460-1	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2
Moisture content	ISO 16979	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2
Internal bond strength	ISO 16984	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2
Bending strength — Modulus of rupture (MOR)	ISO 16978	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2
Bending stiffness — Modulus of elasticity (MOE)	ISO 16978	—	REG MR1 MR2	REG MR1 MR2	REG MR1 MR2
Thickness swelling	ISO 16983	MR1 MR2	MR1 MR2	REG MR1 MR2	REG MR1 MR2
Surface soundness	ISO 16981	—	REG MR1 MR2	—	—
Moisture resistance	ISO 20585 ISO 16998 ISO 16987	MR1 MR2	MR1 MR2	MR1 MR2	MR1 MR2

5.2 Optional tests

If information on additional properties is agreed between the user and manufacturer, it shall be determined using test method(s) nominated from ISO 3340, ISO 16985 and/or ISO 27528.

6 Thickness ranges

Specification values shall be related to the ranges of thickness, δ , shown. The specification of a particular thickness of product shall be determined by consulting the correct thickness range.

$\delta \leq 3$ mm
3 mm < $\delta \leq 4$ mm
4 mm < $\delta \leq 6$ mm
6 mm < $\delta \leq 13$ mm
13 mm < $\delta \leq 20$ mm
20 mm < $\delta \leq 25$ mm
25 mm < $\delta \leq 32$ mm
32 mm < $\delta \leq 40$ mm
$\delta > 40$ mm

7 Expression of specification limits and general requirements

7.1 Expression of specification limits

This International Standard may be used to evaluate groups of panels or production batches. To evaluate a group of panels, this requires that

- the mandatory tests of [Table 2](#) be applied to samples of the group. Conditioning of test specimens is required as specified in each test method, and
- the results of the tests be evaluated against the appropriate specification limits in [Tables 3 to 16](#), according to the product type and thickness range of the panels. [Tables 1 and 2](#) apply to all product types and thickness ranges of panels.

For density variation and dimensions ([Table 3](#)), specification limits are based on the mean values for individual panels (calculated in accordance with [Annex A](#)) and are maximum tolerances. For formaldehyde emission, [Table 4](#) gives upper specification limits for individual panel results.

Specification limits in [Tables 5 to 16](#) are based on 5 (lower) or 95 (upper) percentile expressions, according to [7.2](#) and [7.3](#).

7.2 Lower specification limits

The requirements in [Tables 5 to 16](#) are the lower specification limits for the following properties:

- bending strength — modulus of rupture (MOR);
- bending stiffness — modulus of elasticity (MOE);
- internal bond strength;
- surface soundness;
- internal bond strength after cyclic test;
- internal bond strength after boil test;
- wet bending strength.

The 5-percentile values based on the mean values for individual panels and calculated in accordance with [Annex A](#) shall be equal to or greater than the lower specification limits in [Tables 5 to 16](#).

7.3 Upper specification limits

The requirements in [Tables 5 to 16](#) are the upper specification limits for the following properties:

- a) thickness swelling after 24 h;
- b) thickness swelling after cyclic test.

The 95-percentile values based on the mean values for individual panels and calculated in accordance with [Annex A](#) shall be equal to or less than the upper specification limits in [Tables 5 to 16](#).

7.4 Moisture resistance requirement options

Requirements for moisture resistance are dependent upon the test method employed to assess this property. Three alternative sets of requirements (Option 1, Option 2 and Option 3) are set out in [Tables 9 to 16](#) corresponding to the three principal recognized methods of evaluation. It is necessary to show compliance with only one of these three options, as follows.

- Option 1: Requirements apply to those particleboards subjected to a cyclic accelerated ageing test, followed by the determination of thickness swelling and internal bond strength, as described in ISO 16987.
- Option 2: Requirements apply to those particleboards subjected to an accelerated ageing test, consisting of immersion in boiling water followed by determination of internal bond strength, as described in ISO 16998.
- Option 3: Requirements apply to those particleboards subjected to an accelerated ageing test consisting of immersion in water at 70 °C followed by determination of the wet bending strength (MOR) as described in ISO 20585:2005, Method A.

NOTE Moisture resistance testing is not intended to prove durability of a new resin system, but to confirm the correct processing of panels made from a resin system proven to provide the required durability.

7.5 Density variation, dimension and moisture content requirements

At least 95 % of the mean values of the individual panels shall be within the maximum tolerances stated in [Table 3](#).

Table 3 — Requirements for density variation, dimensions and moisture content

Property	Test method	Requirement	
Density variation within panel	ISO 9427	±10 % max from mean	
Length and width	ISO 9426	±2 mm/m, max. ±5 mm	
Squareness	ISO 9426	<2 mm/m	
Thickness	ISO 9426	Thickness range (mm, nominal)	
		≤12	>12
		— Unsanded panel	— Sanded panel
		-0,3 +1,5	-0,5 +1,7
		±0,3	±0,3
Moisture content (advisory only)	ISO 16979	5 to 14 % (see Note)	

NOTE This ISO Standard applies internationally. Wood products attain a moisture content according to the temperature and relative humidity of their environment. The upper limits of this moisture content range will only apply in hot, humid areas.

7.6 Formaldehyde requirements

Compliance with formaldehyde requirements may be confirmed by applying only one test method of those listed in [Table 2](#). The reference chamber method can take up to four weeks for each test to

be completed. The other tests are designated production control methods because one test may be completed within 24 h. Each individual panel result shall comply with the specification limits stated in [Table 4](#) for the selected method.

Table 4 — Maximum limits of formaldehyde emission/content

Property	Method ^a	Unit	Requirement
Emission	ISO 12460-1	mg/m ³	0,124
Emission	ISO 12460-3	mg/m ² /h	3,5
Emission	ISO 12460-4	mg/L	0,7
Content	ISO 12460-5	mg/100 g	8,0
NOTE 1 National regulations may impose restrictions on the use of panels of particular formaldehyde emission levels.			
NOTE 2 If any other method is used for production control, correlations should be established with the reference chamber method to determine the emission value that is equivalent to the chamber method limit value stated in this table. Correlations may be regional, national, company or plant specific as appropriate.			

7.7 Load bearing particleboard

When particleboard is classified P-LB or P-HLB and nominated for load bearing applications, the characteristic strength and stiffness values shall be established based upon testing in accordance with ISO 16572 or equivalent ASTM or EN standards. Alternatively, for specific load bearing applications (e.g. walls, roofs, floors, joist webs), the load bearing particleboard shall meet the specific performance requirements for that intended application.

8 Specific property requirements

8.1 Requirements for general purpose particleboard for use in dry conditions (P-GP REG)

The requirements for P-GP REG particleboard are listed in [Table 5](#).

Table 5 — Requirements for P-GP REG particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	11,5	11,5	11,5	10,5	10,0	9,5	8,5	7,0	5,5
Internal bond strength	ISO 16984	MPa	0,31	0,31	0,31	0,28	0,24	0,20	0,17	0,14	0,14

8.2 Requirements for furniture grade particleboard for use in dry conditions (P-FN REG)

The requirements for P-FN REG particleboard are listed in [Table 6](#).

Table 6 — Requirements for P-FN REG particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	13,0	13,0	12,0	11,0	11,0	10,5	9,5	8,5	7,0
Modulus of elasticity (MOE)	ISO 16978	MPa	1 800	1 800	1 950	1 800	1 600	1 500	1 350	1 200	1 050
Internal bond strength	ISO 16984	MPa	0,45	0,45	0,45	0,40	0,35	0,30	0,25	0,20	0,20
Surface soundness	ISO 16981	MPa	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8

8.3 Requirements for load bearing particleboard for use in dry conditions (P-LB REG)

The requirements for P-LB REG particleboard are listed in [Table 7](#).

Table 7 — Requirements for P-LB REG particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	14,0	15,0	16,0	15,0	15,0	13,0	11,0	8,0	7,0
Modulus of elasticity (MOE)	ISO 16978	MPa	1 800	1 950	2 200	2 200	2 100	1 900	1 700	1 200	1 200
Internal bond strength	ISO 16984	MPa	0,50	0,45	0,45	0,40	0,35	0,30	0,25	0,20	0,20
24 h thickness swelling	ISO 16983	%	25	25	21	19	16	16	16	15	14

8.4 Requirements for heavy-duty load bearing particleboard for use in dry conditions (P-HLB REG)

The requirements for P-HLB REG particleboard are listed in [Table 8](#).

Table 8 — Requirements for P-HLB REG particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	17,0	20,0	20,0	20,0	18,0	16,0	15,0	14,0	12,0
Modulus of elasticity (MOE)	ISO 16978	MPa	2 700	2 800	2 900	3 150	2 900	2 550	2 400	2 200	2 050
Internal bond strength	ISO 16984	MPa	0,70	0,65	0,65	0,60	0,50	0,40	0,35	0,30	0,25
24 h thickness swelling	ISO 16983	%	18	18	16	16	15	15	15	14	14

8.5 Requirements for general purpose particleboard for use in temperate humid conditions (P-GP MR1)

The requirements for P-GP MR1 particleboard are listed in [Table 9](#).

Table 9 — Requirements for P-GP MR1 particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	12,0	12,0	13,0	13,0	12,0	11,0	10,0	7,0	5,5
Internal bond strength	ISO 16984	MPa	0,35	0,35	0,30	0,28	0,24	0,20	0,17	0,14	0,14
24 h thickness swelling	ISO 16983	%	26	24	23	18	15	13	13	12	12
Moisture resistance											
Option 1, cyclic test:											
Internal bond strength	ISO 16987	MPa	0,16	0,15	0,14	0,13	0,11	0,08	0,07	0,06	0,05
Thickness swelling		%	25	24	23	21	20	18	17	15	14
Option 2, boil test:											
Internal bond strength	ISO 16998	MPa	0,06	0,09	0,09	0,08	0,07	0,06	0,05	0,04	0,04
Option 3: Wet bending strength	ISO 20585 Method A	MPa	4,6	4,7	4,9	4,6	4,2	3,9	3,5	2,5	2,3

8.6 Requirements for furniture grade particleboard for use in temperate humid conditions (P-FN MR1)

The requirements for P-FN MR1 particleboard are listed in [Table 10](#).

Table 10 — Requirements for P-FN MR1 particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	13,0	13,0	14,0	14,0	13,0	12,0	11,0	8,0	7,5
Modulus of elasticity (MOE)	ISO 16978	MPa	1 800	1 800	1 900	1 900	1 900	1 700	1 400	1 200	1 200
Internal bond strength	ISO 16984	MPa	0,50	0,50	0,45	0,45	0,40	0,35	0,30	0,25	0,25
Surface soundness	ISO 16981	MPa	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8
24 h thickness swelling	ISO 16983	%	25	23	20	16	14	13	13	12	12
Moisture resistance											
Option 1, cyclic test:											
Internal bond strength	ISO 16987	MPa	0,18	0,18	0,18	0,15	0,13	0,12	0,10	0,09	0,08
Thickness swelling		%	15	15	20	18	16	14	13	11	11
Option 2, boil test:											
Internal bond strength	ISO 16998	MPa	0,09	0,09	0,09	0,09	0,08	0,07	0,07	0,06	0,06
Option 3: Wet bending strength	ISO 20585 Method A	MPa	5,3	5,3	5,6	4,9	4,5	4,2	3,9	3,2	2,9

8.7 Requirements for load bearing particleboard for use in temperate humid conditions (P-LB MR1)

The requirements for P-LB MR1 particleboard are listed in [Table 11](#).

Table 11 — Requirements for P-LB MR1 particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	16,0	18,0	19,0	17,0	16,0	14,0	12,0	9,0	9,0
Modulus of elasticity (MOE)	ISO 16978	MPa	2 000	2 400	2 450	2 450	2 400	2 100	1 900	1 550	1 550
Internal bond strength	ISO 16984	MPa	0,50	0,50	0,45	0,45	0,40	0,35	0,30	0,30	0,25
24 h thickness swelling	ISO 16983	%	16	16	14	13	11	11	11	10	9
Moisture resistance											
Option 1, cyclic test:											
Internal bond strength	ISO 16987	MPa	0,30	0,30	0,30	0,20	0,20	0,18	0,16	0,14	0,12
Thickness swelling		%	12	12	12	15	13	12	11	10	9
Option 2, boil test:											
Internal bond strength	ISO 16998	MPa	0,15	0,15	0,15	0,14	0,14	0,12	0,10	0,09	0,09
Option 3: Wet bending strength	ISO 20585 Method A	MPa	6,0	6,5	6,7	6,4	5,6	4,9	4,2	3,6	3,4

8.8 Requirements for heavy-duty load bearing particleboard for use in temperate humid conditions (P-HLB MR1)

The requirements for P-HLB MR1 particleboard are listed in [Table 12](#).

Table 12 — Requirements for P-HLB MR1 particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	18,0	20,0	21,0	21,0	19,0	18,0	16,0	14,0	13,0
Modulus of elasticity (MOE)	ISO 16978	MPa	2 900	3 000	3 100	3 000	2 900	2 700	2 400	2 200	2 200
Internal bond strength	ISO 16984	MPa	0,80	0,75	0,75	0,75	0,70	0,65	0,60	0,45	0,40
24 h thickness swelling	ISO 16983	%	12	10	10	10	10	10	10	9	9
Moisture resistance											
Option 1, cyclic test:											
Internal bond strength	ISO 16987	MPa	0,45	0,45	0,40	0,34	0,32	0,29	0,27	0,20	0,20
Thickness swelling		%	11	11	12	11	10	10	10	10	9
Option 2, boil test:											
Internal bond strength	ISO 16998	MPa	0,25	0,25	0,25	0,23	0,21	0,20	0,18	0,14	0,12
Option 3: Wet bending strength	ISO 20585 Method A	MPa	6,5	7,3	7,7	7,7	7,0	6,3	6,0	5,0	4,5

8.9 Requirements for general purpose particleboard for use in high tropical humid conditions (P-GP MR2)

The requirements for P-GP MR2 particleboard are listed in [Table 13](#).

Table 13 — Requirements for P-GP MR2 particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	15,0	14,0	14,0	13,0	12,0	11,0	10,0	7,0	5,5
Internal bond strength	ISO 16984	MPa	0,35	0,35	0,30	0,28	0,24	0,20	0,17	0,14	0,14
24 h thickness swelling	ISO 16983	%	20	16	14	12	12	10	10	9	8
Moisture resistance											
Option 1, cyclic test:											
Internal bond strength	ISO 16987	MPa	0,21	0,20	0,19	0,17	0,14	0,11	0,10	0,09	0,08
Thickness swell		%	16	15	14	13	12	11	10	9	8
Option 2, boil test:											
Internal bond strength	ISO 16998	MPa	0,16	0,15	0,15	0,14	0,12	0,09	0,08	0,07	0,06
Option 3: Wet bending strength	ISO 20585 Method A	MPa	7,5	7,0	7,0	6,5	6,0	5,5	5,0	3,5	2,7

8.10 Requirements for furniture grade particleboard for use in high tropical humid conditions (P-FN MR2)

The requirements for P-FN MR2 particleboard are listed in [Table 14](#).

Table 14 — Requirements for P-FN MR2 particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	20,0	18,0	17,0	16,0	15,0	13,0	12,0	10,0	8,0
Modulus of elasticity (MOE)	ISO 16978	MPa	2 300	2 200	2 100	2 000	1 900	1 700	1 600	1 600	1 400
Internal bond strength	ISO 16984	MPa	0,50	0,50	0,45	0,45	0,40	0,35	0,30	0,25	0,25
Surface soundness	ISO 16981	MPa	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8
24 h thickness swelling	ISO 16983	%	18	16	14	12	12	10	10	9	8
Moisture resistance											
Option 1, cyclic test:											
Internal bond strength	ISO 16987	MPa	0,25	0,24	0,23	0,22	0,18	0,16	0,14	0,12	0,10
Thickness swell		%	16	14	13	12	11	10	9	8	7
Option 2, boil test:											
Internal bond strength	ISO 16998	MPa	0,24	0,23	0,22	0,22	0,20	0,17	0,15	0,14	0,12
Option 3: Wet bending strength	ISO 20585 Method A	MPa	10,0	9,0	8,5	8,0	7,5	6,5	6,0	5,0	4,0

8.11 Requirements for load bearing particleboard for use in tropical humid conditions (P-LB MR2)

The requirements for P-LB MR2 particleboard are listed in [Table 15](#).

Table 15 — Requirements for P-LB MR2 particleboard

Property	Test method	Units	Requirement								
			Thickness ranges mm, nominal								
			≤3	>3 to ≤4	>4 to ≤6	>6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	21,0	20,0	19,0	18,0	16,0	15,0	14,0	12,0	10,0
Modulus of elasticity (MOE)	ISO 16978	MPa	2 600	2 600	2 600	2 600	2 400	2 100	1 900	1 700	1 500
Internal bond strength	ISO 16984	MPa	0,55	0,55	0,50	0,50	0,45	0,40	0,35	0,30	0,25
24 h thickness swelling	ISO 16983	%	16	14	13	12	10	10	10	9	8
Moisture resistance											
Option 1, cyclic test:											
Internal bond strength	ISO 16987	MPa	0,40	0,40	0,35	0,30	0,25	0,25	0,20	0,18	0,15
Thickness swell		%	12	11	10	10	9	9	8	7	6
Option 2, boil test:											
Internal bond strength	ISO 16998	MPa	0,30	0,28	0,28	0,28	0,20	0,17	0,15	0,13	0,12
Option 3: Wet bending strength	ISO 20585 Method A	MPa	10,5	10,0	9,5	9,0	8,0	7,5	7,0	6,0	5,0

8.12 Requirements for heavy-duty load bearing particleboard for use in high tropical humid conditions (P-HLB MR2)

The requirements for P-HLB MR2 particleboard are listed in [Table 16](#).

Table 16 — Requirements for P-HLB MR2 particleboard

Property	Test method	Units	Requirement					
			Thickness ranges mm, nominal					
			≥6 to ≤13	>13 to ≤20	>20 to ≤25	>25 to ≤32	>32 to ≤40	>40
Bending strength (MOR)	ISO 16978	MPa	22,0	20,0	18,0	17,0	16,0	14,0
Modulus of elasticity (MOE)	ISO 16978	MPa	3 350	3 100	2 900	2 800	2 600	2 400
Internal bond strength	ISO 16984	MPa	0,75	0,70	0,65	0,60	0,50	0,45
24 h thickness swelling	ISO 16983	%	9	8	8	8	7	7
Moisture resistance								
Option 1, cyclic test:								
Internal bond strength	ISO 16987	MPa	0,45	0,42	0,39	0,36	0,33	0,30
Thickness swell		%	10	9	9	8	7	6
Option 2, boil test:								
Internal bond strength	ISO 16998	MPa	0,37	0,35	0,32	0,30	0,27	0,25
Option 3: Wet bending strength	ISO 20585 Method A	MPa	11,0	10,0	9,0	8,5	8,0	7,0

9 Marking

Each panel or pack of panels shall be marked by the manufacturer either by direct indelible printing or by an adhesive label with at least the following information:

- the manufacturer's name, trademark or identification mark specific to the production facility;
- a reference to this International Standard, i.e. ISO 16893;
- the panel type, e.g. P-FN MR1;
- the nominal thickness;
- the formaldehyde classification;
- the batch number or production week and year;
- additional attributes such as resistance to fire, insects or decay.

Annex A (normative)

Calculation of 5-percentile and 95-percentile values

A.1 General

This Annex specifies a method of calculating the 5-percentile and 95-percentile values, as given in [A.3](#).

A.2 Notation symbols

Some general notation symbols used in this Annex are as follows.

m	number of test pieces cut from each single panel of the sample, in each direction
n	number of panels taken as sample, i.e. size of the sample
$x_{5\%}$	lower 5-percentile values of the sample
s	estimate of the standard deviation calculated from test values or measurements
$s_{w,j}$	estimate of the standard deviation within a panel, j , of the sample
$s_{\bar{x}}$	estimate of the standard deviation between panel means
\bar{s}_w	estimate of the mean standard deviation between panels
t_n	single-sided 5 %- t -value of a normally distributed sample of n panels (see Table A.1)
$x_{95\%}$	upper 95-percentile values of the sample
x_{ij}	single test value or measurement
\bar{x}_j	mean value (arithmetic mean) of the m single test values, or measurements, obtained from a single panel, j
$\bar{\bar{x}}$	grand mean, i.e. mean value (arithmetic mean) of all ($m \times n$) test values, or measurements, obtained from a sample

A.3 Calculations

A.3.1 Mean value of each individual panel (panel mean)

For each group of test pieces, or measurements, the mean value of each individual panel shall be calculated in accordance with Formula (A.1).

$$\bar{x}_j = \sum_{i=1}^m x_{ij} / m \quad (\text{A.1})$$

A.3.2 Standard deviation within each panel

For each group of test pieces, or measurements, the standard deviation within each panel shall be calculated in accordance with Formula (A.2).

$$s_{w,j} = \sqrt{\sum_{i=1}^m (x_{ij} - \bar{x}_j)^2 / (m-1)} \tag{A.2}$$

A.3.3 Grand mean (mean of panel means)

The grand mean of all test pieces, or all of a group of test values from the sample shall be calculated in accordance with Formula (A.3).

$$\bar{x} = \sum_{j=1}^n \sum_{i=1}^m x_{ij} / mn = \sum_{j=1}^n \bar{x}_j / n \tag{A.3}$$

A.3.4 Standard deviation of panel means

The standard deviation between panel means shall be calculated in accordance with Formula (A.4).

$$s_{\bar{x}} = \sqrt{\sum_{j=1}^n (\bar{x}_j - \bar{x})^2 / (n-1)} \tag{A.4}$$

A.3.5 Mean standard deviation of the test values within panels

The mean standard deviation of the test values within panels shall be calculated in accordance with Formula (A.5).

$$\bar{s}_w = \sum_{j=1}^n \bar{s}_{w,j} / n \tag{A.5}$$

A.3.6 5- and 95-percentile of a normally distributed panel property

The 5-percentile of a normally distributed panel property shall be calculated in accordance with Formulae (A.6) and (A.7).

$$x_{5\%} = \bar{x} - t_n s_{\bar{x}} \tag{A.6}$$

$$x_{95\%} = \bar{x} + t_n s_{\bar{x}} \tag{A.7}$$

Table A.1 — Single-sided *t*-values in relation to the sample size, *n*

Sample size, <i>n</i>	4	6	8	10	12	15	20	25	30	35	40	60	100
<i>t_n</i>	2,35	2,02	1,89	1,83	1,80	1,76	1,72	1,71	1,70	1,69	1,68	1,67	1,65

NOTE *t_n* values for sample sizes between those in [Table A.1](#) may be determined by linear interpolation.

(Updated: 15/10/2015 15:57)

