

**BS 1088:2018**



BSI Standards Publication

## **Marine plywood – Requirements**

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## Summary of pages

This document comprises a front cover, and inside front cover, pages i to iv, pages 1 to 10, an inside back cover and a back cover.

Requirements in this standard are drafted in accordance with *Rules for the structure and drafting of UK standards*, subclause **G.1.1**, which states, “Requirements should be expressed using wording such as: ‘When tested as described in Annex A, the product shall ...’”. This means that only those products that are capable of passing the specified test will be deemed to conform to this standard.

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## 1 Scope

BS 1088 specifies requirements for two classes of marine plywood:

- standard; and
- lightweight,

intended for use primarily in the manufacture of marine craft and in other marine and waterway applications.

The requirements also take into consideration the use of marine plywood in building construction.

BS 1088 addresses in particular the resistance of plywood to bio-deterioration and loss of bond strength with time. It does not make provision for other properties which might additionally be relevant in a particular end use.

Plywood made in accordance with this standard might also need to meet additional requirements in legislation and/or standards specific to its end use that are not covered by this standard.

With particular reference to building construction, experience has shown that rapid ingress of water at the panel edge during the build process can cause differential swelling in the core, resulting in localized catastrophic rupture of the wood fibres, thus giving the appearance of delamination. If subsequent integrity of the waterproof envelope of the building is not maintained, similar problems can arise. BS 1088 cannot make provision for such events since the choice of veneer species is based only on density and resistance to bio-deterioration.

*NOTE 1* Where marine plywood is to be used in building construction, attention is drawn to the Construction Products Regulations 2013 [1]. Conformity with these can be verified through demonstrating conformity with BS EN 13986.

*NOTE 2* When used in building construction, good site practice with particular reference to protection of the building elements against wetting is of the highest importance for ensuring the intended results for the building.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions 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.

[BS 1203](#), *Hot-setting phenolic and aminoplastic wood adhesives — Classification and test methods*

BS EN 314-1, *Plywood — Bonding quality — Part 1: Test methods*

BS EN 314-2:1993, *Plywood — Bonding quality — Part 2: Requirements*

BS EN 322, *Wood-based panels — Determination of moisture content*

BS EN 324-1, *Wood-based panels — Determination of dimensions of boards — Part 1: Determination of thickness, width and length*

BS EN 324-2, *Wood-based panels — Determination of dimensions of boards — Part 2: Determination of squareness and edge straightness*

BS EN 326-1, *Wood-based panels — Sampling, cutting and inspection — Part 1: Sampling and cutting of test pieces and expression of test results*

BS EN 335:2013, *Durability of wood and wood-based products — Use classes: definitions, application to solid wood and wood-based products*

[BS EN 350:2016](#), *Durability of wood and wood-based products — Testing and classification of the durability to biological agents of wood and wood-based materials*

BS EN ISO 3166-1, *Codes for the representation of names of countries and their subdivisions — Part 1: Country codes*

### 3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

#### 3.1 amino resin

thermosetting synthetic resin derived from a condensation reaction of the –NH– groups of amines or amides with aldehydes

*NOTE* “Urea–formaldehyde (UF)” and “melamine–formaldehyde (MF)” resins are mainly of significance in the adhesives field.

[SOURCE: BS EN 923:2015, 2.3.51, modified]

#### 3.2 batch

output, which may comprise boards of more than one thickness, of a single product type within a single shift of maximum 8 h duration

#### 3.3 layer

either one ply or two or more plies glued together with their grain direction parallel, or another material

[SOURCE: BS EN 313-2:2000, 2.11]

#### 3.4 standard marine plywood

veneer plywood comprising heartwood of wood species of superior natural biological durability with an exterior glue bond

[SOURCE: BS EN 314-2:1993]

#### 3.5 lightweight marine plywood

veneer plywood comprising wood species of lower density than those used in standard marine plywood (see 3.4) with an exterior glue bond

*NOTE 1* Lower density wood species in most cases have lower natural biological durability than the species used in standard marine plywood.

*NOTE 2* Lightweight marine plywood is generally specified only where low weight is of critical importance to the design. An example of a lower density timber species is gaboona.

#### 3.6 pMDI (diphenylmethane diisocyanate, isomers and homologues)

mixture containing 4,4'-methylenediphenyl diisocyanate (MDI), other methylenediphenyl diisocyanate isomers, and low oligomers

*NOTE* It is produced by the reaction of aniline and formaldehyde, using hydrochloric acid as a catalyst to produce a mixture of diamine precursors, as well as their corresponding polyamines. These diamines are reacted with phosgene to form a mixture of isocyanates. Distillation of the mixture leads to pMDI.

#### 3.7 phenolic resin

thermosetting synthetic resin derived from a condensation reaction of a phenol with an aldehyde

*NOTE* The main phenols used are:

- phenol, cresol, xylenol, butyl- and octyl-phenol, resorcinol and cashew nut shell liquid (from *Anacardium occidentale*), which consists mainly of substituted phenols. Mixtures of these phenols are used, as well as mixtures of aldehydes like formaldehyde or furfuraldehyde for the manufacture of these resins;
- "lignin", a major constituent of wood obtained as a by-product of chemical pulping, has a phenol-like chemical composition and is usually used in combination with phenol-formaldehyde (PF) resins as a phenol substitute; and
- "condensed tannins" obtained from the bark of several species of trees have a phenol-like composition and are generally used in combination with PF resins.

[SOURCE: BS EN 923:2015, 2.3.52, modified]

### 3.8 ply

either one single veneer or two or more veneers joined edge to edge or end to end

[SOURCE: BS EN 313-2:2000, 2.17]

### 3.9 tight side

side of the veneer opposite the loose side

[SOURCE: BS 6100-4.3:1984, 430.2111]

*NOTE 1* In accordance with BS 6100-4.3:1984, definition 430.2110, the loose side is the "side of a peeled or sliced veneer that is in contact with the knife as the veneer is being cut and which undergoes an elongation often producing lathe checks".

*NOTE 2* This is sometimes referred to as "slack side".

### 3.10 veneer

thin sheet of wood not more than 7 mm in thickness

[SOURCE: BS EN 313-2:2000, 2.14]

## 4 Requirements for manufacture

### 4.1 Selection of timber species

The timber species of the veneers used in the manufacture of marine plywood shall be selected according to [Table 1](#) so that the required durability is obtained.

Where a range of durability classes is given for a species or species mixture, the least durable class shall be used as the basis for conforming to [Table 1](#).

*NOTE 1* Where an increase in durability is required it might be necessary to apply preservative treatment, either to the veneers before bonding, to the adhesive (which will diffuse into the veneers during hot pressing), or to the finished plywood, but only if incorporated by the original manufacturer. Guidance on preservative treatment is given in DD CEN/TS 1099.

*NOTE 2* Plywood for marine use is employed in many different circumstances and the nature of the hazard (wet rot, insect attack, soft rot, marine borer attack) to which it might be exposed can vary widely. Where resistance to marine borer attack is desirable, e.g. if marine plywood is likely to come into direct contact with water, it is important that species with an adequate resistance to marine borer attack are used. BS EN 350 includes a limited list of species having such resistance, but it is not exhaustive and other species may also be used if adequate resistance to marine borers can be demonstrated from previous experience or by testing.

**Table 1** — Durability requirements for standard and lightweight marine plywood

Class	Requirements
Standard	<p>The wood species used shall be from those listed in <a href="#">BS EN 350:2016</a>, Annex B, as having natural biological durability Class DC 3 or better and with a nominal density &gt;500 kg/m<sup>3</sup> at 12% moisture content</p> <p>The aim shall be to exclude sapwood, but for practical reasons up to 5% sapwood per veneer shall be permitted, assessed on a visual inspection of the surface area of the veneer prior to assembly</p>
Lightweight	<p>The wood species used shall be from those listed in <a href="#">BS EN 350:2016</a>, Annex B, as having natural biological durability Class DC 4 or better and with a nominal density ≤500 kg/m<sup>3</sup> at 12% moisture content</p> <p>The aim shall be to exclude sapwood, but for practical reasons up to 5% sapwood per veneer shall be permitted, assessed on a visual inspection of the surface area of the veneer prior to assembly</p>

*NOTE Ideally, all veneers consist entirely of heartwood but, for practical reasons, a small percentage of sapwood is permitted.*

Where species to be used, and similarly sources of the wood, are not listed in [BS EN 350:2016](#), Annex B, it shall be demonstrated that the required natural durability class in accordance with [BS EN 350](#) has been met and the proposal presented according to [BS EN 350:2016](#), Annex G.

#### 4.2 Materials — Veneers

Veneers shall be either sliced or rotary cut. Veneers prepared by either method shall have smooth surfaces. The outer plies of a panel shall be prepared by the same method, i.e. sliced or rotary cut, except for decorative face veneers (see [4.3.3](#)). The permissible number of natural defects and edge joints shall not exceed the limits given in [Table 2](#).

**Table 2** — Permissible frequencies of defects and joints in veneer for outer and inner plies

Defect/joint type	Veneer for outer plies	Veneer for inner plies
Pin knots	Up to 6 per square metre of panel surface	No limit
Closed splits	A maximum of 2 per metre width of panel area with a total length of 200 mm	No limit
Open splits	Not permitted	A maximum of 1 split of up to 0.5 mm wide on any panel edge
Small worm holes, $\leq 1.5$ mm diameter	Up to 2 per square metre. Holes in plane of veneer not permitted	Greater number permitted, including some in plane of veneer, provided they do not produce voids
Variation in colour	Low contrast variation in colour is permitted if free from fungal decay	Permitted, if free from fungal decay
Edge joints	For peeled face veneers the minimum distance between edge joints shall be 300 mm  For sliced face veneers the minimum distance between edge joints shall be 100 mm	No limit
End joints	Not permitted	Not permitted
Compression failure	Not permitted	Not permitted
Others: Knots other than pin knots Worm holes $> 1.5$ mm diameter Fungal decay	Not permitted	Not permitted
Repairs	Not permitted	Properly made and tightly fitted glued patches with their grain aligned with the grain of the veneer and having a maximum dimension of 60 mm permitted up to 3 per square metre

### 4.3 Lay-up and panel structure

*NOTE* The requirements of 4.3.3 and 4.3.4 aim to ensure that the marine plywood has the balanced construction essential to most applications.

#### 4.3.1 Number of plies

Panels having a thickness of 6.5 mm or less shall have three or more plies. Panels having a thickness greater than 6.5 mm shall have five or more plies.

#### 4.3.2 Edge joints

Glued edge joints shall be made using either a thermosetting phenolic or an aminoplastic adhesive. In the case of the latter, the moisture resistance shall be class H2, or better, in accordance with BS 1203. Thermoplastic adhesives shall not be used.

Metal fastenings, tapes or stitching shall not be used for edge joints in inner plies.

*NOTE* Veneers for outer plies may be taped or stitched to repair splits.

Where outer plies have been taped or stitched, such material shall be removed after pressing.

### 4.3.3 Lay-up

Adjacent plies shall be laid up with their grains at right angles to each other.

*NOTE 1 Cores (centres) may comprise two veneers of equal thickness with their grains parallel, provided that the panel conforms to 4.3.1.*

In order to ensure a balanced construction, the veneers forming any one layer and the corresponding layer on the opposite side of the central plane of the panel shall be of the same thickness and species, or of species known to be similar to one another in physical characteristics. These veneers shall be cut by the same method.

*NOTE 2 Decorative outer veneers (face veneers) may be cut by different methods, but the physical characteristics and thickness of the veneers are selected to avoid distortion of the panel in service.*

Outer plies shall be laid up with the tight side of the veneer outermost.

### 4.3.4 Panel structure

#### 4.3.4.1 General

Panels shall conform to 4.3.4.2 or 4.3.4.3 after sanding, when conditioned to a moisture content of between 6% and 14%.

#### 4.3.4.2 Three-ply panels

The combined thickness of the two outer plies after sanding shall be not less than 40% and not more than 65% of the nominal, unsanded thickness of the panel.

#### 4.3.4.3 Multi-ply panels

After sanding, the thickness of each of the two outer plies, combined with those of the core and other inner plies with their grain direction parallel to the outer plies, shall be not less than 40% and not more than 65% of the nominal, unsanded thickness of the panel. In addition, for panels with a nominal thickness of greater than 3.8 mm, each outer ply shall be not less than 1.0 mm thick after sanding and each inner and core ply shall be not more than 4.8 mm thick.

## 4.4 Durability and classification

### COMMENTARY ON 4.4

*The durability of marine plywood derives from both the resistance to degradation by moisture of the glue line and the resistance to bio-deterioration of the timber species used for the veneers.*

Marine plywood shall be classified according to its durability in accordance with Table 3.

**Table 3** — Marine plywood application and use class

Class	Application
Standard	Plywood suitable for use when exposed to regular wetting or frequent or continuous exposure to water (fresh or salt), e.g. use classes 3.2, 4 or 5 in BS EN 335:2013
Lightweight	Plywood suitable for use when wetted occasionally or, if wetting is more prolonged, when the plywood is protected, e.g. use class 3.1 in BS EN 335:2013

*NOTE Lightweight plywood is normally only specified where low weight is of critical importance to the design.*

## 5 Requirements for finished marine plywood

*NOTE In case of dispute, a consignment may be sampled in accordance with BS EN 326-3. Testing of the sample is limited to those requirements specified in 5.1 to 5.5 that are in dispute.*

### 5.1 Dimensional tolerances, squareness and edge-straightness

When tested in accordance with BS EN 324-1, at a minimum sampling frequency of one panel per batch, the nominal length, width and thickness of the panels shall be within the tolerances given in [Table 4](#).

When tested in accordance with BS EN 324-2, at a minimum sampling frequency of one panel per batch, the squareness and edge-straightness of the panels shall be within the tolerances given in [Table 4](#).

**Table 4** — Permissible tolerances for nominal length, width, thickness and squareness, and edge-straightness of panels

Tolerances on nominal thickness $t$ mm	Unsanded panels		Sanded panels	
	Thickness tolerance within one panel mm	Tolerances on nominal thickness mm	Thickness tolerance within one panel mm	Tolerances on nominal thickness mm
$3 \leq t \leq 12$	1.0	+ (0.8 + 0.03 $t$ ) - (0.4 + 0.03 $t$ )	0.6	+ (0.2 + 0.03 $t$ ) - (0.4 + 0.03 $t$ )
$t > 12$	1.5			
Tolerance on nominal length and width	$\pm 3.5$ mm			
Tolerance on squareness and edge-straightness	1 mm/m			

### 5.2 Moisture content

When determined in accordance with BS EN 322, at a minimum sampling frequency of one panel per batch, at the time of leaving the manufacturer's premises the moisture content of marine plywood shall be between 6% and 14%.

### 5.3 Quality of surface appearance

On visual inspection the surface of panels after sanding shall not exceed the limits given in [Table 2](#).

### 5.4 Manufacturing defects

Panels shall not contain any of the following manufacturing defects: open joints (e.g. core gaps, overlaps and pleats, blisters, hollows, bumps and imprints), roughness (other than that due to the irregular structure of the wood), sanding through, foreign particles, or defects in the edges of panels (e.g. due to sanding, sawing, missing wood).

Glue penetration through to the surface shall only be allowed close to areas of permitted defects, up to a maximum of 5% of the area of each outer ply.

### 5.5 Bonding quality

When tested in accordance with BS EN 314-1, the bonding quality shall meet the requirements of BS EN 314-2:1993, Bonding Class 3. Minimum sampling frequency shall be one pair of glue-lines per every 2 000 pairs of glue-lines produced, whatever the lay-up of the panel, but not more than one panel per batch. Test pieces shall be sampled from the selected panels in accordance with BS EN 326-1.

The adhesive(s) used for bonding the plies shall be selected to ensure that the product meets these bonding requirements.

*NOTE 1 Examples of adhesive types that might be suitable include:*

- a) a phenolic resin;
- b) a melamine–formaldehyde (amino) resin containing sufficient resorcinol (or other phenol); and
- c) pMDI (diphenylmethane diisocyanate, isomers and homologues).

*NOTE 2 Additives may be included only with the adhesive manufacturer's written approval.*

## 6 Marking and documentation

### 6.1 Marking

Panels shall be indelibly marked on the edge or back with the following information, in upper case, in the order shown:

- a) the number and date of this British Standard, i.e. BS 1088:2018,<sup>1</sup> and the word “MARINE”;
- b) the letters “PT” if there has been any application of preservative treatment;
- c) the nominal panel thickness, in millimetres (mm);
- d) the manufacturer's name or identification mark;
- e) the country of manufacture (alpha-2 code, in accordance with BS EN ISO 3166-1);
- f) identification of panel type, using the words either STANDARD or LIGHTWEIGHT; and
- g) the name(s) of the predominant wood specie(s) according to [BS EN 350](#), expressed as either the four digit code or the common name.

*NOTE An example is given in [Annex A](#).*

### 6.2 Documentation

The documentation for each consignment of panels shall include the information in [6.1](#), together with a list of all the species used in their construction and details of any preservative treatment which has been applied.

Test reports for [5.1](#) to [5.5](#) shall be retained by the manufacturer and made available to the purchaser on request.

*NOTE Where biocides are added during manufacture to improve resistance to bio-deterioration, the Biocidal Regulation No. 528/2012 [2], Article 58, Clause 3, specifies the provision of the following accompanying information:*

- a) a statement that the treated article incorporates biocidal products;
- b) where substantiated, the biocidal property attributed to the treated article;
- c) the name of all active substances contained in the biocidal products;
- d) the name of all nanomaterials contained in the biocidal products, followed by the word “nano” in brackets; and
- e) any relevant instructions for use, including any precautions to be taken because of the biocidal products with which a treated article was treated or which it incorporates.

<sup>1</sup> Marking BS 1088:2018 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third-party certification of conformity.

## Annex A (informative)

### Example of marking

An example of marking is:

BS 1088:2018, MARINE/PT/12MM/MFR/GB/LIGHTWEIGHT/GABOON

This marking indicates the plywood conforms to BS 1088:2018 and has the following characteristics:

- a) preservative treatment (PT) applied;
- b) nominal thickness of 12 mm;
- c) manufacturer's name or identification mark: MFR;
- d) country of manufacture: Great Britain;
- e) panel type: lightweight; and
- f) timber species: gaboon.

## Bibliography

### Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[BS 6100-4.3:1984](#), *Glossary of building and civil engineering terms — Part 4: Forest products — Section 4.3: Wood based panel products*

BS EN 313-2:2000, *Plywood — Classification and terminology — Part 2: Terminology*

BS EN 326-3, *Wood-based panels — Sampling, cutting and inspection — Part 3: Inspection of an isolated lot of panels*

BS EN 636, *Plywood — Specifications*

BS EN 923:2015, *Adhesives — Terms and definitions*

BS EN 13986, *Wood-based panels for use in construction — Characteristics, evaluation of conformity and marking*

BS EN ISO 9000, *Quality management systems — Fundamentals and vocabulary*

BS EN ISO 9000-1, *Quality management and quality assurance standards — Part 1: Guidelines for selection and use*

[BS EN ISO 9001:2015](#), *Quality management systems — Requirements*

BS ISO 9000-2:1997, *Quality management and quality assurance standards — Part 2: Generic guidelines for the application of ISO 9001, ISO 9002 and ISO 9003*

DD CEN/TS 1099, *Plywood — Biological durability — Guidance for the assessment of plywood for use in different use classes*

### Other publications

- [1] GREAT BRITAIN. *The Construction Products Regulations 2013*. London: The Stationery Office.
- [2] EUROPEAN PARLIAMENT AND COUNCIL OF THE EUROPEAN UNION. *Regulation (EU) No 528/2012 of the European Parliament and of the Council of 22 May 2012 concerning the making available on the market and use of biocidal products*. Luxembourg: Office for Official Publications of the European Communities, 2012.



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