BRITISH STANDARD

BS 1088-1:2003

Marine plywood —

Part 1: Requirements

ICS 79.060.10

BSi
British Standards

Committee responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/541, Wood based panels, upon which the following bodies were represented:

APA The Engineered Wood Association
Association of British Plywood and Veneer Manufacturers
British Marine Industries Federation
British Woodworking Federation
Canada Wood UK
Department of Trade and Industry
Eternit Building Materials
Flat Roofing Alliance
Forestry Commission
Furniture Industry Research Association
Institution of Structural Engineers
Lloyds Register of Shipping
Mineral Bonded Board Products Federation
Ministry of Defence
National Federation of Roofing Contractors
National House-Building Council
National Panel Products Association
Timber Research and Development Association
Timber Trade Federation
Wood Panel Industries Federation
Zurich Municipal Building Guarantee

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Contents

Foreword

This part of BS 1088 has been prepared by Technical Committee B/541. Together with BS 1088-2, it supersedes BS 1088:1966 and BS 4079:1966, which are withdrawn.

BS 1088 is issued in two parts:

— *Part 1: Requirements;*

— *Part 2: Determination of bonding quality using the knife test.*

Guidance on preservative treatment of plywood, which was previously included in BS 4079, is now dealt with by reference to DD ENV 1099.

Unlike performance-based plywood standards, BS 1088 is unique in giving specific requirements for wood species, construction, lay-up and adhesives. These features have been maintained and where appropriate cross-referenced to current British and European Standards.

Although the term "marine plywood" is widely used in commerce, there has not previously been a formal definition in British, European or International Standards. A definition is included in Clause 3 of this standard.

Standard marine plywood as defined in and meeting the requirements of BS 1088 has outstanding resistance to both biodeterioration and loss of bond strength with time. Lightweight marine plywood as defined in and meeting the requirements of BS 1088 has outstanding resistance to loss of bond strength with time. BS 1088 was originally developed to specify plywood meeting the exacting requirements of use in marine craft, but marine plywood is also suitable for use in extreme climates and in such applications as vehicle bodies and general building work where the cost of replacement in the event of failure might be high. The scope of this edition reflects this wider range of use. The biological durability of marine plywood is expected to be greater than that of plywood of the same species that meets only the minimum requirements of BS EN 636-3.

BS 1088:1966 and BS 4079:1966 were confirmed without amendment in 1992. The original text is no longer useable for a number of reasons: conformity to many requirements cannot be verified by tests on the finished product subsequent to manufacture, several references are now obsolete, there are no adequate verification and labelling clauses and the language does not give the degree of precision and lack of ambiguity required by BS 0.

The main technical changes in this edition are in the specification of the adhesive type to overcome the original unverifiable requirements for BS 1203 type WBP, and the use of shear testing in place of the knife test for determining bonding quality. The knife test, described in Part 2 of this standard, may still be used for quality control in the mill. The mycological test has been deleted.

The original edition gave no requirements for a statistical control of production for the purpose of verifying conformity.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Assessed capability. Users of this British Standard are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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

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1 Scope

This part of BS 1088 specifies requirements for marine plywood for use in the manufacture of marine craft and in other marine and waterway applications. It also applies to marine plywood that has been selected for use in building construction, in extreme climates and in such applications as vehicle bodies and general building work where a high standard of durability is required or where the cost of replacement in the event of failure might be high.

This standard does not include strength data, which can be used to derive characteristic values or grade stresses for use in engineering design.

NOTE 1 Where marine plywood is to be used in construction, attention is drawn to the requirements of the Construction Products Directive. Compliance with these requirements can be verified through demonstrating compliance with BS EN 13986.

NOTE 2 Where marine plywood is to be used for load-bearing applications in building construction, it is necessary to substantiate the design or design calculations. BS 5268-2 and DD ENV 1995-1-1 (Eurocode 5) provide suitable methods for achieving this.

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.

BS 1203, *Hot-setting phenolic and aminoplastic wood adhesives — Classification and test method.*

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

BS EN 314-2, *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 335-3, *Durability of wood and wood-based products — Definition of hazard classes of biological attack — Part 3: Application to wood-based panels.*

BS EN 350-2, *Durability of wood and wood-based products — Natural durability of solid wood — Part 2: Guide to natural durability and treatability of selected wood species of importance in Europe.*

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.

[Adapted from BS EN 923:1998, definition **2.3.51**]

3.2
layer
either one ply or two or more plies glued together with their grain direction parallel, or another material
[BS EN 313-2:2000, definition **2.11**]

3.3 marine plywood

3.3.1
standard marine plywood
veneer plywood possessing outstanding durability with respect to fungal decay and bonding quality making it suitable for the construction of marine craft and certain applications in building construction

3.3.2
lightweight marine plywood
veneer plywood made from timber species of lower density than those used in standard marine plywood (see **3.3.1**)

NOTE 1 Other than the requirement for density (see **4.3.2**), all other requirements are the same as for standard marine plywood. Lightweight plywood is normally only specified where low weight is of critical importance to the design. An example of a lower density timber species is gaboon.

NOTE 2 Lower density timber species generally have lower durability than the species used in standard marine plywood.

3.4
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;

— "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.

[Adapted from BS EN 923:1998, definition **2.3.52**]

3.5
ply
either one single veneer or two or more veneers joined edge to edge or end to end
[BS EN 313-2:2000, definition **2.17**]

3.6
tight side
side of the veneer opposite the loose side
BS 6100-4.3:1984, definition **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.

3.7
veneer
thin sheet of wood not more than 7 mm in thickness
[BS EN 313-2:2000, definition **2.14**]

4 Requirements for manufacture

4.1 Materials

4.1.1 *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 **4.2.3**). The permissible number of natural defects and edge joints shall not exceed the limits given in Table 1.

Table 1 — 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, ≤ 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

4.1.2 *Adhesive for bonding the plies*

The adhesive shall be based on either:

a) a phenolic resin; or

b) a melamine–formaldehyde (amino) resin containing sufficient resorcinol (or other phenol) to ensure that the requirements of **5.6** are met. Additives shall be included only with the manufacturer's written approval.

4.2 Lay-up and panel structure

NOTE The requirements of **4.2.3** and **4.2.4** aim to ensure that the marine plywood has the balanced construction essential to most applications. For some applications, however, marine plywood with an unbalanced construction is advantageous. Such material may be supplied provided that it conforms in all other respects to the requirements of this standard.

4.2.1 *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.

4.2.2 *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 type MR, or better, in accordance with BS 1203. Thermoplastic adhesives shall not be used.

Inner plies shall not be edge joined with metal fastenings, tapes or stitching.

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.

4.2.3 *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 the requirements of **4.2.1**.

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 should be selected to avoid distortion of the panel in service.

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

4.2.4 *Panel structure*

4.2.4.1 *General*

Panels shall conform to the requirements of **4.2.4.2** or **4.2.4.3** after sanding, when conditioned to a moisture content between 6 % and 14 %.

4.2.4.2 *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.

4.2.4.3 *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.

4.3 Durability

NOTE The durability of marine plywood derives from both the resistance of the glue line to degradation by weathering and the resistance to biodeterioration of the timber species used for the veneers.

4.3.1 *Classification*

Marine plywood shall be classified according to its durability as specified in Table 2.

Table 2 — Marine plywood durability classes

Class	Description
Standard	Plywood suitable for use when exposed to regular wetting or permanent exposure to water (fresh or salt), e.g. Hazard Classes 4 or 5 in BS EN 335-3
Lightweight	Plywood suitable for use when wetted occasionally or, if wetting is more prolonged, when the plywood is protected
NOTE Lightweight plywood is normally only specified where low weight is of critical importance to the design.	

4.3.2 *Selection of timber species*

The timber species of the veneers used in the manufacture of marine plywood shall be selected according to Table 3 so that the required durability is obtained.

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. Guidance on preservative treatment is given in DD ENV 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 350-2 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 3 — Durability requirements for standard and lightweight marine plywood

Class	Requirements
Standard	Standard marine plywood shall be made throughout of timbers having a durability rating of Class 3, BS EN 350-2, or better. The nominal density of the timber species used shall be > 500 kg/m^3 Up to 5 % sapwood per veneer shall be permitted[a]
Lightweight	For lightweight marine plywood, the nominal density of the species used shall be ≤ 500 kg/m^3 It shall be made throughout of timbers having a durability rating of Class 4, BS EN 350-2, or better Up to 5 % sapwood per veneer shall be permitted[a]
NOTE 1 The durability classification used in BS EN 350-2 refers to the natural durability rating of a timber against fungal attack. NOTE 2 Ideally, all veneers should consist entirely of heartwood but, for practical reasons, a small percentage of sapwood is permitted.	
[a] The percentage of sapwood shall be assessed by visual inspection.	

5 Requirements for marine plywood

NOTE In case of dispute, consignment testing may be carried out in accordance with BS EN 326-3. This testing should be limited to those requirements specified in **5.1** to **5.7** 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 eight hours or per shift, the tolerance on the nominal length, width and thickness of the panels shall conform to Table 4.

When tested in accordance with BS EN 324-2, at a minimum sampling frequency of one panel per eight hours or per shift, the tolerance on the squareness and edge-straightness of the panels shall conform to 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	± 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 eight hours or per shift, 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 1.

5.4 Manufacturing defects

Panels conforming to this standard 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, defects in the edges of panels (e.g. due to sanding, sawing, missing wood).

Glue penetration shall only be permitted in areas adjacent to permitted defects, up to a maximum of 5 % of the area of each outer ply.

5.5 Adhesive type

The adhesive shall comply with **4.1.2**.

5.6 Bonding quality

When tested in accordance with BS EN 314-1, the bonding quality shall meet the requirements of BS EN 314-2, 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 per shift. Test pieces shall be sampled from the selected panels in accordance with BS EN 326-1.

NOTE 1 In order to assess bonding quality for internal factory quality control purposes, the test method given in BS 1088-2 may be used provided that a relationship between the results of tests made by this method and by the method given in BS EN 314-1 is established. The method given in Annex A may be used to establish this relationship.

NOTE 2 Where using BS 1088-2 to assess bonding quality for internal factory quality control purposes, the bonding quality number derived by the method given in Annex A may be assigned as the minimum bonding quality requirement. This requirement should be met both by samples pretreated by cold water immersion and those pretreated by boiling water or steam.

NOTE 3 A minimum bonding quality number should be determined for both standard and lightweight marine plywood.

5.7 Density

For standard marine plywood the nominal density at 12 % moisture content (as defined in BS EN 350-2) of the species used shall be > 500 kg/m^3. For lightweight marine plywood the nominal density at 12 % moisture content (as defined in BS EN 350-2) of the species used shall be ≤500 kg/m^3.

6 Marking and documentation

6.1 Marking

Panels conforming to this standard shall be indelibly marked on the edge or back with the following information in the order shown:

a) the number and date of this British Standard, i.e. BS 1088-1:2003,[1)] and the word "MARINE";

b) the word "UNBALANCED" if panels are of unbalanced construction;

c) the word "TREATED" if there has been any application of preservative treatment;

d) the nominal panel thickness;

e) the manufacturer's name or identification mark;

f) the country of manufacture;

g) the panel type, i.e. Standard (S) or Lightweight (LW);

h) the name of the timber species according to BS EN 350-2:1994.

NOTE An example is given in Annex B.

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 **5.7** shall be retained by the manufacturer and shall be made available to the purchaser on request.

[1)] Marking BS 1088-1:2003 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)
Method of determining the relationship between the test methods given in BS 1088-2 and BS EN 314-1

A.1 Principle

Proximate samples are taken from panels and tested for shear strength and bonding quality, respectively. If the first sample passes the test for shear strength, the bonding quality determined for the second sample is assigned as the value against which production quality control will be gauged.

A.2 Selection and preparation of test pieces

For five consecutive shifts, take one panel per shift. From each panel, prepare a set of test pieces in accordance with BS EN 314-1, and a separate set of 10 proximate test pieces in accordance with BS 1088-2.

A.3 Procedure

Test the first sample from each panel in accordance with BS EN 314-1. If this sample meets the requirements of BS EN 314-2, Bonding Class 3, test the second sample from the same panel in accordance with BS 1088-2.

A.4 Calculation of results

The arithmetic mean of the assigned bonding qualities of all the test pieces tested in accordance with BS 1088-2 and expressed to the nearest whole number is the minimum bonding quality value against which production quality control will be gauged.

A.5 Test report

The report shall contain the following information:

a) the test report for BS EN 314-1;

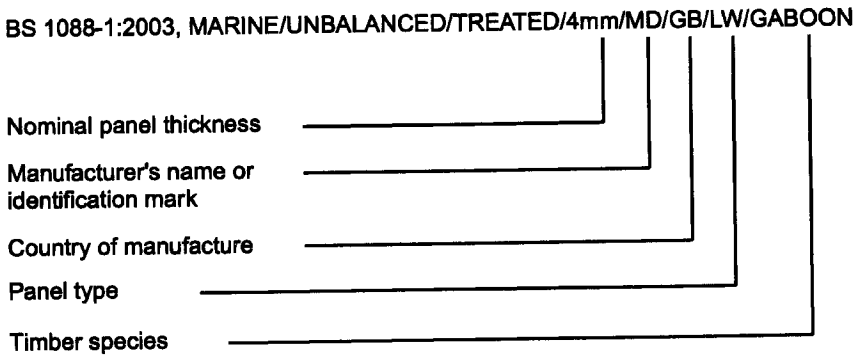
b) the test report for BS 1088-2;

c) a statement of the assigned bonding quality value against which production quality control will be gauged.

A.6 Test repetition

This relationship should be re-established at intervals of not more than 12 months.

Annex B (informative)
Example of marking



This marking indicates the plywood conforms to this standard and has the following characteristics:

a) unbalanced construction;

b) preservative treatment applied;

c) nominal thickness of 4 mm;

d) manufacturer's name or identification mark, MD;

e) country of manufacture, Great Britain;

f) panel type, lightweight;

g) timber species, gaboon.

Bibliography

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

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 a consignment of panels.*

BS EN 923:1998, *Adhesives — Terms and definition.*

BS EN ISO 9000:2000, *Quality management systems — Fundamentals and vocabulary.*

BS EN ISO 9000-1:1994, *Quality management and quality assurance standards — Part 1: Guidelines for selection and use.*

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.*

BS EN ISO 9001:2000, *Quality management systems — Requirements.*

DD ENV 1099, *Plywood — Biological durability — Guidance for the assessment of plywood for use in different hazard classes.*

DD ENV 1995-1-1:1994, *Eurocode 5 — Design of timber structures — Part 1-1: General rules and rules for buildings* (together with United Kingdom National Application Document).

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