TRADA

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WOODINFORMATION

Specification & treatment of exterior plywood

Conditions of exterior exposure

Exterior service, in building terms, covers a wide range of situations from full and severe exposure (sign boards, sea front fascias) to sheltered and protected (soffits under porches and balconies). There are also applications other than in buildings that impose similar stresses on plywood in service. The use of plywood for formwork is covered in a separate Wood Information Sheet.

Two different exterior situations where plywood has a long history of successful use can be recognised:

- exterior but protected - where direct wetting of surfaces and edges is unlikely once construction is completed – such usage (sheathing, soffits, sarking, roof decking etc) is designated as Hazard Class 2 according to BS EN 335-1 *Hazard classes of wood and wood-based products against biological attack. Classification of hazard classes* and BS EN 335-3 *Application to wood-based panels*. BS EN 636-2 *Plywood- Specifications. Requirements for plywood for use in humid conditions* is appropriate to these types of usage.
- full exposure to weather (characterised by the possibility of high moisture content in service, driving rain and full exposure to sunlight). Examples include cladding, fascias, exterior doors. These uses are designated Hazard Class 3 in terms of the risk of biological attack (mould, stain, decay). *BS EN 636-3 Plywood- Specifications. Requirements for plywood for use in exterior conditions* is appropriate to these types of usage.

The factors of exterior exposure that can be significant to the performance of plywood are:

- rain (particularly wind-driven) and where drying-out is slow
- fluctuations in relative humidity
- sunlight, particularly on south-facing aspects and dark coloured surfaces
- fungal organisms
- frost, insect attack and severe chemical pollution may sometimes also have an adverse effect on the service life of plywood.

Rain, either wind-driven or running down the facade of a building, can be rapidly absorbed by unprotected end grain of timber. Plywood contains much end grain around the edges which must be protected if satisfactory performance is to be achieved. If the edges are not protected, water can enter and give rise to stresses which can eventually cause splitting of the wood and separation of the veneers around the edges even of 'exterior' bonded panels. In the shorter term, it often gives rise to unsightly staining behind a finish and can lead to mould growth, blistering of paint and ultimately decay.

Water usually penetrates much more rapidly than it is lost. This is particularly the case if its entry is localised, such as through an area of improperly applied edge sealant. Under these conditions, water can be trapped for long periods behind fairly impermeable finishes, putting considerable demands on the durability or preservative treatment of the plywood and the adhesion of the finish.

Fluctuations in relative humidity cause dimensional changes. Under normal service conditions this eventually results in the lathe checks, created as a result of the peeling of the veneer, coming through to the surface. This may disrupt the finish if this is a paint, varnish, textured coating or similar film-forming coating of limited flexibility.

Sunlight, in conjunction with rain, will result in rapid change of colour of unprotected plywood. Prolonged exposure will lead to splitting, surface roughness and loss of fibre. A protective finish is necessary unless a bleached, weathered appearance is acceptable.

External exposure varies not only in kind but also in duration. Therefore two broad 'desired service life' categories are used in this guide to specification. These are termed 'normal' and 'short' but no attempt has been made to define them precisely. 'Normal' is intended to apply to uses where the service life is measured in decades; 'short' to situations where exposure periods are measured in months.

Durability of glue bonds

Plywoods are produced with glue bonds which range from those suitable for interior uses only, to those which will withstand full exposure for long periods.

BS EN 314-2 *Plywood bonding quality. Requirements* defines three classes on the basis of test requirements that the plywood bond must meet:

- Class 1: dry conditions (interior, dry uses)
- Class 2: humid conditions (protected external service, 'damp' internal uses and limited exposure during construction)
- Class 3: exterior conditions (exposure to weather over substantial periods or continuous exposure to high relative humidity).

Full exterior bonding

Class 3 bonds are a requirement for plywood to comply with BS 636-3. The bonds are largely comparable with what were known as WBP - weather and boil-proof plywood bonds (to BS 6566 Part 8, now withdrawn), except that the requirement that effectively they be made with phenolic-type glues has been dropped. To qualify, the bond must now only meet the stipulated test requirements.

There are three main commercial groupings of plywood in the 'full exterior' category:

- Douglas fir and softwood plywoods from Canada and the USA. These are termed 'exterior' in accordance with the national standards to which they are manufactured. When subject to quality assurance by APA - The Engineered Wood Association, the Canadian Plywood Association (CPA) or Timberco Inc (TECO) the plywoods are classified as Class 3.
- Birch throughout, birch faced and softwood plywoods from Finland, Russia and Sweden. Exterior types of these plywoods are bonded with phenolic adhesives capable of meeting the Class 3 requirements.
- Tropical hardwood plywood (WBP). There are six main source areas for plywood of this type;

  South east Asia, South America, continental Europe, Middle East, Africa and the UK with the first being by far the most important in volume terms. Most of these plywoods are still being produced to national or even mill standards. Designers must satisfy themselves that the bonding of these plywoods complies with BS EN 314-2 and BS EN 636-3.

Marine grade plywoods are specified in BS 1088 and 4079 *Plywood for marine craft*. The bond quality requirements for marine plywood as defined in the UK were essentially the same as for WBP. The superiority of marine plywood for demanding end uses relates to the greater control over types, thicknesses and quality of veneer and the manufacturing processes which the marine standard imposes. These requirements make marine grade plywood more costly than the equivalent general purpose 'exterior' type, a fact which should be borne in mind when deciding which type to specify.

Restricted exterior grade bonding

Class 2 bonds to BS EN 314-2 are a requirement for plywood to comply with BS EN 636-2. They are described as being suitable for plywood used in 'humid' conditions and are required to meet the bond strength requirements after pretreatment with cold water and (on different samples) a 6 - hour boil. The nearest equivalent to this

category was the boil resistant, BR, plywood bond defined in the long-superseded BS 1455.

The following commercial designations of plywood available in the UK (or of historic interest) come into this category and may be considered suitable bonds for sheltered or protected exterior exposure or where only limited service life is required of an exterior board.

Type I Exterior

Refers to test methods laid down in the Korean Export Plywood standard. Plywood with this level of performance can be considered to be equivalent to that of the BR (boil resistant) category of the former BS 1455. It does not have the resistance to weather associated with Class 3 or WBP bonding and the adhesives used are rarely phenolic (although these are not precluded and the designation; 'Type 1 phenolic' may occasionally be met). Plywood of this type is produced from tropical hardwood of the lauan type.

CBR Cyclic boil resistant

Defined in BS 6566 Part 8, this superseded BR, boil resistant, was defined in BS 1455 (now withdrawn) and aligned more closely with equivalent overseas standards. CBR bonds were required to be "resistant to weather but may fail under prolonged exposure or other demanding conditions of use. They have a good resistance to boiling water, will withstand cold water for many years and are highly resistant to attack by micro-organisms". The test conditions defined well-made plywood bonds made with melamine-urea-formaldehyde adhesives and those types of phenolic bonds which did not qualify for WBP.

APA - The Engineered Wood Association Exposure 1 plywood

This grade is bonded with phenolic adhesives but, due to other compositional factors, such plywoods have limited full-exposure capabilities that are intended to cope only with exposure to the weather during construction. They can be best utilised in a Bonding Class 2 application.

Bond types unsuitable for exterior use

Class 1 to BS EN 314-2 and older designations such as MR (moisture resistant), Type 2 and INT (interior) bonded plywood types cannot be recommended for normal exterior use. However, MR and Type 2 bonds will survive exposure to cold water for periods of up to several years, so that they might be contemplated for use in a non-demanding, short life exterior situation.

Durability of veneer species

The fact that a plywood employs 'exterior' bonds, ie Classes 2 or 3 to BS EN 314-2, in its manufacture does not automatically imply that it is suitable for long term exterior exposure in its 'as-received' state. The wood component of plywood must be durable, ie resistant to fungi etc, in addition to being adequately bonded. Many situations of exterior use require that a durable veneer species or preservative treatment is needed for satisfactory long-term service.

The two types of exterior use listed on page 1 correspond with Hazard Classes 2 and 3 of BS EN 335-1 in respect of fungal decay and stain organisms. (Insect attack of plywood in service is a very infrequent occurrence in the UK and is not considered further here.) Having identified which of the two hazard classes is appropriate, one could, if dealing with solid timber consult the appropriate BS ENs to identify which species of timber has adequate inherent decay resistance (natural durability) or, if not, what level of preservative treatment would be appropriate. With plywood, however, the situation is not yet so straightforward. DD ENV 1099 *Plywood – Biological durability – Guidance for the assessment of plywood for use in different hazard classes,* a Draft for Development, or pre Standard, gives some guidance on the durability classes of the veneers used to manufacture a plywood that are deemed suitable for normal service in Hazard Classes 2 and 3.

This is not of much practical help, however, since it can be virtually impossible to determine the constituent species of many plywoods, and, in any case, no plywood specification totally excludes sapwood. Sapwood is always rated in the lowest durability class. As a result, the guidance falls between preservative treatment 'usually being necessary' or 'not usually being necessary'

in Hazard Classes 3 and 2 respectively. If preservative treatment is specified, the only official guidance that exists at present is the UK National Annex to DD ENV 1099, issued as an amendment to the 1998 edition, in April 1999 as a replacement for BS 6566 Part 7.

In practice, decay in external plywood is relatively uncommon, despite the fact that it may well contain sapwood. Attention to design detailing and maintenance can do much to reduce the risk.

There remains a category of plywood that has not yet been subjected to European Standardisation - so-called marine plywood, to BS 1088/4079. This standard lays down in considerable detail the selection of suitably durable species, the bonding requirements and such constructional parameters as maximum and minimum veneer thickness, maximum allowable sapwood and limitations on manufacturing imperfections.

Marine grade plywood to BS 4079 *Plywood made for marine use and treated against attack by fungi, insects and marine borers* is inherently durable because strictly controlled preservative treatment of the veneers is specified. Marine grade plywood to BS 1088 *Marine plywood manufactured from selected untreated tropical hardwoods* is similarly durable because (with the exception of that made from gaboon which must be specially marked) veneers are restricted to those of adequate durability and the amount of sapwood permitted is restricted.

Table 1 is an attempt to combine the bonding requirements of BS 636 with the natural durability/ preservative treatment guidance given in DD ENV 1099. It also attempts to make a distinction between normal and short service lives (see explanation on page 2), which the BS ENs do not. The final decision, however, must be based on individual assessment of the exposure conditions and risk of failure in service. Guidance on life and risk assessment is included in the Wood Information Sheet 4 - 28 *Durability by design*.

TABLE 1 Suitability of plywoods for exterior use

Note: Plywoods suitable for structural use are listed in BS 5268-2.

	Normal service life		Short service life	
	Hazard Class 2	Hazard Class 3	Hazard Class 2	Hazard Class 3
European birch, birch faced	Bond Class 2 (O)	Bond Class 3 (X)	Bond Class 2 (O)	Bond Class 2 (X)
European softwood	Bond Class 2 (O)	Bond Class 3 (X)	Bond Class 2 O	Bond Class 2 (O)
N American Douglas fir/softwood	Exterior (O)	Exterior (X)	Exterior O	Exterior (O)
Mahogany/S American hardwoods	Bond Class 2 (O)	Bond Class 3 (X)	Bond Class 2 O	Bond Class 2 (O)
SE Asia meranti/lauan type	Bond Class 2(O) Type 1*	Bond Class 3 (X)	Bond Class 2 O Type 1 *	Bond Class 2 (O) Type 1 *
S American Parana pine	Bond Class 2 (O)	Bond Class 3 (X)	Bond Class 2 (O)	Bond Class 2(X)
Marine grade (not gaboon) (durable veneers and restricted sapwood content, or preservative treated)	WBP	WBP		

O natural

(O) natural durability is normally sufficient when used in conjunction with protective design features, surface finishes, edge sealants etc, but for certain uses, preservative treatment can be advisable. Annex A of BS EN 460 gives further guidance

(X) preservative treatment is normally advisable, but in certain end uses, natural durability can be sufficient, see BS EN 460 Annex A

* Type 1 is not suitable for structural use under these circumstances.

Appearance, surface characteristics and finishes

Appearance grades

Plywood exposed to the weather and having long service life expectations should have no open defects (eg knot holes, splits) on the exposed face(s). Defects may have been cut out and repaired with wood patches or synthetic filler during manufacture and grades which allow such treatment are acceptable where opaque coatings are to be used or where the resulting appearance is acceptable. Guidance on appropriate grades is given below.

BS EN 635 *Plywood. Classification by surface appearance* has adopted a comparable grading system for the two broad groupings of commercial plywoods, namely hardwood and softwood. The grades correspond approximately to the following intended end uses:

- Grade E Natural surface intended to remain visible
- Grade I Surface which may remain visible
- Grade II Surface which may be directly overlaid or painted
- Grade III Surface generally intended to be unseen, painted or coated
- Grade IV Surface for which appearance is not the prime consideration.

It is likely that much plywood will continue to be sold to commercial grades applied in the country of origin. The approximate equivalents of these grades are shown in Table 2.

Table 2 Appearance grades - approximate equivalents

BS EN 635-2/3	Temperate hardwood	Tropical hardwood	Coniferous
Grade E	E, A-Finland	A	N-N America
Grade I	B	B	A, N
Grade II	S-Finland		B
Grade III	BB	BB	C,C-plugged
Grade IV	BB, WG-Finland C,CP-Russia	C, CC	D-N America X,C,D-Europe C-S American Parana pine

N-N America: natural finish; no defects or repairs. Canadian softwood plywoods carry descriptive designations although the grades of the veneers use a letter code.

DD ENV 635-4 *Parameters of ability for finishing. Guideline* lays down the surface appearance classification requirements for various types of surface finish ie paints, varnishes, stains, overlays. These recommendations differ between the three exposure categories, particularly with reference to limits of thickness of face veneers. A 5 mm maximum thickness of inner veneers is imposed for 'humid' and 'exterior' types. The tables are extensive and are not reproduced here. They should be consulted for guidance on detailed specification where surface appearance /finish is important.

Surface characteristics

Most plywoods have one or both faces sanded. Rough surfaced plywood is not suitable for coating with paint or textured finishes but can be finished with an exterior wood stain. Certain textured, striated, sculptured, plank-effect, etc, plywoods are available as proprietary items. Similarly, speciality plywoods are available with a resin or resin impregnated paper overlay. High density overlays of this type have weather resistance without further surface treatment. They are available in a range of muted shades.

A medium density overlay of paper impregnated with phenolic resin which is bonded to the original plywood surface under heat and pressure is designed to improve the performance of paint on plywood. This can be unsatisfactory, particularly where full exposure to weather is involved. The medium density overlaid plywood, MDO, sometimes referred to as 'painting grade overlaid', is not intended to be self-finished although it does have considerable weather resistance. A further advantage of many overlaid board types is that factory sealing of edges is standard. Cut edges obviously require sealing before installation.

Finishes

Except perhaps for short-life, utilitarian uses, eg hoardings on building sites, a protective finish, maintained as appropriate, is necessary. Impregnation with creosote or copper/chromium/arsenic preservatives may be satisfactory for eg farm buildings with medium service life requirements.

Conventional paints are suitable for use on exposed plywood with painting grade overlays. Such paint may be factory- or site-applied. Plywood used as infill panels should be fully painted before installation, bearing in mind that the paint

is there to prevent water ingress as well as to provide decoration. If there is any possibility of water reaching the reverse face of such panels, at least a primer coat should be specified for this face, to reduce the amount of wetting and thus the tendency to blister. It is possible to obtain reasonable performance from a conventional paint finish on plywood without overlay. However, especially for plywoods which are prone to face checking, extensible acrylic paints are preferable. Care with surface preparation, application conditions and timely maintenance are all essential if paint performance is to be acceptable.

Textured finishes, which range from fine sand texturing to the incorporation of stone chippings, resembling stucco, in a heavy synthetic base coat can provide a satisfactory solution. However, not all such finishes are suitable for use on plywood, many having been developed primarily for masonry. When specifying such a finish, it is necessary to obtain the manufacturer's assurance that it is capable of giving the desired performance on plywood. Again, overlaid plywood will provide a more uniform substrate but an advantage of these heavy-build textured coatings over conventional paints is that they are able to bridge surface checks without cracking. To do this, they rely heavily on adhesion to the plywood surface and this will not be achieved unless a well prepared, dry surface is available and correct primer and finishing specifications are followed.

Exterior penetrative wood stains provide an alternative method of finishing. These act by creating a water repellent surface which sheds rain. Moisture content fluctuations will occur because these finishes do not form thick plastic skins over the surface, but neither do they trap moisture or invite failure by blistering. Surface checking will occur eventually with exterior wood stains, but this does not cause flaking and loss of adhesion and can be masked by further maintenance applications. Further details can be found in the TRADA WI Sheet *Finishes for exterior timber*.

Note that some plywood/exterior finish combinations in protected situations eg as soffits or under eaves, can cause salts to migrate and appear on the surface of the coating. The use of light colours can make this effect unobtrusive.

Factors determining plywood performance

Design

Much depends on the actual conditions, but it is possible to state some general rules applicable to all but very temporary exterior use of plywood.

Edges of boards must be sealed to prevent absorption of water. Such sealing may be with

- special sealing compounds, such as pitch epoxy
- non-setting mastics if the plywood is set in frames
- wooden beading bonded with exterior adhesives
- metal or plastic cappings or channels fixed with non-setting mastic
- (as an absolute minimum) with extra coats of the finish used on the faces.

Good workmanship is essential in all cases. In addition to edge sealing, the lower edges of boards should be weathered ie bevelled to promote shedding of water.

Detailing and design must be such that water is shed effectively and does not soak into the backs of boards. Protection of the backs of boards is essential to minimise the consequences of ageing of sealants for example. Also, cavities should be adequately ventilated to allow dispersal of moisture which might penetrate the first defence.

Clearance at panel joints should be such that free drainage of water can take place. Mastic joints between boards are unlikely to be satisfactory due to the cumulative movement across the width or length of the board being concentrated in the area of the joint. Exposed or concealed joints may be used but, in each case, should provide an expansion/drainage gap wide enough to facilitate retreatment of the board edges on redecoration. Edge sealing is vital.

Similar considerations apply when detailing the junctions between plywood and masonry. Adequate clearance should be left at the junction to allow drainage, prevent capillary absorption of water from the porous masonry and to allow periodic reinforcement of the edge sealing. The bottom edges of the boards should stand well clear of flashings or sills for similar reasons.

Non-concealed fixings should be non-ferrous. Particular attention to the fixing method is necessary when translucent finishes are used since any staining due to moisture or corrosion products is readily visible against plywood's often uniform background.

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Specification

A plywood supplier does not always know the end use to which plywood will be put and the responsibility for interpreting a user's requirements should not be his unless specific guidance has been sought. Correct specification should cover the properties required of the basic material as well as treatments, finishes, fixing details, etc. A checklist for specification is as follows, although not all items will be appropriate to every situation and others may be involved:

1 bond quality, eg Class 2 or 3

2 face veneer species, face grain orientation, plywood types, eg birch faced, marine grade BS 1088, or country of origin (see Table 1)

3 thickness (usually nominal)

4 number of veneers (may be appropriate for structural uses but will normally be restricted by 2 and 3 above)

5 board size - the first dimension quoted indicates the face grain direction

6 face/reverse veneer appearance grade (BS EN 635 or national commercial grade)

7 surface characteristics, eg sanded, medium density overlay, textured

8 preservative treatment, eg double vacuum impregnation with organic solvent type wood preservative, insecticidal treatment by glueline additive (see Table 1), BS EN 460 and National Annex to DD ENV 1099.

9 moisture content (but beware, resistance-type moisture meters can give misleading readings on plywood)*

10 edge sealing treatment, eg factory sealed, pitch epoxy*

11 finish, eg exterior wood stain, textured finish.*

*TRADA Wood Information Sheets are available on these subjects.

Workmanship

Plywood correctly specified and used is a robust material. Its performance in service can, however, be impaired if the design features and finishing treatments are not carried out satisfactorily. This particularly applies to its appearance, but for example, poor workmanship leading to leakage into unventilated cavities could eventually result in decay.

Most problems with plywood in service stem from the absence of, or inadequate, edge sealing, eg ingress of moisture into plywood infill panels in curtain walling due to the use of incorrect or badly applied sealants. Failure to leave expansion gaps around the edges of panels can lead to buckling (3 mm on each edge is generally considered adequate). The standard of workmanship can greatly affect the performance achieved by a finish and in general this effect is greater with the long-life low maintenance finishes. Exterior wood stains are probably more tolerant in this respect but should not be regarded as cheap and completely undemanding. Indeed, in terms of appearance, the very fact that some types allow the grain pattern to show through, puts quite high demands on the quality of application. Runs, skips and overlaps show up with a stain finish.

Maintenance

The specification of the bond quality of the plywood and any preservative treatment which is considered necessary will ensure adequate durability from the basic material. Maintenance is then restricted to the augmentation or renewal of surface coatings, the repair of edge sealing, the replacement of sealants and possibly remedial action on fixings.

Maintenance procedures for paint are well established and the only unusual feature is likely to be the stripping of weathered paint films from overlaid plywood. This operation requires care if damage to the overlay by heat or chemical stripper is to be avoided. Maintenance of textured finishes varies with the type. With lightly textured paints, a maintenance coat of conventional gloss or emulsion paint may suffice, but more extensive deterioration of the finish may require removal of the original coating and renewal. Exterior wood stains require redecoration every 2-4 years in exposed locations if their visual aspect is to be maintained. This operation is relatively inexpensive and easy, so long as access is straightforward. The weathered surface is cleaned of superficial dirt and two coats of stain applied, except perhaps to protected areas under eaves which weather more slowly. It is the characteristic of these finishes that they weather by erosion, rather than cracking and flaking, making renovation easy.

Certainly, for fully exposed plywood, and frequently in more sheltered exterior exposure, protection of plywood by a finish is necessary for long service life. This protection need not, and usually in practice will not, be continuous since maintenance is rarely anticipatory, but it must be realised that future appearance and durability of coatings will suffer if weathering of the substrate is allowed to progress too far as a result of neglected maintenance.

References

British Standards

BS EN 314-2: 1993 Plywood bonding quality. Part 2 Requirements

BS EN 335-1: 1992 Hazard classes of wood and wood-based products against biological attack. Part 1 Classification of hazard classes
BS EN 335-3: 1996 Hazard classes of wood and wood-based products against biological attack. Part 3 Application to wood-based panels.

BS EN 460: 1994 Durability of wood and wood-based products. Natural durability of solid wood. Guide to the durability requirements for wood to be used in hazard classes

BS EN 635-1: 1995 Plywood. Classification by surface appearance. Part 1 General
BS 635-2: 1995 Plywood. Classification by surface appearance. Part 2 Hardwood
BS EN 635-3: 1995 Plywood. Classification by surface appearance. Part 3 Softwood
DD ENV 635-4: 1997 Plywood. Classification by surface appearance. Part 4 Parameters of ability for finishing. Guideline

BS EN 636-2: 1997 Plywood. Specifications. Part 2 Requirements for plywood for use in humid conditions
BS EN 636-3: 1997 Plywood. Specifications. Part 3 Requirements for plywood for use in exterior conditions

BS 1203: 1979 Synthetic resin adhesives (phenolic and aminoplastic) for plywood.

BS 1088 & 4079: 1966 Specifications for plywood for marine craft

BS 5268-5: 1989 Code of practice for the preservative treatment of constructional timber

BS 5589: 1989 Code of practice for the preservation of timber

DD ENV 1099: 1998 Plywood – Biological durability – Guidance for the assessment of plywood for use in different hazard classes

TRADA Wood Information Sheets

Finishes for exterior timber. WIS 2/3-1

Wood based sheet materials for formwork linings. WIS 2/3 - 17

Edge sealants for wood based boards. WIS 2/3 - 20

Introduction to wood based panel products. WIS 2/3 - 23

Moisture content of timber. WIS 4 - 14

Durability by design. WIS 4 - 28

British Standards now withdrawn (listed for information only)

BS 1455: 1972 Specification for plywood manufactured from tropical hardwoods.

BS 6566-1: 1985 Specification for construction of panels and characteristics of plies, including marking.
BS 6566-2: 1985 Glossary of terms.
BS 6566-3: 1985 Specification for acceptance levels for post-manufacture batch testing, including sampling.
BS 6566- 4: 1985 Specification for tolerances on the dimensions of plywood panels.
BS 6566- 5: 1985 Specification for moisture content.
BS 6566- 6: 1985 Specification for limits of defects for the classification of plywood by appearance.
BS 6566- 7: 1985 Specification for classification of resistance to fungal decay and wood borer attack. (Obsolescent)
BS 6566- 8: 1985 Specification for bond performance of veneer plywood.

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