

Introduction

There are certain fundamental requirements and procedures that need to be followed to ensure good long term performance of tongue and groove (T&G) flooring. This data sheet provides recommendations concerning the choice of product, installation and finishing.

The recommendations are applicable to the construction of domestic dwellings where a traditional timber bearer and joist system supports either a feature floor (polished and exposed to view) or a covered floor (carpet or other covering laid on top). Recommendations for non-structural timber floors laid over concrete slabs or on top of structural sheet or strip flooring is covered by Technical Data Sheet 18. Commercial and Industrial Timber Floors are covered in the NAFI Timber Manuals, Datafile SS3.

Movement in Timber Floors

Timber is a natural product that responds to changes in weather conditions. During periods of high humidity timber will absorb moisture from the air causing it to swell or increase in size. Conversely, during drier times when humidities are low, timber will shrink, reducing in size. Unless T & G flooring is placed in a permanently controlled environment, it will always move in response to changing environmental conditions. Gaps between individual T & G boards can be expected as the floor accommodates seasonal changes. Therefore a 'continuous mirror finish' cannot be expected from floor finishes. Localised shrinkage may also occur when areas of flooring are exposed to heat sources such as fireplaces or sunlight through large doors or windows.

Both the overall movement and rate of movement of timber varies depending on the timber species and cutting pattern of individual boards. Small moisture content variations in boards at the time of installation and differing conditions within the house (i.e. from sun exposure or fireplaces) will also cause variation in board movement. Consequently, gapping across a floor can be expected to be relatively even but actual gap size between individual boards will vary. An uneven distribution of gaps detracts from the appearance of the floor and can occur if a number of boards are bonded together by the finish penetrating into the joints. (Refer to the section on finishing). Floor finishes will not prevent timber movement, but may reduce the rate of response to climatic changes.

A small amount of noise can be expected from most timber floors when walked on. Noises can occur from movement of one board edge against another or from boards moving on nails. A floor is often more noisy during drier weather due to loosening at the joints.

Selecting a Timber Floor

Species, Colour, Grade and Hardness

The species or species mix chosen will generally determine the overall colour of the floor. As a guide, Table 1 indicates the range of colours that may be expected. The sapwood of many hardwoods can be much lighter than adjacent heartwood and some boards may contain both light and dark colours. Even within a single species large colour variations can occur and this should be discussed with flooring suppliers. Lyctid susceptible sapwood of some hardwood species eg spotted gum is required by some state legislation, including Queensland, to be preservative treated.

Some treatments may impart a brown or green-grey tinge to sapwood, while boron preservative is non-colouring. LOSP treatment can also be used. In this instance an H3 treatment may be used in lieu of H2 treatment to avoid the coloured dyes often used with H2 LOSP treatments.

The character of the floor is influenced by the species characteristics and therefore the grade. Grading is a process that sorts boards according to the number and size of features present (e.g. gum veins and knots). Table 1 indicates the grades contained in relevant Australian Standards, but it should be noted that some manufacturers have their own grades.

Hardness indicates a species' resistance to indentation and abrasion. Damage to timber floors may occur due to continual movement of furniture, heavy foot traffic and in particular "stiletto-heel" type loadings. The selection of a hard timber species ensures improved resistance to indentation and abrasion. Soft timber species, if used in feature floors can be expected to indent. Floor finishes will not improve the hardness of timber flooring.

Cover Widths, Profiles, Spans and End-Matching

Typical cover widths and thicknesses for T & G strip flooring are shown in Table 1. Actual cover widths may vary from those shown and should be checked with individual suppliers. Typical T & G profiles are shown in Figure 1. Some profiles are produced with grooves or rebates on the underside. Where the underside of a floor forms a ceiling, the board edges may be arched to form a 'v' joint profile. The "standard profile" is used for face nailing and is the profile commonly used for wider boards. The 'uninail' profile is used for both top nailing and secret fixing. When secret fixing the cover width should be limited to a maximum of 85 mm. The "uni-nail (secret nail) profile" may also be used for face nailing.

If the species or species mix contains a significant variation in colour the appearance of the floor will differ depending on the cover width, with narrower boards tending to blend the colour variations together. Gapping between boards during drier times is also less with narrower boards than it is with wide boards. A maximum board width of 100 mm is recommended to limit potential gap size and other movement effects such as cupping (edges of the board higher or lower than the centre).

End-matching is a process where a tongue and groove joint is provided at the ends of boards. This allows joints to be placed between joists, resulting in less wastage than plain end flooring which must have its ends fixed over joists.

Moisture Content

The moisture content of timber is the percentage weight of water present in the timber compared to the weight of timber with all water removed. Moisture content varies with changes in the humidity and temperature in the surrounding air. To minimise the movement of a floor (swelling on moisture uptake, shrinkage on moisture loss) due to changes in moisture content it is important to lay and fix timber floors close to the average moisture content of timber in the area where it is to be laid. Along coastal Queensland where higher humidities can be expected, moisture contents of flooring may vary from 9% to 14%. Timber flooring is usually supplied at an average moisture content between 10% and 12.5% and most boards can be expected to be within a few percent of the average. Where conditions are drier such as inland Queensland

TABLE 1 TIMBER SPECIES AND GRADES

Species	Colour	Hardness	Some Typical Cover Widths (mm)	Thickness (mm)
HARDWOODS - Grades: Select and Standard. (Feature grade is available from some producers) Australian Standard AS 2796 - Timber - Hardwood - Sawn and Milled Products				
Spotted gum	brown, dark brown, light sapwood	very hard	60, 80, 130	19
Brushbox	mid brown even colour	hard	"	"
Blackbutt	pale straw to light brown	hard	"	"
Tallowwood	pale straw to light brown	hard	"	"
Ironbark	dark brown or dark red	very hard	"	"
Rose Gum	pink to red	hard	"	"
Sydney Blue Gum	pink to pink brown	hard	"	"
Mixed Qld. species	a mix of the above or selected reds/whites	moderately/very hard	"	"
Jarrah	dark red brown	hard	67, 80	"
Tasmanian Oak / Victorian Ash	pale straw to light brown, pink	moderately hard	80, 85, 133	"
CYPRESS - Grades: No.1 and No.2 Australian Standard AS 1810 - Timber - Seasoned Cypress - Milled Products				
Cypress	pale straw sapwood, dark brown heartwood	moderately hard	62, 85, 133	19, 20
SOFTWOODS - Grade: Standard grade (Other manufacturers grades are available for Araucaria (Hoop Pine)) Australian Standard AS 4785 Timber-Softwood-Sawn and milled products				
Araucaria (Hoop Pine)	white to straw	soft	87, 89, 102, 133, 140, 152	21
Pinus species	straw	soft - firm	87, 133	19, 21

Notes:

1. Timber species other than those listed in Table 1 are available, however quantities may be limited.
2. To limit potential gap size and cupping, it is recommended that the maximum width be limited to 100 mm.

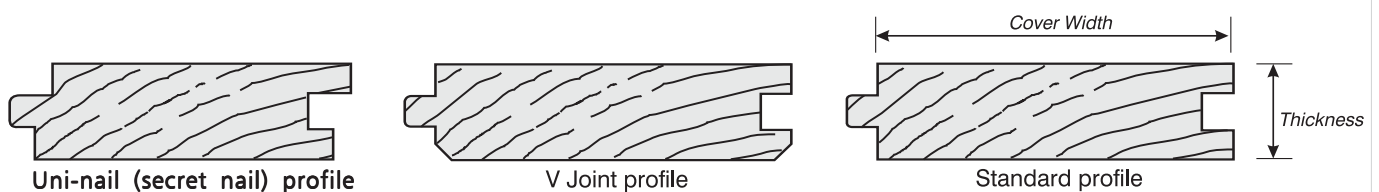


Figure 1 - Typical flooring profiles

or in air conditioned buildings, average moisture contents of flooring may vary from 7% to 12%. In these situations flooring may need to be acclimatised on-site. Timber Queensland can be contacted for advice.

Ordering Flooring

When ordering timber flooring, the following details should be provided to the timber supplier: -

- species
- grade
- profile and end-joint type
- cover width
- thickness
- quantity (in linear metres)
- any variation to the standard moisture content provisions

To calculate the linear metres of flooring required, the following method is recommended.

Total length of flooring required

$$= \frac{\text{area of floor (m}^2\text{)} \times 1000}{\text{cover width (mm)}} + \text{Wastage}$$

Allowance for waste should be approximately 5% for end matched flooring and 10% for plain end butt joined flooring.

Storage and Handling

Timber merchants should fully protect timber flooring products to maintain them at the appropriate moisture content. It is the installers responsibility to ensure that the timber is at the appropriate moisture content at the time of installation and therefore flooring products must be protected from weather exposure and other sources of dampness on site until the project is completed.

Packs of timber flooring should be supplied wrapped in plastic (top, sides and ends) which will provide some protection from moisture ingress. Plastic wrapping is however easily damaged and should not be relied upon to keep the flooring dry. If moisture penetrates the plastic or timber is stored over a moist surface, subsequent moisture uptake can result in significant swelling of some boards. Flooring should not be layed in this condition, as wide gaps at board edges may result as boards redry. Wrapped packs should be protected from excessive sun exposure as this too can have a detrimental effect.

Ideally, flooring should not be delivered to site until it can be immediately stored under permanent cover. If this is not achievable other precautions that are equally effective, to prevent moisture uptake and excessive sun exposure, will be needed.

Construction Methods

Fitted (Cut-In floors)

With this method, the timber flooring is installed after the roof cladding and external wall cladding are in place and the house is weather tight. This prevents initial degrade due to water and sunlight exposure and reduces damage from trades during construction. **This method is strongly recommended for the construction of feature floors** (polished floors).

Platform Floors

This method provides a working platform for the builder with the floor being laid prior to the erection of wall and roof framing. **This method is not recommended for feature floors as the flooring is exposed to the weather.** It is difficult to adequately protect a platform floor, and degrade due to the effects of sunlight, wetting or work practices may occur. If this construction method is used for T & G feature floors, the builder must accept the associated risks. Manufacturers or suppliers of flooring products will not take responsibility for problems arising as a consequence of weather exposure.

Sub-floor Framing

Bearer size, floor joist size and flooring spans

The size of timber members used to support the flooring boards can be determined from AS 1684 - Residential timber-framed construction. For end-matched flooring profiles, joists with a minimum thickness of 35 mm may be used. Where plain end flooring is butt joined at floor joists, 45 mm or 50 mm thick joists are recommended to reduce splitting problems at butt ends.

Unseasoned floor framing for T & G floors should be in single or similar species to limit differential shrinkage effects. Species exhibiting high tangential shrinkage rates, or prone to collapse or distortion should not be used unless seasoned. The potential effects of floor frame shrinkage should be assessed prior to specifying or ordering unseasoned timber framing, and due allowance made in the building design and detailing.

It is recommended that seasoned joists be used with secret nailed flooring. After laying, it is not possible to repunch nails prior to sanding and finishing. If subsequent shrinkage of joists occurs, movement of boards on the nails is likely to cause excessive squeaking.

The allowable span of timber flooring is dependent on the timber species, density, grade, thickness and whether or not the flooring is end matched. Table 2 gives the maximum allowable floor joist spacing for various flooring products where fixed to timber joists.

Table 2 - Maximum Allowable Joist Spacing

Species Group	Grade	Thickness (mm)	Max. Allowable Joist Spacing (mm)	
			Butt Joined	End-Matched
Hardwood -Qld, Northern NSW & Jarrah -Victorian Ash & Tasmanian Oak	Standard	19	640	490
	Select	19	680	520
	Standard	19	620	470
	Select	19	680	520
Cypress	Grade 1	19	580	450
	Grade 2	20	580	450
Slash Pine	Standard	19	580	450
Araucaria and other Pinus Species	Standard	19	510	390
	Standard	20	580	450

NOTES:

- (i) AS1684 provides tables for joist spacings of 450 mm and 600 mm.
- (ii) Joist spacings shown in Table 2 are suitable for domestic floor construction with live loads of 1.5 kPa uniformly distributed or 1.8 kN concentrated load. Where high floor loads are expected in domestic situations such as spa baths, water beds etc., larger joists and/or closer spacing will be necessary.
- (iii) These spacings are not applicable for flooring fixed to metal joists.

Sub-Floor Moisture

The humidity in an enclosed sub-floor space can have a profound effect on the performance of a floor. If conditions are very moist, the lower surface of the boards may take up moisture causing substantial swelling. Differential movement between the upper and lower surfaces of floor boards may also cause them to cup. Similarly, caution needs to be exercised with timber floors laid in areas where the micro-climate is often moist. In such locations the floor may reach higher moisture contents than in other nearby areas and additional allowance for expansion of the floor may be required. (Refer to:- Floor Installation - Allowance for expansion in floors.)

Timber floors should not be laid over moist sub-floor spaces. Structural sub-floors, over which T & G floors may be laid will provide some protection, however, they cannot be relied upon to prevent moisture uptake in the T & G flooring if humidities in the sub-floor space remain high for extended periods.

Timber T & G floors must be provided with a minimum sub-floor ventilation that exceeds BCA requirements. The levels outlined in the BCA are primarily to limit the moisture content of sub-floor framing timbers, which can generally tolerate greater fluctuations in moisture content, than timber floors. The recommended minimum level for timber floors is 7500 mm²/m length of wall with vents evenly spaced to ensure that cross ventilation is provided to all sub-floor areas.

Further information, refer to Timber Queensland Technical Data Sheet 14 -Sub-floor Ventilation which provides further details and information concerning moist sub-floor spaces.

Houses on Open Sloping Land

Special precautions must be taken when timber floors are laid in a house that is open underneath and built on steeply sloping land or escarpments. In such locations, very dry winds or wind blown rain or fog can directly affect the lower surface of the floor. This can result in either extreme shrinkage or extreme swelling. In the latter case the floor may lift off the joists and structural damage to the building may occur. Depending on the severity of the exposure, options to protect the floor include providing an oil based sealer to the underside of the floor, installing a weatherproof lining to the underside of the joists or building-in the underfloor space.

Araucaria (Hoop Pine) Flooring and Floor Framing

Where Araucaria floors and floor framing are not fully enclosed it is necessary to seal the framing members and lower surface of the floor boards to prevent attack from the Queensland Pine Beetle. Attack is specific to the Araucaria species (including Bunya) and generally restricted to the area from Bundaberg to Murwillumbah and east of the Great Dividing Range. In this region exposed framing and floors (including ventilated sub-floor spaces) require sealing to meet the requirements of the QFS Technical Pamphlet No.1 and thereby the BCA. The sealer provided needs to be a film forming finish and if a solvent borne product is chosen, it will have the added benefit of reducing seasonal movement in the floor.

Floor Installation

Pre-installation and acclimatising fitted floors

Prior to laying a timber floor it is important to consider the average moisture content of the flooring and the environment in which it is to be installed. Flooring is usually produced at an average moisture content in the range from 10% to 12.5% (individual boards may range from 9% to 14%).

Flooring supplied within this range is suitable for laying where the average in-service moisture content is also similar. This includes most of southeast and central Queensland, east of the Great Dividing Range. In areas where higher average moisture conditions persist and where floors are expected to have higher moisture contents, additional allowance should be made for subsequent expansion. Such areas include tropical North Queensland and in the south areas of dense bushland and rainforest, particularly upland and mountain areas.

Methods to achieve this include:-

- Providing additional intermediate expansion allowance (refer to Figure 3.)
- Acclimatising the flooring. Acclimatisation is the process of allowing partial equalisation of the moisture content of the timber as supplied to the moisture content of the surroundings in which the timber is to be installed. This will only be effective if the humidity in the air is sufficient to cause moisture uptake. Care must also be exercised as the rate of moisture uptake differs from species to species. Some higher density species are very slow to take up moisture from the air (e.g. spotted gum) while others react more quickly (e.g. Blackbutt and Brushbox).

If flooring is to be laid in a dry environment such as western Queensland or a frequently air-conditioning building then acclimatising can be effective in reducing the average moisture content of the flooring prior to laying and thereby reducing gap sizes at board edges from board shrinkage. Acclimatising can only be effective if undertaken within the air-conditioned

environment or in dry localities during drier periods. The species and period for which it is acclimatised will also influence effectiveness. For some higher density species that are slow to loose moisture acclimatising may have little effect. Acclimatising does not negate the need to provide for floor expansion during periods of wet weather.

Laying

The moisture content, size and profile of the flooring should be checked prior to laying or a suppliers certificate should be provided for the material at the time of delivery. If the moisture content is not correct or the boards do not fit together properly, or are considered to have unacceptable defects, the installer should contact the supplier to resolve these issues before commencing laying. Similarly any board found during laying that has unacceptable defects should not be laid.

Flooring should be laid in straight and parallel lines. Butt joined boards should be cut to join over floor joists. Joins in adjacent boards should be staggered. End-matched joints in adjacent boards should not occur within the same span between joists.

It is essential that boards are in contact with the joists at the time of nailing, particularly when machine nailing is used as this type of nailing cannot be relied on to pull the board down to the joist. It is recommended that not more than 800 mm of flooring be cramped at any one time. The pressure used to cramp the boards together will differ from one floor to another depending on the moisture content of the flooring at installation, the air humidity and the average moisture content conditions for the location. As a general rule, cramping should be sufficient to just bring the edges of adjoining boards together.

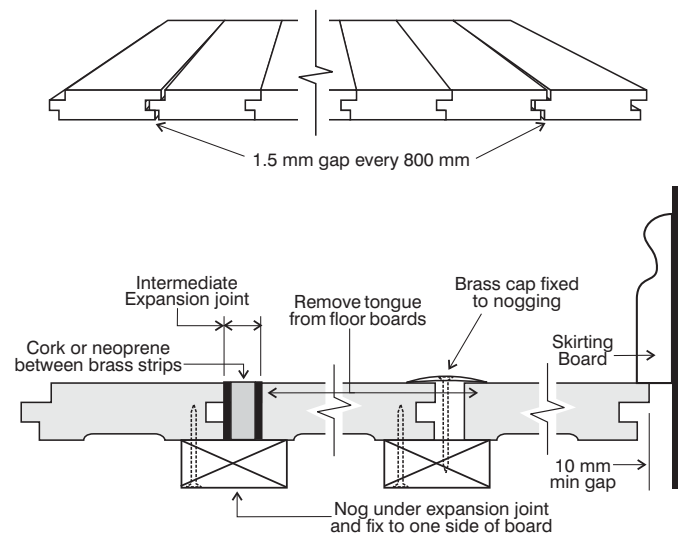


Figure 3 - Expansion gap details

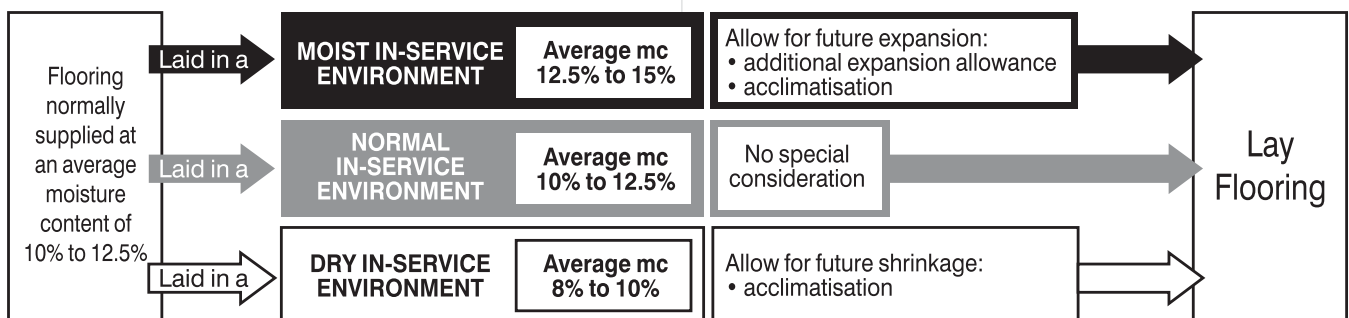


Figure 2 Pre-installation considerations

Allowance for expansion in floors

All fitted floors require a 10 mm expansion gap between the floor boards and any internal or external wall structures. Fitted and platform floors up to 6 m (measured at right angles to the run of boards) should not require intermediate expansion joints provided normal atmospheric conditions exist.

For fitted and platform floor widths over 6 m or where extra allowance for expansion is required (e.g. moist locations) an intermediate expansion joint, or a series of smaller expansion joints every 600 mm to 1000 mm should be provided. Refer to Figure 3 for details of expansion gaps.

Fixing of floors

Boards with cover widths of 65 mm or less should be top nailed with at least one nail at each joist. Boards with cover widths over 65 mm should be top nailed with two nails at each joist. Secret nailing with a single nail or staple per joist is suitable with uni-nail (secret nail) profile boards having nominal cover widths not greater than 85 mm.

For top nailing the recommended minimum nail sizes are shown in Table 3. The recommended minimum edge distance for nailing at butt joints or board ends is 12 mm. All nails including machine nails should be punched a minimum of 2 to 3 mm below the top surface. During fixing, the joint between floor boards and the top surface of floor joists should be checked to ensure that gaps are not present. If gaps are present, nails should be punched to draw boards tightly onto joists.

Table 3 - Minimum Recommended Nail Size

TYPE OF FIXING	FLOOR JOIST TIMBER	
	SOFTWOOD & LVL	HARDWOOD & CYPRESS
Top Nailed		
Hand driven	65 x 2.8 mm bullet head	50 x 2.8 mm bullet head
Machine driven	65 x 2.5 mm	50 x 2.5 mm
Secret Nailed		
Hand driven	50 x 2.5 mm	45 x 2.5 mm
Machine driven	50 x 15 gauge staple	45 x 15 gauge staple

NOTES:

- (i) For fixing to other than solid timber joists refer to product manufacturers recommendations.
- (ii) Nails of smaller diameter and shorter length are not suitable for timber T & G floors and may affect the floor's performance (nail popping etc.).

Weather protection of platform floors

Where platform floor construction has been used, (**not recommended for polished feature floors**) the flooring will require protection from wetting by rain and wet trades. All flooring should be flood coated with a clear water repellent sealer. This coating requires replacement at four week intervals. Where extreme weather conditions or construction practices exist, additional coats should be applied.

Linseed oil is not a suitable protective coating for timber flooring as it provides limited protection against moisture ingress, it may not be compatible with the selected finish and it encourages mould growth. Covering a floor with plastic is also not recommended as heat build up and development of high humidity under the plastic may cause future problems with the floor.

Finishing

Punched nail holes should be filled with a rapid drying wood filler compatible with the floor finish. Fillers should not be used to fill gaps between boards as seasonal movement may squeeze filling out of gaps. Linseed oil based fillers are also not recommended.

Covered Floors

Timber floors which are to be overlaid with carpet, vinyl or other thin coverings should be lightly sanded. Floors which are located in wet areas require adequate moisture protection. The relevant building regulations and floor covering manufacturer's recommendations should be followed.

Feature Floors

The finishing of feature floors should be carried out by a professional floor sander and finishing contractor. Some finishes have the potential to bond board edges together at the tongue and groove joint. With seasonal moisture changes in the floor, this bonding or 'gluing effect' may produce a pattern across the floor where there are four or five tight boards followed by a large gap. In some instances the bonded joint is of sufficient strength that boards may split. It is therefore recommended that finishes and finish systems are used that do not promote gluing. Modified urethane and oil based finishes or finish systems containing a bond breaking sealer followed by polyurethane top coats are considered appropriate. Liming of timber floors requires specialist advice to ensure compatibility between the liming finish and the subsequent finish.

Further Information, refer to Timber Queensland Technical Data Sheet 21 - Timber Floor Finishes, which provides information on different coating systems.

Maintenance

Feature timber floors should be regularly cleaned using dry methods i.e. vacuuming and sweeping. Water based cleaners should only be used to clean isolated spots. Antistatic or oil mops are also an effective means of cleaning. Providing the floor finish is in good condition, damp mopping may be used on occasions. A cap full of methylated spirits assists in drying the floor quickly. Note that excessive moisture may damage the floor. For feature floors it is advisable to provide door mats at all entry points to remove dirt and grit from shoes. This will reduce abrasive damage to the floor and finishes and reduce maintenance costs. Before refinishing of feature floors, it is advisable to check the compatibility of proposed finishes with existing finishes.

References

QDPI - FOREST SERVICE, 1 OCTOBER 1991
"Technical Pamphlet No. 1 - Building Timbers, Properties and Recommendations for their Use in Queensland"

Safe Working

Working with timber produces dust particles. Protection of the eyes, nose and mouth when sanding, sawing and planing is highly recommended. Refer to tool manufacturers for safe working recommendations for particular items of equipment.

Disposal of Offcuts and Waste

For any treated timber, do not burn offcuts or sawdust. Preservative treated offcuts and sawdust should be disposed of by approved local authority methods.



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