

DRYING

New Zealand pine is one of the easiest wood species to dry. With appropriate drying equipment, it can be dried rapidly with little degrade. However, wood from close to the centre of the log (corewood) can tend to twist because of spiral grain. If the wood is correctly dried to, and installed at, the appropriate moisture content for the end use, it will be stable in use.

DRYING PROPERTIES

The properties of New Zealand pine that affect its drying can be summarised as follows.

The wood is predominantly sapwood of high moisture saturation (moisture content 100-220%, depending on the density), the heartwood having a much lower moisture content (about 40-50%).

The sapwood is highly permeable and, therefore, capable of drying rapidly. Heartwood, although less permeable, has a lower initial moisture content and drying takes slightly less time than for the sapwood. The high initial moisture content and rapid drying may cause difficulties where drying equipment has insufficient heating, airflow, or venting capacity.

New Zealand pine is harvested exclusively from plantations, and can vary from about 25 years to 35 years old when felled.

The wood is of moderate density. Wood from within the first 10 rings of growth (juvenile wood or corewood) presents a special warping problem as spiral grain can cause twist.

High-temperature drying and stack weighting of 500-1000 kg/m² of stack surface, should be used to reduce the distortion of this material.

As with most species, the sapwood is prone to infection by fungi. Anti-sapstain treatment is essential for short-term protection against stain and mould. The risk of infection by decay fungi during air drying, especially with large-section lumber or round produce, must be minimised. Kiln drying, if carried out very soon after sawing, will avoid the need for anti-sapstain treatment. Dry lumber will not be infected by stain and mould fungi, provided it is kept dry.

Water-borne preservatives are widely used to offset the low natural durability of New Zealand pine. Pressure preservation processes using copper-chrome-arsenate (CCA) preservatives, change the drying properties of the wood markedly, and re-drying after treatment is slower and more difficult, and gives a more variable final moisture content.

The performance of any

wood species used for the

manufacture of high

quality products is

greatly influenced by

moisture content.

It must be properly dried

or it will shrink & twist.

New Zealand pine is

no exception.



DRYING

KILN DRYING SUMMARY TABLE FOR 50 MM THICK LUMBER

	Low temperature kiln*	Conventional kiln	Accelerated conventional kiln	High temperature kiln
Temperature (°C)	40-60	70-80	80-100	120-140
Airflown (m/s)	1.5	3.0	4.5	5.0-8.0
Drying time	15 days	5 days	2.5 days	13-20 hours
Minimum final MC (%)	10-11	6	3	2
Capital cost/m ³ dried	low	high	medium	low
Typical annual production/dryer (m ³)	2,000	3,600	6,000	18,000
Operator skill	average	skilled	skilled	skilled
Maintenance requirements	low	high	high	medium
Sterilises lumber	no	yes	yes	yes
Conditioning period	generally not required	required (in kiln)	required (in kiln)	required (separate chamber)
Stack weighting to reduce distortion	no	possible	yes	yes

* Low temperature kiln includes heat pump dryers.

Example: accelerated conventional drying schedule for 50 mm thick New Zealand pine.

Operation	Kiln conditions	Time (hours)	Remarks
Heat up	90°C/90°C	4	Vents closed during heat up
Dry	90°C/60°C	36-48	Until target moisture content reached
Final steam	100°C/100°C	2-3	Vents closed (time on setting)
Fan reversals			At least three times

Total drying time 42-45 hours. Stack weights of 600 kg/m² should be used and left on during the cooling down period of at least 12 hours.

DRYING METHODS

A full range of drying methods can be used for New Zealand pine, from air drying to high-temperature kiln drying. These methods can be classified simply in terms of drying temperature.

- Ambient temperature drying – air drying and forced air drying.
- Low temperature dryers (up to 60C, usually 40-50°C) – heated forced-air dryers and low temperature kilns including most heat pump dryers (dehumidifiers).
- Conventional kilns (usually temperatures of 60-80°C for New Zealand pine).
- Accelerated conventional-temperature kilns operating at temperatures of 80-100°C.
- High temperature kilns (temperatures above 100°C, usually 120°C or higher).
- Vacuum drying, which is new to New Zealand, offers the potential of rapid drying and minimising discoloration of high quality lumber.

DRYING PRACTICES

Air drying – The lumber stacks should be at least 300 mm above the ground, separated by 300-400 mm, and aligned parallel to the prevailing wind to promote rapid drying. Fillets should be of uniform thickness between 19 and 25 mm, and evenly spaced and aligned.

Warping and surface checking are adequately controlled by good stacking, avoiding overhanging ends, and using stack covers.

Low-temperature drying – This includes heat pump dryers and dehumidifiers.

Preliminary air drying to 60% moisture content reduces the drying time, lessens the risk of moulds and fungal stains, and results in a more uniform final moisture content. An airflow of at least 1.5 m/s is required and for heat pump dryers the compressor size may need to be increased above that normally used to 0.5 kW/m³ of lumber to avoid prolonged drying times with lumber green off the saw. Stress relief is not possible with this drying method.

Conventional kiln drying – Design requirements associated with the higher operating temperatures of these dryers are an increase in the heat input rate, venting capacity and airflow, and airflow reversal capability. These features are necessary to avoid slow and uneven drying. An airflow of 3 m/s or higher is required. The recommended kiln schedules involve a single step with EMC of 8-9% for untreated lumber or for lumber treated by boron. Lumber preservative treated with CCA requires a multi-stepped schedule.

When final moisture contents are to be lower than 12%, final wet-bulb depressions of 15-20°C should be used during the later stages of drying.

At the end of drying, it is essential that the lumber be given an effective final steam conditioning to relieve drying stresses and reduce the moisture content variation within and between pieces. Steaming should be done at 5°C above the final dry-bulb setting, with maximum possible relative humidity. Steaming time should be four hours per 25 mm thickness.

Accelerated conventional-temperature drying – Structural and furniture grade lumber can be dried using these schedules. The permeability of New Zealand pine permits the use of higher temperatures and airflows to reduce drying time while maintaining quality. Successful drying can be achieved by:

- Heat up period 2-4 hours.
- Air flow at least 4.5 m/s.
- Final steam conditioning at 100°C, 100% relative humidity for 2 hours per 25 mm thickness.
- Stack weights 500 kg/m².

If surface checking occurs, a more mild multi-stepped schedule should be used.

High temperature drying – Most widths of 25 mm and 50 mm thick lumber can be dried at high temperature with extremely rapid drying rates.

High temperature drying of furniture grade lumber should not be undertaken on a day-to-day commercial basis unless a very high standard of kiln operation can be maintained. High temperature drying is not recommended for sawn squares or pressure-treated lumber, unless it is to be used for construction purposes where the increased incidence of surface and internal checking may not be important. Kiln construction must be of a high standard, with fan capacity sufficient to achieve a uniform airflow of at least 5 m/s through the load, and heating system sufficient to reach operating temperature in 2 hours and maintain the drying conditions thereafter. Increasing the air flow to 8 m/s will reduce drying times by a further 20%. A final period of steam conditioning is essential to relieve drying stress and reduce the variability of final moisture content.

For successful conditioning, the lumber must first be allowed to cool to below 100°C, but conditioning must be started within 12 hours of the finish of drying. It is important that fully saturated steam is used. Careful kiln stacking is essential and top weights of at least 500 kg/m² are recommended to control warping in the top layers. Weights of 1000 kg/m² are essential for drying lumber containing corewood. The weights should be left in place during conditioning and a 24-hour cooling period.

STORAGE & HANDLING

In common with most species of wood, dry New Zealand pine, especially at moisture contents below 15%, can rapidly pick up moisture on exposure to air. Exposure of dried lumber, in particular after kiln drying, must be minimised.

This means that:

- Kiln stacks must be defilleted within 24 hours of the finish of drying, then block-stacked, and stored under cover. Although it is possible to protect dried lumber by using tarpaulins, sheds are preferable as they are more effective in preventing rain wetting. They should be sufficiently air tight to minimise air exchange.
- If long storage periods are anticipated, individual packets of kiln-dried lumber should be wrapped in plastic. Careful handling of New Zealand pine lumber, especially during transport, will minimise damage. This means that:
 - High value lumber must always be protected either by covers or wrapping. Packets containing lumber of different lengths should be formed so that the short lengths are securely housed within the body of the packet.
 - Where wire strapping is used, protective corner shields should be used to prevent the wire cutting into the lumber.
 - Adequate support should be provided to the lumber packets to minimise any induced distortion or breakage.

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RADIATA CORRECTION FIGURES FOR ELECTRICAL MOISTURE METERS

Meter type	Type of wood & treatment	Meter reading (<i>calibrated for North American Douglas fir</i>)														
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Resistance	Untreated wood	10	11	12	12	13	14	15	16	17	18	19	20	21	22	23
	Boron-treated sapwood	9	10	11	11	12	12	13	13	14	15	16	16	17	18	19
	CCA-treated sapwood	–	–	10	11	12	12	13	14	14	15	16	17	18	19	19
Capacitance – Wagner 1600DF	Untreated wood	12	13	14	15	16	17	18	18	20	20	21	22	23	24	25



MOISTURE MEASUREMENT

There are two main methods to determine the moisture content of New Zealand pine lumber:

- The standard oven drying method.
- Use of electrical moisture meters.

The oven-drying method is quite accurate, provided the lumber has not been treated with organic solvents and is not highly resinous. One of the main disadvantages of this method is the length of time required for a result. Oven drying can be speeded up by using thin samples and a microwave oven.

In the range from approximately 6% moisture content to 24%, electrical resistance and capacitance moisture meters can be used. Most meters are calibrated for one species and must be corrected for other species and treatments.

The correction figures given here for treated and untreated New Zealand pine are for resistance meters which are calibrated to the following standard resistance relationship: 8% - 5,010 M, 12% - 180 M, 16% - 19M.

RECOMMENDED MOISTURE CONTENT FOR INTERIOR WOODWORK IN INTERMITTENTLY HEATED BUILDINGS

Country	Average mc (%)	Country	Average mc (%)
New Zealand	12	United States	
Australia	10	West Coast	11
Korea	8	Nevada/Utah	6
China	7	Gulf/Southeast	11
Japan – <i>excluding Hokaido</i>	10-11	Other states	8
Japan – <i>Hokaido</i>	13	Canada	
Malaysia/Singapore	12	Vancouver	8
(<i>air-conditioned building</i>)		Montreal	5
		Continental Europe	10
		United Kingdom	11

MOISTURE CONTENT TARGETS

There are two main drying situations:

- Final moisture content less than 19%, to minimise degrade from moulds and fungi, and provide some guarantee of stability for structural products.
- Final moisture content in the range 5-15% depending on the equilibrium moisture content (EMC) of the end use situation.

In drying to below 19%, either air or kiln drying can be used. However, the low final moisture contents (less than 15%) necessary for high-quality uses can be obtained only by kiln drying. The required final moisture content will depend on a number of factors, and appropriate standards should be consulted.