

HARDWOOD AND SOFTWOOD DRYING SCHEDULES

Eleven kiln-drying schedules that cover practically the entire range of hardwood and softwood lumber drying have been prepared by the U. S. Forest Products Laboratory, Madison, Wisconsin. These schedules are based on the moisture content of the stock in the kiln, which is the safest basis and the one assuring the most nearly uniform results. They are presented here in two series, Nos. 000, 00, and 0 for softwoods and Nos. 1 to 8 for hardwoods. The two series supplement each other, and taken together form eleven steps from the most severe to the mildest drying conditions recommended for general commercial practice. No. 000 of the softwood schedules is the most severe, and No. 8 of the hardwood schedules is the mildest.

Following the schedules are lists of hardwood and softwood species with an index of the schedules to be used in drying them. The schedules indicated for the softwoods are intended primarily for use in fast-circulation compartment kilns. For natural circulation kilns the same dry bulb temperature may be used but the initial relative humidities must be about 10 percent lower than the indicated values. The schedules indicated for the hardwood species are safe for drying lumber up to $6/4$ inch thick. For each inch over $6/4$ in thickness a schedule one step milder (numbered one higher) than that listed for the species should be used. The schedules to be followed in drying different thicknesses of softwood lumber are listed in the table. When it is necessary to dry in the same kiln run two or more kinds of lumber requiring different drying schedules, the mildest of the schedules required should be followed; for minimum degrade such mixing of stock should be avoided.

Perfect drying does not always result from merely following a schedule, no matter how closely temperature and humidity conditions are made to conform to those specified. The operator must be trained to watch the condition of the stock in the kiln and to apply the proper remedy immediately if things start to go wrong.

GENERAL SCHEDULE 000

The most severe softwood drying schedule

Moisture content of the stock at which the changes should be made; per cent				Dry bulb temp. in degrees F.	Wet bulb temp. in degrees F.	Relative humidity; per cent
Div. I	Div. II	Div. III	Div. IV			
45 or more	40 or more	35 or more	30 or more	180	173	85
40	35	30	25	190	161	50
20	16	13	13	200	150	30

Temperatures for vertical-grain flooring strips may be 10° F. higher than those in the schedule after the stock has dried down to a moisture content of 25 per cent.

GENERAL SCHEDULE 00

A medium softwood drying schedule

Moisture content of the stock at which the changes should be made; per cent				Dry bulb temp. in degrees F.	Wet bulb temp. in degrees F.	Relative humidity; per cent
Div. I	Div. II	Div. III	Div. IV			
45 or more	40 or more	35 or more	30 or more	160	154	85
40	35	30	25	170	144	50
20	16	13	13	180	135	30

GENERAL SCHEDULE 0

The mildest softwood drying schedule

Moisture content of the stock at which the changes should be made; per cent			Dry bulb temp. in degrees F.	Wet bulb temp. in degrees F.	Relative humidity; per cent
Div. I	Div. II	Div. III			
35 or more	30 or more	25 or more	135	128	80
30	25	20	150	126	50
20	16	13	165	132	40
15	12	10	175	130	30

INDEX OF GENERAL SCHEDULES FOR KILN DRYING SOFTWOOD LUMBER OF VARIOUS THICKNESSES

<i>Species of wood</i>	<i>Thickness</i>	<i>Schedule</i>	<i>Remarks</i>
Cedar, Port Orford	4/4 - 6/4	00 - III	
	7/4 - 9/4	00 - IV	
Cedar, western red	4/4 - 6/4	00 - IV	Wide, clear, no sinkers
	4/4 - 6/4	0 - III	Sinker stock
	7/4 - 9/4	00 - III	Free from sinkers
	7/4 - 9/4	0 - III	Sinker stock
	10/4 - 12/4	0 - III	
Cedar, northern white	4/4 - 6/4	00 - II	Flat grain
and southern white	7/4 - 9/4	00 - III	
	10/4 - 12/4	0 - II	
Cypress, southern	4/4 - 6/4	00 - I	
	7/4 - 9/4	00 - II	
	10/4 - 12/4	0 - I	
Douglas fir	3½ x 4½	00 - IV	Cross arms
	4/4 - 6/4	000 - IV	
	4/4 - 6/4	00 - IV	Wide, flat grain
	7/4 - 9/4	00 - IV	
	10/4 - 12/4	0 - III	
Fir, balsam	4/4 - 6/4	000 - I	Wide, flat grain
	7/4 - 9/4	000 - II	Wide, flat grain
	10/4 - 12/4	0 - I	
Fir, lowland white	4/4 - 6/4	000 - I	
	4/4 - 6/4	00 - I	Wide, flat grain
	7/4 - 9/4	000 - II	
	7/4 - 9/4	00 - II	Wide, flat grain
	10/4 - 12/4	0 - I	
Fir, noble	4/4 - 6/4	000 - III	
	4/4 - 6/4	00 - III	Wide, flat grain
	7/4 - 9/4	000 - IV	
	7/4 - 9/4	00 - IV	Wide, flat grain
	10/4 - 12/4	0 - III	
Fir, white	4/4 - 6/4	000 - I	
	4/4 - 6/4	00 - I	Wide, flat grain
	7/4 - 9/4	000 - II	
	7/4 - 9/4	00 - II	Wide, flat grain
	10/4 - 12/4	0 - I	
Hemlock, eastern	4/4 - 6/4	00 - I	

<i>Species of wood</i>	<i>Thickness</i>	<i>Schedule</i>	<i>Remarks</i>
Hemlock, eastern	7/4 - 9/4	00 - II	Wide, flat grain
	10/4 - 12/4	0 - I	
Hemlock, western	4/4 - 6/4	000 - I	
	7/4 - 9/4	000 - II	
	10/4 - 12/4	0 - I	
Larch, western	4/4 - 6/4	00 - II	Wide, flat grain
	7/4 - 9/4	00 - III	Wide, flat grain
	10/4 - 12/4	0 - II	
Pine, red	4/4 - 6/4	000 - II	
	7/4 - 9/4	000 - III	
	10/4 - 12/4	0 - II	
Pine, longleaf, shortleaf, and loblolly	4/4 - 6/4	000 - I	
	7/4 - 9/4	00 - I	
	10/4 - 12/4	0 - I	
Pine, ponderosa	4/4 - 6/4	000 - I	} Except stock subject to brown stain
	7/4 - 9/4	00 - I	
	10/4 - 12/4	0 - I	
Pine, northern white and western white	4/4 - 6/4	00 - II	Wide, flat grain
	7/4 - 9/4	00 - III	Wide, flat grain
	10/4 - 12/4	0 - II	
Redwood	4/4 - 6/4	00 - I	Free from sinker stock
	4/4 - 6/4	0 - I	Sinker stock
	7/4 - 9/4	00 - II	Free from sinker stock
	7/4 - 9/4	0 - II	Sinker stock
	10/4 - 12/4	0 - I	
Spruce, Englemann	4/4 - 6/4	00 - II	
	7/4 - 9/4	00 - III	
	10/4 - 12/4	0 - I	
Spruce, red	4/4 - 6/4	00 - III	
	7/4 - 9/4	00 - IV	
	10/4 - 12/4	0 - III	
Spruce, Sitka	4/4 - 6/4	000 - II	Wide, flat grain
	4/4 - 6/4	00 - II	
	7/4 - 9/4	000 - III	
	7/4 - 9/4	00 - III	
	10/4 - 12/4	0 - II	
Spruce, white	4/4 - 6/4	000 - III	Wide, flat grain
	4/4 - 6/4	00 - III	
	7/4 - 9/4	000 - IV	
	7/4 - 9/4	00 - IV	

<i>Species of wood</i>	<i>Thickness</i>	<i>Schedule</i>	<i>Remarks</i>
Spruce, white	10/4 - 12/4	0 - III	
Tamarack	4/4 - 6/4	00 - II	
	7/4 - 9/4	00 - III	
	10/4 - 12/4	0 - II	

The preceding softwood schedules are suitable primarily for the usual run of upper-grade stock. In lower-grade stock of some species, however, the knots are very likely to become loose or to break at the time of machining. These effects result from drying to a low moisture content at the low relative humidities that are used in the final stages of the schedules. Consequently special schedules are required for the most economical drying of such stock, and in a few cases have been formulated. Further information on special schedules may be obtained by addressing the Laboratory.

GENERAL HARDWOOD SCHEDULES 1 TO 4

Stock moisture content	SCHEDULE 1			SCHEDULE 2			SCHEDULE 3			SCHEDULE 4		
	Dry bulb temp.	Wet bulb temp.	Rel. hum %	Dry bulb temp.	Wet bulb temp.	Rel. hum %	Dry bulb temp.	Wet bulb temp.	Rel. hum %	Dry bulb temp.	Wet bulb temp.	Rel. hum %
45	140	132	80	135	128	80	130	123	80	125	118	80
40	145	135	75	140	130	75	135	126	75	130	121	75
30	150	137	70	145	133	70	140	128	70	135	123	70
25	155	136	60	150	132	60	145	128	60	140	123	60
20	160	135	50	155	131	50	150	127	50	145	122	50
15	165	127	35	160	124	35	155	124	40	150	120	40
10												
to												
Final	170	116	20	165	112	20	160	115	25	155	111	25

GENERAL HARDWOOD SCHEDULES 5 to 8

Stock moisture content	SCHEDULE 5			SCHEDULE 6			SCHEDULE 7			SCHEDULE 8		
	Dry bulb temp.	Wet bulb temp.	Rel. hum %	Dry bulb temp.	Wet bulb temp.	Rel. hum %	Dry bulb temp.	Wet bulb temp.	Rel. hum %	Dry bulb temp.	Wet bulb temp.	Rel. hum %
45	120	113	80	115	108	80	110	105	85	105	101	85
40	125	116	75	120	111	75	115	108	80	110	104	80
30	130	119	70	125	114	70	120	111	75	115	107	75
25	135	121	65	130	116	65	125	112	65	120	109	70
20	140	120	55	135	116	55	130	112	55	125	110	60
15	145	119	45	140	115	45	135	110	45	130	109	50
10												
to												
Final	150	112	30	145	108	30	140	108	35	135	107	40

INDEX OF GENERAL SCHEDULES FOR KILN DRYING HARDWOOD LUMBER

(Up to 6/4 inch in thickness)

<i>Species of wood</i>	<i>Schedule</i>	<i>Remarks</i>
Ash	2	
Basswood	1	
Beech	3	
Birch	1	
Boxwood	5	Squares or quartered stock only
Butternut	2	
Cherry, black	5	
Chestnut	2	
Cottonwood	2	
Elm	2	
Gum, red	2	See special schedule for sap gum on last page
Gum, black, and tupelo	3	
Hackberry	2	
Hickory	5	
Holly	4	
Hop-hornbeam (ironwood)	4	
Locust	5	
Magnolia	2	
Mahogany	4	
Maple, silver and sugar	3	
Oak, red and white	6	Northern highland stock
	7	Northern lowland stock
	7	Southern highland stock
	8	Southern lowland stock
Osage orange	5	
Persimmon	5	
Poplar, yellow	1	
Sycamore	5	
Walnut, black	5	
Willow	2	

SPECIAL SCHEDULE FOR KILN DRYING FLAT-SAWED SAP GUM

When the amount of red gum (heartwood) or of quartersawed sap gum in any kiln charge of gum is so small that it need not be considered, the following schedule is recommended. When this schedule is used for green stock the material should be steamed for four hours at 180° F. and at saturation before drying is started.

Moisture content at which changes should be made	Dry-bulb temperature	Wet-bulb temperature	Relative humidity
Per cent	° F	° F.	Per cent
45 or more	165	148	65
40	165	148	65
30	170	150	60
25	175	154	60
20	175	151	55
15	175	135	35
10 to final	175	125	25

SPECIAL SCHEDULE FOR KILN DRYING EASTERN RED CEDAR

Eastern red cedar, the juniper used for pencils and for cedar chests, is difficult to dry; care must be taken to prevent the shelling off of the streaks of sapwood that result from too steep a moisture gradient and from severe casehardening. The following schedule has been prepared for the drying of 1-inch boards of this species.

Moisture content of samples at which changes should be made	Dry-bulb temperature	Wet-bulb temperature	Relative humidity
Per cent	° F.	° F.	Per cent
25 or more	140	128	70
20	150	127	50
15	155	124	40
10 to final	160	115	25