Air Drying of Ponderosa Pine

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Introduction

Despite marked advances in the art of kiln drying and an increase in the number of dry kilns in use, air drying is and will continue to be an important process. Much lumber is air dried. Most hardwoods are air dried although they may be kiln dried eventually. Softwood lumber of the lower grades is customarily air dried.

Air drying and kiln drying have much in common in that both dry the lumber by exposing it to a mixture of air and water vapor. Here the similarity stops. In kiln drying, the temperature, relative humidity, and air circulation can be controlled. Consequently the rate of drying can be regulated, within limits, and the final moisture content can be pre-determined. In air drying the rate of drying depends on the weather conditions and the movement of the atmosphere in and out of the yard and the lumber piles. Wetting by rain or snow prolongs the period required to reach a certain moisture content. The final moisture content attainable in air drying depends on the atmospheric conditions prevailing at and just prior to the time the pile is taken down. This final moisture content is seldom suitable for exacting-use requirements, and this plus the relatively long drying periods are the chief shortcomings of air drying.

Research in Air Drying

Considerable research on air drying has been conducted in the past. This research was performed on hand-stacked piles ranging in width from 6 feet in some hardwood piles to 16 feet. Drying periods and degrade caused by drying defects were determined. In addition certain features that constitute good air-drying practice were established such as: a clean and well-drained yard; a yard layout providing spaces around the piles; a strong pile foundation to support the pile and to provide sufficient ground clearance; sufficient, dry, and well-aligned stickers; vertical flues or chimneys to permit the downward flow of air; a slope and pitch; and a protective roof. Years ago, some yard piles were built of stickered unit packages handled by several types of cranes. From 10 to 20 years ago, an event occurred that caused a revolution in air-drying practice. The event was the development of fork-lift trucks adapted to the piling and unpiling of lumber. At present fork-lift trucks are in wide use at sawmills, concentration yards, and consumer plants to build and take down yard piles, to load kiln trucks, to load and unload package-loaded kilns, and to load and unload green and finished lumber on and from trucks, trailers, and flat and gondola railroad cars. They are also used to transport lumber.

The changes in yard layout and in piling practices for air drying were so drastic that they invalidated much of the existing air-drying information. As a result the Forest Products Laboratory reactivated research in air drying in 1949. The objects of the research program were to find out the extent of the changes that had occurred, and their effect on air-drying rates and the development of drying defects such as checking, warping, and staining. The study of the air drying of ponderosa pine in Arizona was a part of this broad program.

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(1) Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

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Objects of the Study

Objects of the reactivated research were as follows:

1. To determine the drying periods required to air dry ponderosa pine to a moisture content of 10 percent for 4/4 and 8/4 Common, and 6/4 Shop piled during the four seasons of the year. The 4/4 lumber was piled both at Snowflake and at Flagstaff, the 8/4 at Snowflake, and the 6/4 Shop at Flagstaff.

2. To determine during what months of the year a moisture content of 10 percent could be attained.

3. To determine degrade caused by drying defects and to convert it into dollar loss.

4. To compare the losses in the production of air-dry 4/4 Common by air drying in 1-inch thicknesses or air drying in 2-inch thicknesses and then resawing.

5. To determine losses resulting from the lack of pile roofs.

6. To determine the effect of sticker thickness, 25/32 inch and 2 inches, on drying rate and loss in the air drying of 8/4 Common.

7. To determine losses during the planing of air-dry 4/4 Common.

Experimental Procedure

The study was performed on 79 thousand feet board measure of green ponderosa pine lumber. The lumber was 4/4 and 8/4 No. 3 Common and Better 12 inches wide and 6/4 Shop of random width. All of the lumber was graded green and made into stickered unit packages 4 feet wide and of varying height. Certain of the boards were used to prepare samples and 12 full-length boards of each unit package were treated as samples. The samples were studied intensively to yield information on initial and final moisture content, on drying rate, and on surface checking and end splitting.

The unit packages were built into piles with a fork-lift truck, 4/4 and 8/4 lumber at Snowflake and 4/4 and 6/4 lumber at Flagstaff (fig. 1). Piles were erected during June-July and October 1953 and January and May 1954. There were no May piles at Snowflake. Each pile contained three test unit packages. The piles were not roofed.

When the pile samples indicated that the moisture content had reached or was approaching 10 percent, the piles were taken down. The samples were tested for moisture content and the surface checks and end splits measured. The lumber was graded and where degrade occurred, the cause was recorded. In addition, the 4/4 lumber was graded after planing.

The Data

Climatological

Both Snowflake and Flagstaff are located in an arid region. Flagstaff is at an elevation of 6,900 feet, while Snowflake is several thousand feet lower. Snowflake is hotter and drier and has less rainfall than Flagstaff. Climatological conditions affect drying rate, the minimum moisture content attainable, and the development of drying defects. At both Snowflake and Flagstaff the months of May, June, and September are the periods of rapid drying and at Snowflake the month of April may be added. At Snowflake lumber can attain a moisture content of 10 percent during all months except January, July, and December; and at Flagstaff during all months except January, March, July, and December. The climatological data are shown in figures 2 and 3.

(3) Figures 1, 8, 9, 10, 11 and 12 not shown - due to space.

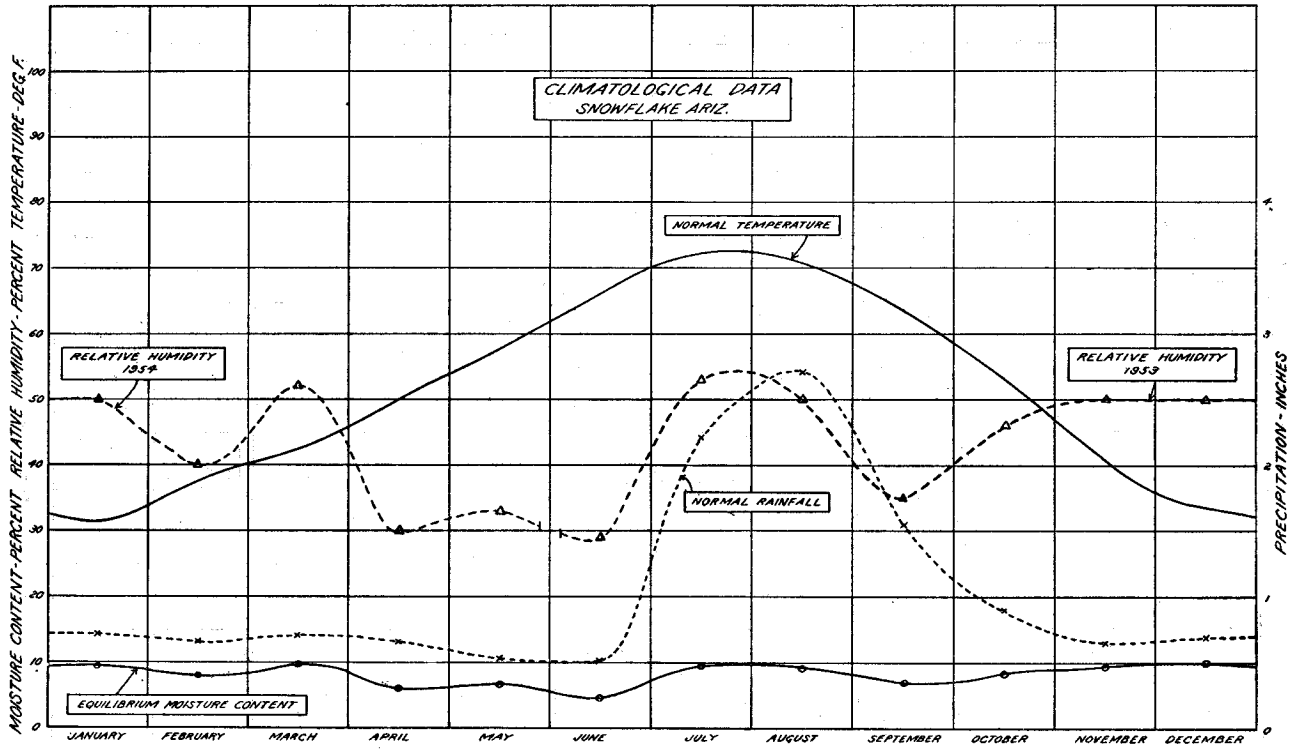

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Figure 2

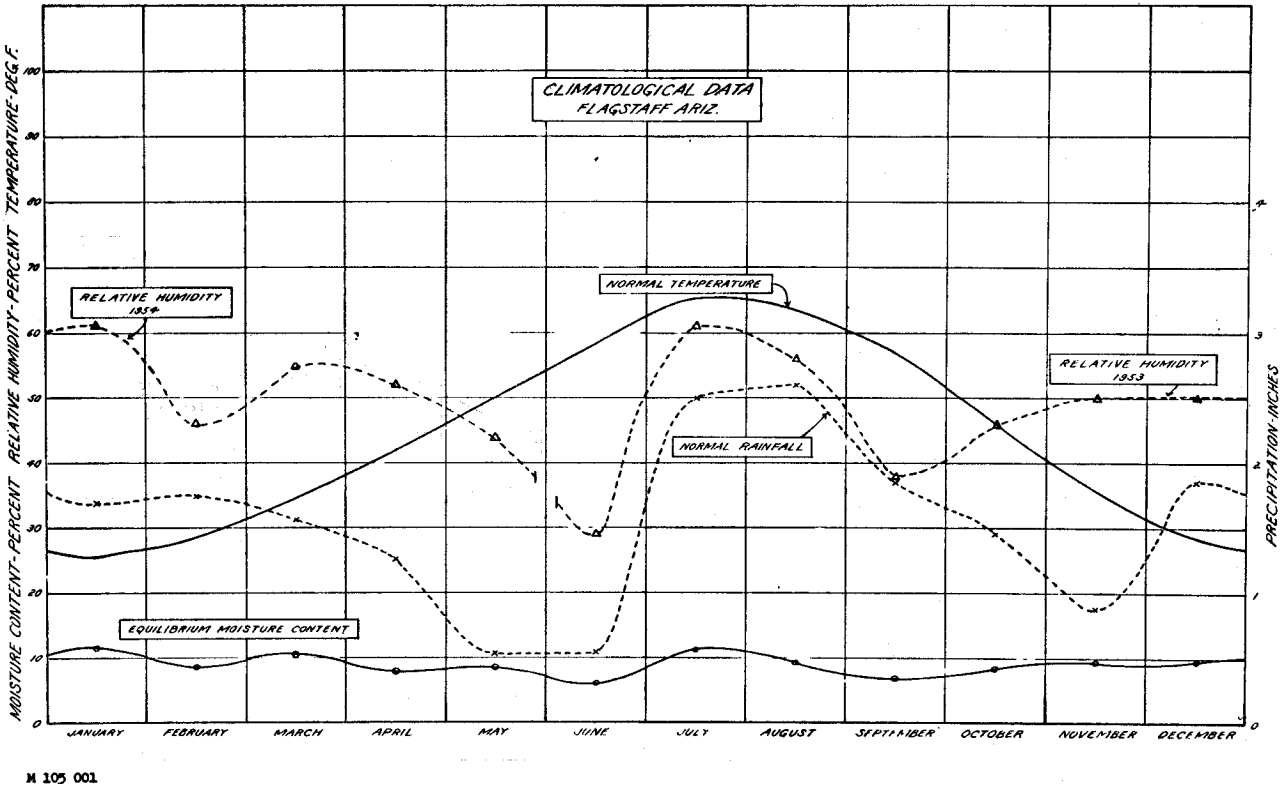

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Figure 3

Drying Periods

The number of days required to reach a moisture content of 10 percent varied with the thickness and character of the lumber and the time of year that the pile was erected. The 4/4 Common air dried in shorter periods than the 8/4 Common and the 6/4 Shop. The 6/4 Shop took longer to air dry than the 8/4 Common, chiefly because of the higher green moisture content. The green moisture content of the 8/4 Common was 52 percent, compared to 122 percent for the 6/4 Shop. The greatest variations in the drying periods were caused by the weather. The periods needed to reach a moisture content of 15 percent were shorter than those required to reach a moisture content of 10 percent, but were subject to the same sort of variation.

Figures 4 to 7 inclusive, show the number of days required to reach a moisture content of 10 percent for 4/4, 6/4, and 8/4 lumber in piles erected during each month of the year.

Figures 8 to 11 inclusive show the same data based on attaining a moisture content of 15 percent.

The periods in figures 4 to 11 inclusive are approximations and were derived by interpolating and extrapolating using the data for the test piles as bases.

Drying Defects and Degrade

Most of the degrade during air drying was caused by surface checking. This is particularly true with the 6/4 Shop and 8/4 Common. In the 4/4 Common warping and loose knots were also important. Table 1 gives the loss, in dollars per thousand feet board measure and in percentage of the green grade value, for each of the test piles.

The average losses per thousand feet board measure were: 4/4 Common, $2.82; 8/4 Common, $11.70; and 6/4 Shop, $13.88. In percent of green value the losses were: 4/4 Common, 3.1; 8/4 Common, 12.6; and 6/4 Shop, 9.8. The January piles suffered the heaviest and the June-July piles the lightest losses. The losses for the May piles erected at Flagstaff were less than those for the January piles but more than for the others.

The loss in value during the air drying of 8/4 Common was about four times greater than the loss in 4/4 Common. The average difference in loss per thousand was $8.88. If the lumber is to be resawed after air drying and sold as 4/4, it would probably be profitable to resaw the green 8/4 and air dry as 4/4. Not only is the degrade less in 4/4 than in 8/4, but it dries in a shorter period.

Losses Resulting from Lack of Pile Roofs

Where yard piles are not roofed, the top course of lumber is exposed to sunshine and wetting and the courses immediately below are exposed to wetting. Alternate drying and wetting cause checking and the growth of checks once they occur. Increased warping also occurs and staining where the water collects and remains under the stickers. The two top courses of each test pile were analyzed for degrade and loss of value after discounting the amount of degrade suffered by the pile as a whole. These data are given in table 2.

The average losses per pile for the three types of lumber were: 4/4, $1.15; 8/4, $5.36; and 6/4, $3.94. Generally, the losses were greatest in the January piles. The losses per pile form bases for solving the question of roofing on an economic basis. The losses for piles of 8/4 Common and 6/4 Shop indicate that it might prove profitable to roof such piles.

Where lumber is made into unit packages for air drying, and where there is a mixture of grades, the top courses of the unit packages should consist of relatively low-grade boards. Upper-grade boards in the upper courses of the

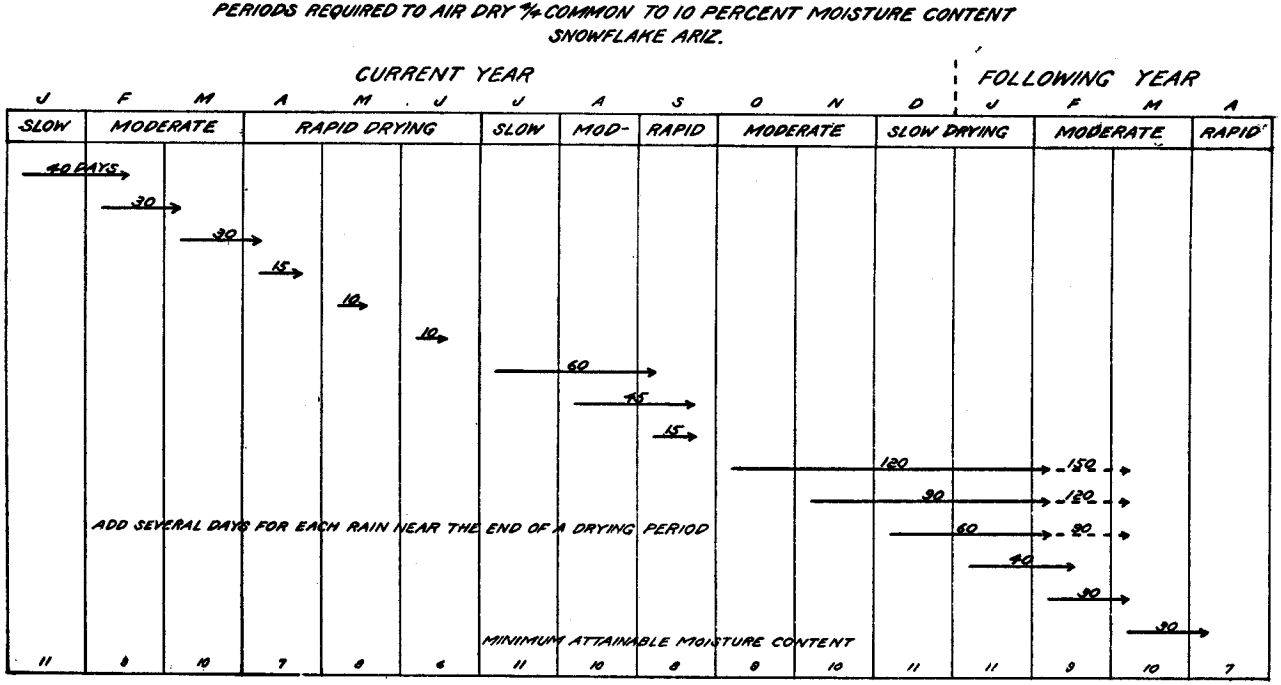

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Figure 4

PERIODS REQUIRED TO AIR DRY 4/4 COMMON TO 10 PERCENT MOISTURE CONTENT
FLAGSTAFF ARIZ.

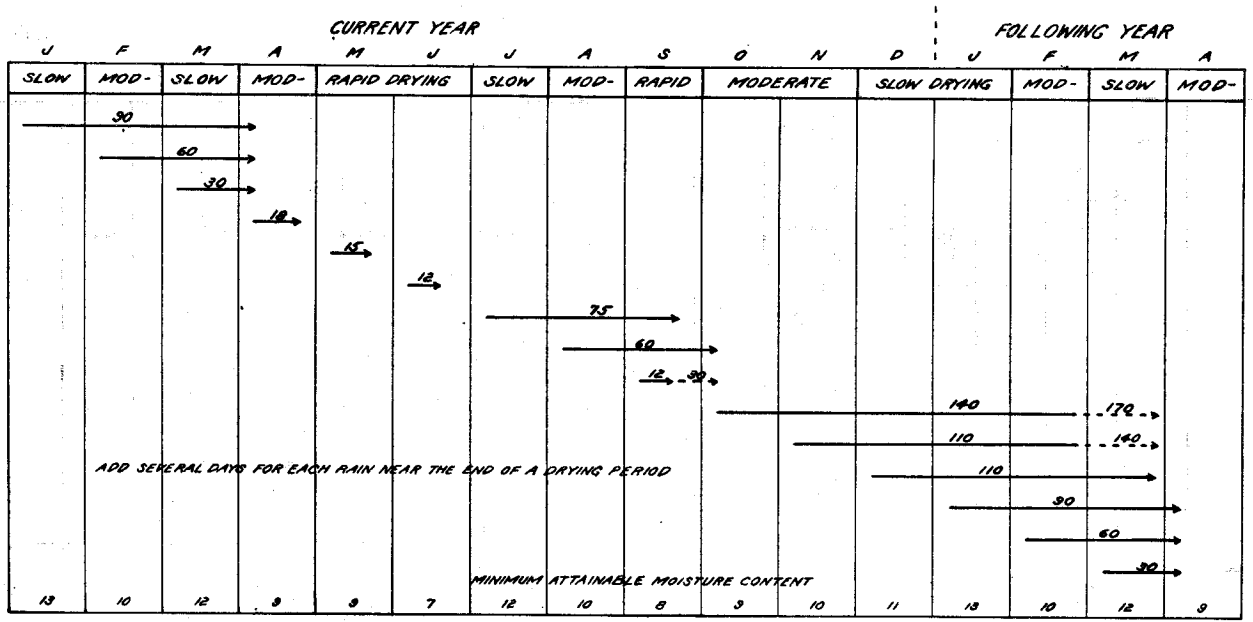

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Figure 5

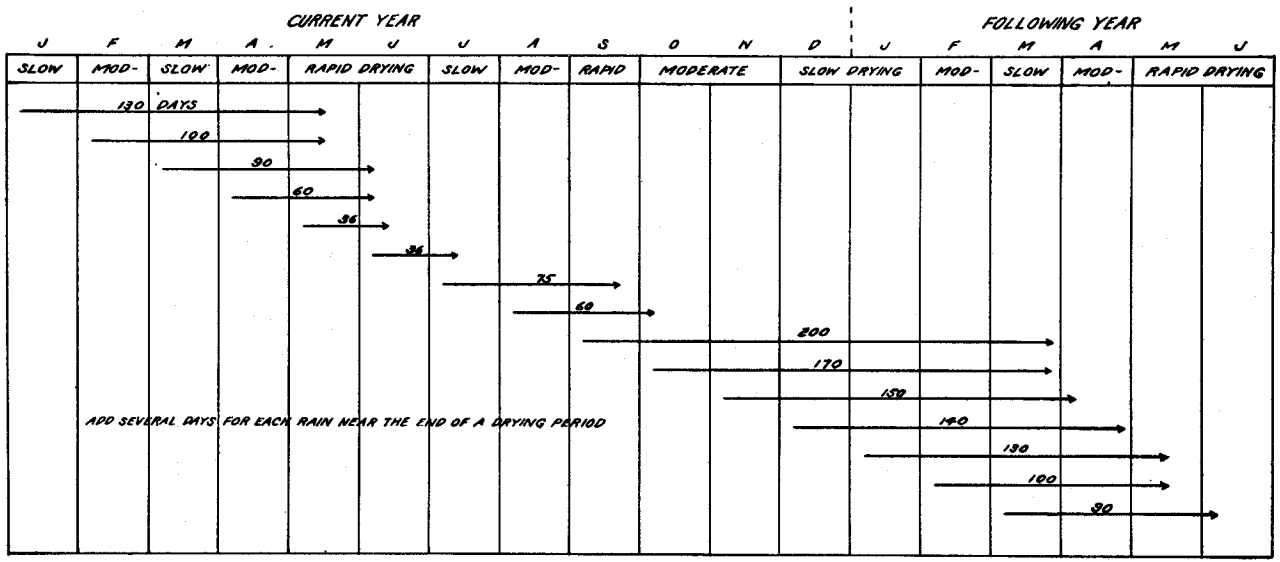
PERIODS REQUIRED TO AIR DRY ¾ SHOP TO 10 PERCENT MOISTURE CONTENT
FLAGSTAFF ARIZ.
CURRENT YEAR
FOLLOWING YEAR
J F M A M J J A S O N D J F M A M J
SLOW
MOD-
SLOW
MOD-
RAPID DRYING
SLOW
MOD-
RAPID
MODERATE
SLOW DRYING
MOD-
SLOW
MOD-
RAPID DRYING
130 DAYS
100
90
60
36
36
75
60
200
170
150
140
130
100
90
ADD SEVERAL DAYS FOR EACH RAIN NEAR THE END OF A DRYING PERIOD
M 105 133

Figure 6

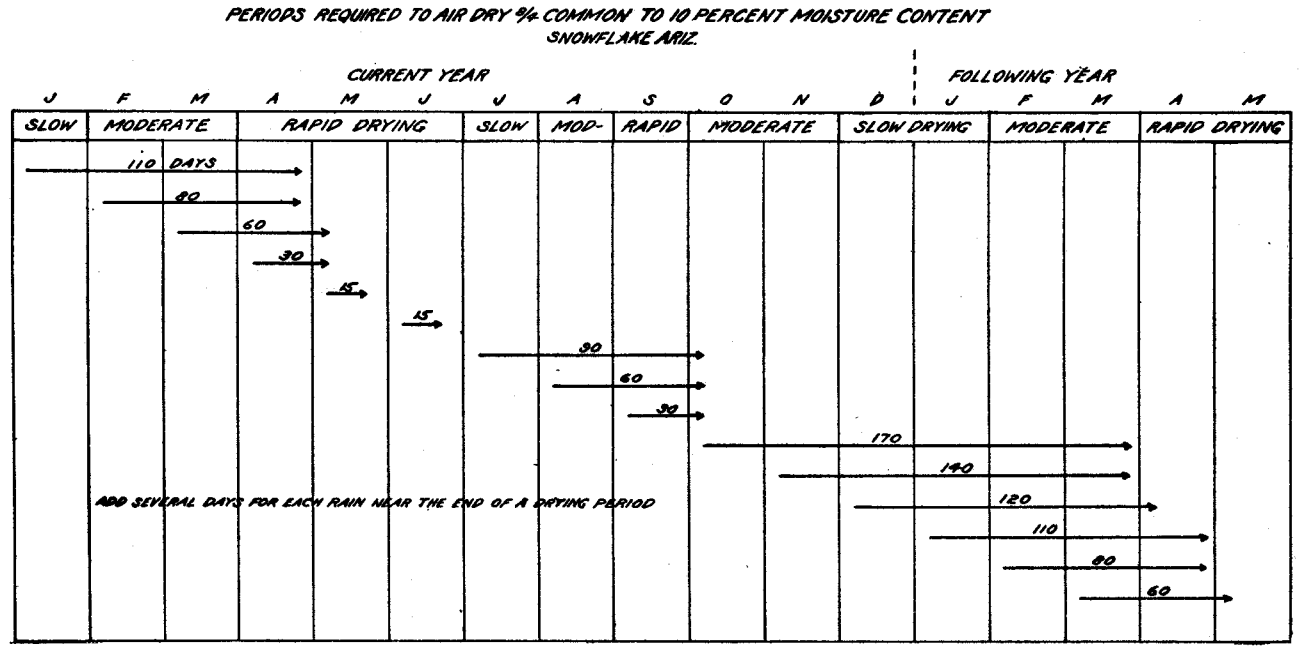

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Figure 7

top unit package of a pile invariably suffer severe degrade and considerable loss in value during air drying.

The Effect of Sticker Thickness In Air Drying 8/4 Common

The 8/4 lumber was piled with rough 2-inch and with dressed 25/32-inch stickers. Although the lumber in the piles with 2-inch stickers dried more rapidly than the others during the early stages, there was no appreciable difference in the periods required to reach 15 and 10 percent moisture content. The average loss in value per thousand feet board measure was $12.58 for the piles with 2-inch stickers and $10.81 for the piles with 25/32-inch stickers. The lesser loss and the ability to pile more lumber in a unit package of specified height result from the use of the thinner sticker.

Losses During Planing of 4/4 Common

The chief sources of degrade during planing are the knocking out or loosening of knots and planer splits. The lower the moisture content at the time of planing, the greater is the degrade. Table 3 gives the losses in value during planing, the corresponding losses during air drying, and the moisture content of the lumber at the time of planing. The average loss during planing, because of degrade, was $3.50 per thousand, compared with $2.09 during air drying. The greater average loss during planing was caused by the heavy losses in the January and May piles where lumber was at a moisture content of 10.1 and 10.6 percent at the time of planing. In the lumber of the other four piles, planed at moisture content values of 11.5 to 15.0 percent, the average loss, per thousand feet board measure, during planing was $1.77, and during air drying it was $1.72.

The moisture content at the time of planing has an enormous effect on the degrade and consequent loss in value. Lumber that was taken from the pile during a rain and snowstorm, so that the surfaces absorbed enough moisture to increase the average moisture content to 15 percent, suffered a loss of only $0.80 per thousand feet board measure during planing. Lumber from a pile with an average moisture content of 10.1 percent suffered a loss 12 times as great. Figure 12 shows the loss and the number of boards that were degraded because of loose or lost knots and splits during planing of the lumber from the piles at Flagstaff. Four-quarter Common, 12 inches wide, at a moisture content of 10 percent, cannot be planed without serious loosening and losing of knots and splitting. The splitting is caused by the inability of the dry-cupped boards to resist the flattening out between the rolls without failing. Wood at a higher moisture content can be deformed sufficiently to pass between the rolls without failing. The results of the study of degrade during planing confirm the practice of drying Common lumber only to about 13 percent moisture content for planing, or the practice of wetting the surfaces of overdry lumber before planing.

Summary

1. Four-quarter Common boards, piled in Arizona, can be air dried to 15 percent moisture content in 6 to 94 days; to 10 percent moisture content in 10 to 170 days.

2. Eight-quarter Common boards, piled in Arizona, can be air dried to 15 percent moisture content in 10 to 104 days; to 10 percent moisture content in 15 to 170 days.

3. Six-quarter Shop, piled in Arizona, can be air dried to 15 percent moisture content in 25 to 130 days; to 10 percent moisture content in 36 to 200 days.

4. Air drying defects, principally surface checks, cause degrade and loss in value. The average loss, per thousand feet board measure, was $2.82 for 4/4, $11.70 for 8/4, and $13.88 for 6/4 Shop.

5. The loss per pile, resulting from the lack of a pile roof, was $1.15 for

4/4, $5.36 for 8/4, and $3.94 for 6/4 Shop.

6. The average loss, per thousand, during the planing of 4/4 boards, was $3.50.

7. Four-quarter boards, planed at 10.1 percent moisture content, dropped in value $9.64 per thousand, compared to $0.80 for lumber planed at 15 percent moisture content.

Table 1.—**Loss in value because of air-drying defects in piles of ponderosa pine at Snowflake and Flagstaff, Ariz.**

Locality	Type of lumber	Loss							
		Per thousand board measure				Percent of green value			
		June July 1953	Oct. 1953	Jan. 1954	May 1954	June July 1953	Oct. 1953	Jan. 1954	May 1954
		$	$	$	$				
Snowflake	4/4 Common	2.03	1.77	7.23		2.4	1.7	7.5	
Flagstaff	4/4 Common	1.86	1.21	3.14	2.50	2.3	1.4	3.4	3.0
Do	6/4 Shop	5.29	7.77	26.09	16.37	4.0	6.3	16.6	12.2
Snowflake	8/4 Common (2" Stickers)	15.36	5.66	16.73		16.2	6.1	17.6	
Do	8/4 Common (25/32" stickers)	11.86	7.52	13.06		13.1	8.2	14.5	

Table 2.—**Loss of value in the two upper courses of ponderosa pine piles, erected at Snowflake and Flagstaff.**

Location	Thickness and grade	Loss							
		Value				Percent of green value			
		June July 1953	Oct. 1953	Jan. 1954	May 1954	June July 1953	Oct. 1953	Jan. 1954	May 1954
		$	$	$	$				
Snowflake	4/4 Common	1.78	(1) 0	2.83		16.0	(1) 0	23.9	
Flagstaff	4/4 Common	2.05	.82	.28	.32	19	6.9	2.7	3
Do	6/4 Shop	2.48	1.54	5.71	6.04	13.9	9.1	19	24.4
Snowflake	8/4 Common (2″ Stickers)	.25	3.11	4.27		1.1	10.5	16.8	
Do	8/4 Common (25/32″ stickers)	2.89	8.56	13.06		12.6	25.4	48.7	

(1) The degrade in the boards of the two upper courses was zero or less than that of the pile as a whole.

Table 3.—**Loss in value during planing of 4/4 Common ponderosa pine air dried at Snowflake and Flagstaff.**

Location	Loss in value(1)								Moisture Content when planed			
	Per thousand board measure				% of green value							
	June July 1953	Oct. 1953	Jan. 1954	May 1954	June July 1953	Oct. 1953	Jan. 1954	May 1954	June July 1953	Oct. 1953	Jan. 1954	May 1954
	$	$	$	$					%	%	%	%
Snowflake	1.92 (2.03)	3.12 (1.77)			2.2 (2.4)	3 (1.7)			11.5	13.5		
Flagstaff	1.25 (1.86)	(2).80 (1.21)	9.64 (3.14)	4.29 (2.50)	1.5 (2.3)	1 (1.4)	10.6 (3.4)	5.2 (3)	13	(2)15	10.1	10.6

(1) Values in parentheses are losses that occurred during air drying.

(2) This lumber was wetted by rain and snow when the pile was taken down.