

THE EFFECT OF PRE-STEAMING ON STAIN CONTROL
AND DRYING RATE OF REDWOOD

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INTRODUCTION

In 1951 the Research Committee of the C. R. A. , recognizing the deleterious effect of redwood seasoning stain, initiated research in this area (1)*. On the assumption that stain was caused by extractives, the distribution of water soluble extractives in and around stained areas in dry redwood lumber was first investigated (2). This substantiated the theory that stain was caused by extractives, and indicated that during drying, extractives migrated from areas where evaporation is impeded to areas where evaporation is more rapid.

Subsequently, studies were designed to evaluate the amount of extractives concentrated at the surface during air and kiln drying (3). Both chemical treatments (4) and white fir stickers (5) were evaluated for effectiveness in reducing sticker stain. A basic investigation of the processes underlying discoloration has been published (6). The effect of drying schedules and various pretreatments on the

* Numbers in parenthesis refer to Literature Cited at the end of this report.

occurrence of stain has been reported (7, 8) along with the distribution of extractives in solvent seasoned lumber (9). A pretreatment that appeared to be effective in reducing seasoning stain was steaming. This treatment simply involves steaming green lumber with saturated steam at 212° F. for 2 to 4 hours prior to air or kiln drying. Because of the initial success of this treatment in pilot tests at the University of California Forest Products Laboratory, a full scale field test was run by the Simpson Timber Company at their Korbel, California, plant. A steam chamber was built which could accommodate one full unit of lumber up to 18 feet in length. The procedure used for the entire study was reported, along with the results of the first ten series, at the 13th annual meeting of the Western Dry Kiln Clubs in Medford, Oregon, June 15-16, 1961 (10).

This report includes the results of test series 7-10, as well as the results of the remaining series in the study, and is complete except for the results of long-term exposure tests. The purpose of these test series was to evaluate the effect of presteaming green redwood lumber upon seasoning stain, lumber quality and drying rate.

The test schedule was planned by staff members of the Simpson Timber Company and the tests were conducted by L. W. Benjamin, their dry kiln Superintendent at Korbel. The Pacific Lumber Company, Scotia, contributed the use of their experimental kiln to dry one series.

PROCEDURE:

Clear and Aye sinker redwood was steamed up to 4 hours, solid piled up to 90 days, and either kiln dried green or air-dried before kiln-drying.

Each series consisted of a test unit of lumber and a matching control unit. Stock was prepared by resawing freshly cut 2" lumber, one board from each 2" piece being placed in the test unit and the other in the control unit. In series 7 through 18, and 24, the test unit only was steamed at 212° F. and 100% relative humidity. In series 21 and 22, both units were steamed. Drying rate data were collected for all series.

Series 7-18: Matching boards were placed in the same relative position in matching test and control units, which were placed next to each other in the yard and in the same dry kiln charge. After drying, the stock was surfaced and evaluated for frequency, severity and type of stain.

Series 21: The test unit was prepared so that the boards were free to move without restraint, other than their own weight, as they dried. The control unit was stickered in the normal manner.

Series 22: Five stickers per course were used in the test unit. A normal three stickers per course were used in the control unit.

Series 24: After steaming of the test unit, the stock was trucked to Scotia for drying in an experimental kiln. The test unit was immediately put into the kiln and dried on a schedule based upon the moisture content of sample boards. The control unit was stickered and wrapped in polyethylene for 24 days, until the test unit had been dried. It was then dried on the same moisture content schedule. Data on the occurrence of stain was not collected in this series. The variables included in each test series are presented in Table 1. (Series 1 through 6 and 19, 20 and 23 were not part of this study)

RESULTS

The specific results for each test appear in tabular or graphic form in the Appendix. In general, steaming before air or kiln drying was effective in reducing the amount and severity of stain. Four hours of steaming were more effective than two hours. Solid piling after sawing reduced the effectiveness of steaming and tended to cause a general increase in stain.

Board restraint imposed by stickers had no effect on distortion in the series tested.

Comparison of 3 vs. 5 stickers on distortion of steamed lumber showed that lumber stickered on 2-foot centers tended to distort considerably more than lumber stickered on 4-foot centers.

Kiln drying time for 4/4 green sinker stock was reduced from 32 to 24 days by steaming for two hours before drying. Air drying time was reduced by 30 to 60 days.

CONCLUSIONS

When green redwood is steamed for 2 to 4 hours prior to drying the following benefits may be gained: 1) the degrade due to extractive staining is reduced; 2) the quality of the grade is raised by lowering the frequency and severity of staining, in addition to the reduction in degrade; 3) drying times are reduced by approximately 25%. Points 1 and 3 are of predictable value and in the case of kiln drying of green lumber would result in a saving of about \$5.50/MBM after deducting the cost of steaming; in the case of air seasoning followed by kiln drying, the net saving would be about \$0.70. Additionally, the California Redwood Association has estimated that the increase in grade quality due to presteaming is worth \$2.00/MBM.

The problem of Board distortion due to thermal expansion has not been solved, but distorted boards do return to normal shape when stored in solid piles after drying.

APPENDIX

DISCUSSION OF TABLE II:

Because of the varying susceptibility of redwood to staining, it is difficult to compare one test series with another in a more than general way. Comparison of control boards within a given test series is entirely valid because of the careful matching of the material.

SERIES 7-12:

In this group of six tests, all kiln-dried green, the general comparative observations are:

1. The steamed material had (a) a greater percentage of unstained boards; (b) a substantially smaller percentage of boards downgraded because of stain.
2. The unsteamed material had (a) a smaller percentage of boards with sticker stain; and (b) fewer generally stained boards in the four tests which were solid piled prior to drying.

In both the steamed and unsteamed groups the per cent of unstained material decreased and the per cent downgraded increased as solid piling time increased. Also the amount of sticker stain decreased and the per cent of generally stained boards increased with solid piling time.

SERIES 13-18:

In this group of six tests, all air-dried prior to kiln drying, the general comparative observations are:

1. The steamed material had (a) less stain in all categories when solid piling was not a factor (tests 13-14); (b) a much smaller percentage of boards downgraded because of

stain when solid piling time did not exceed 45 days; and (c) a smaller percentage of boards with sticker stain.

2. The unsteamed material had (a) a smaller percentage of generally stained boards in the tests which were solid piled before drying; (b) a larger percentage of unstained boards in the tests which were solid piled before drying; and (c) less downgrade when solid piled for 90 days.

Solid piling reduces the per cent of unstained material and increases the per cent downgraded in both groups. It also appears that where solid piling followed by air drying before kiln drying is practiced, presteaming is not very effective in reducing stain; and if the solid piling time exceeds 45 days, presteaming will probably be detrimental.

To illustrate this further, each board in series 15 through 18 was evaluated for severity of stain, using a five point scale as follows:

- 0 - no stain
- 1 - very light stain
- 2 - light stain
- 3 - medium stain
- 4 - heavy stain

Based on this rating system, the average stain severity for each series was as follows:

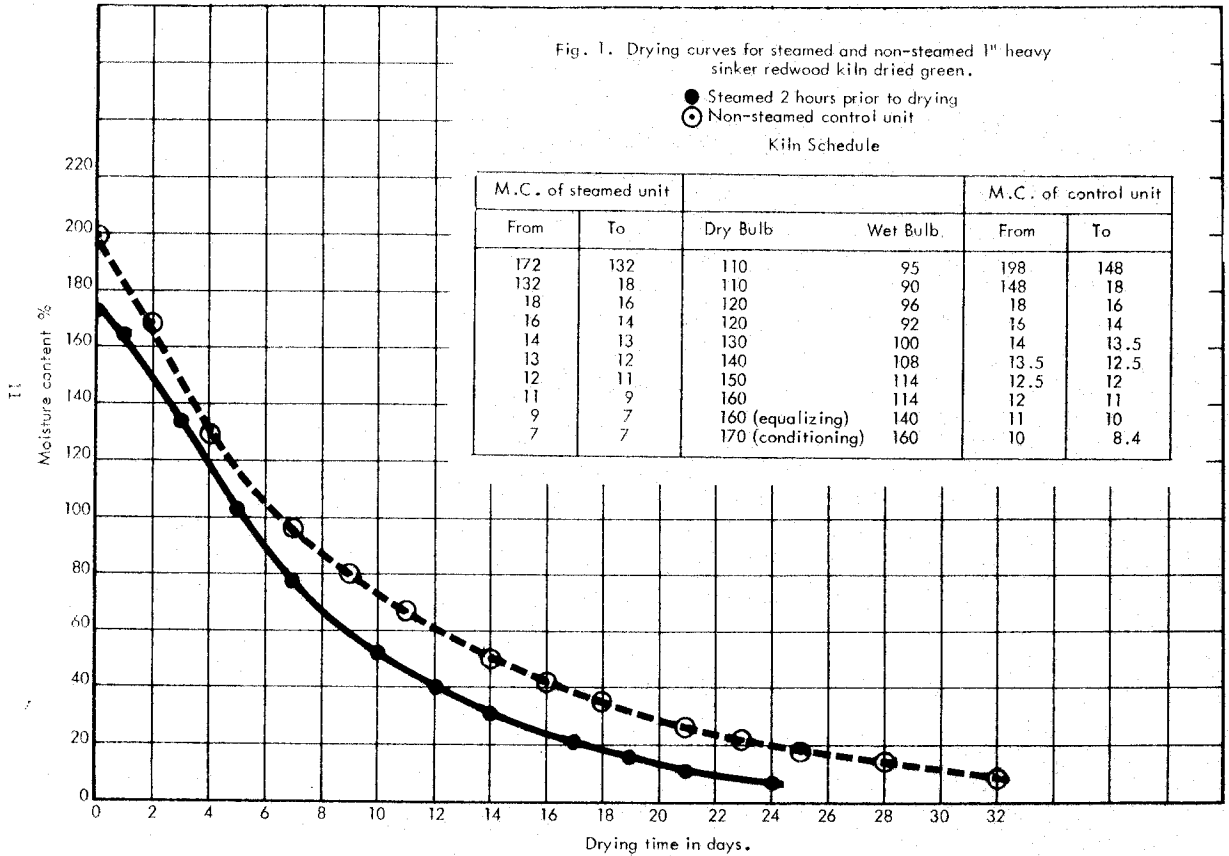
Series No.	Stain Rating	
	Control	Steamed
15	1.90	1.71
16	1.30	0.86
17	1.30	1.37
18	1.26	1.85

Because of the variability of the material, comparison between tests cannot be made, but analysis within a series is valid. In series 15 and 16 which were solid piled for 45 days, the steamed material is less severely stained than the controls; but in series 17 and 18, solid piled for 90 days, the reverse is true.

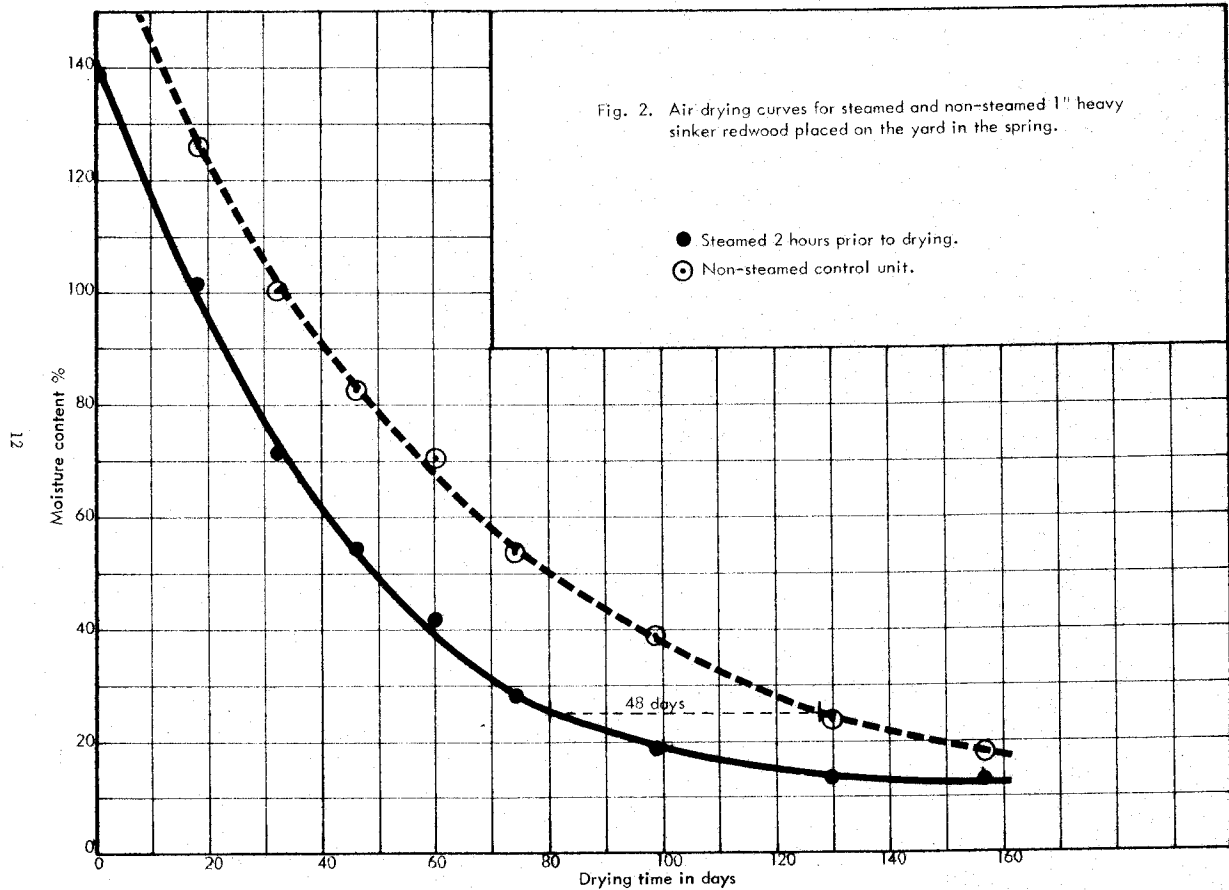
DRYING RATE:

Drying rate data collected on series 7-10 indicated that a savings in kiln time of approximately 3 days could be expected from presteaming 1" sinker redwood for as little as 2 hours. Since both steamed and control units were dried together with regular charges of 1" green sinker stock, it was apparent that the drying rate was controlled by the slowest drying material. Test series No. 24 (described earlier) was designed to learn the actual drying rate difference between steamed and non-steamed matched material dried separately, but using the same kiln schedule. The kiln schedule was based on the moisture content of sample boards. Since the moisture content dropped from an average of 204 to 172 per cent as a result of the two hour steaming period it might be argued that this accounts for the difference in drying time. Careful study of the kiln schedules and drying curves (Fig. 1) show that this is not the case. The initial change in kiln condition was made after a moisture gradient was established (3 days in each case). At this time, the control unit had an average moisture content of 148%, while the average for the steamed unit was 132%. The control unit made up this difference in less than one day, but then began to lose ground rapidly and required 8 more days than the steamed unit to reach 18 per cent. From this point on, the drying rate difference was less pronounced, but was still apparent even though the last 4 kiln changes prior to equalizing were made at slightly higher moisture contents for the control unit.

The final difference in drying time of 8 days is somewhat conservative, because the control unit was not dried to as low a final moisture content as the steamed unit; but even so, the difference

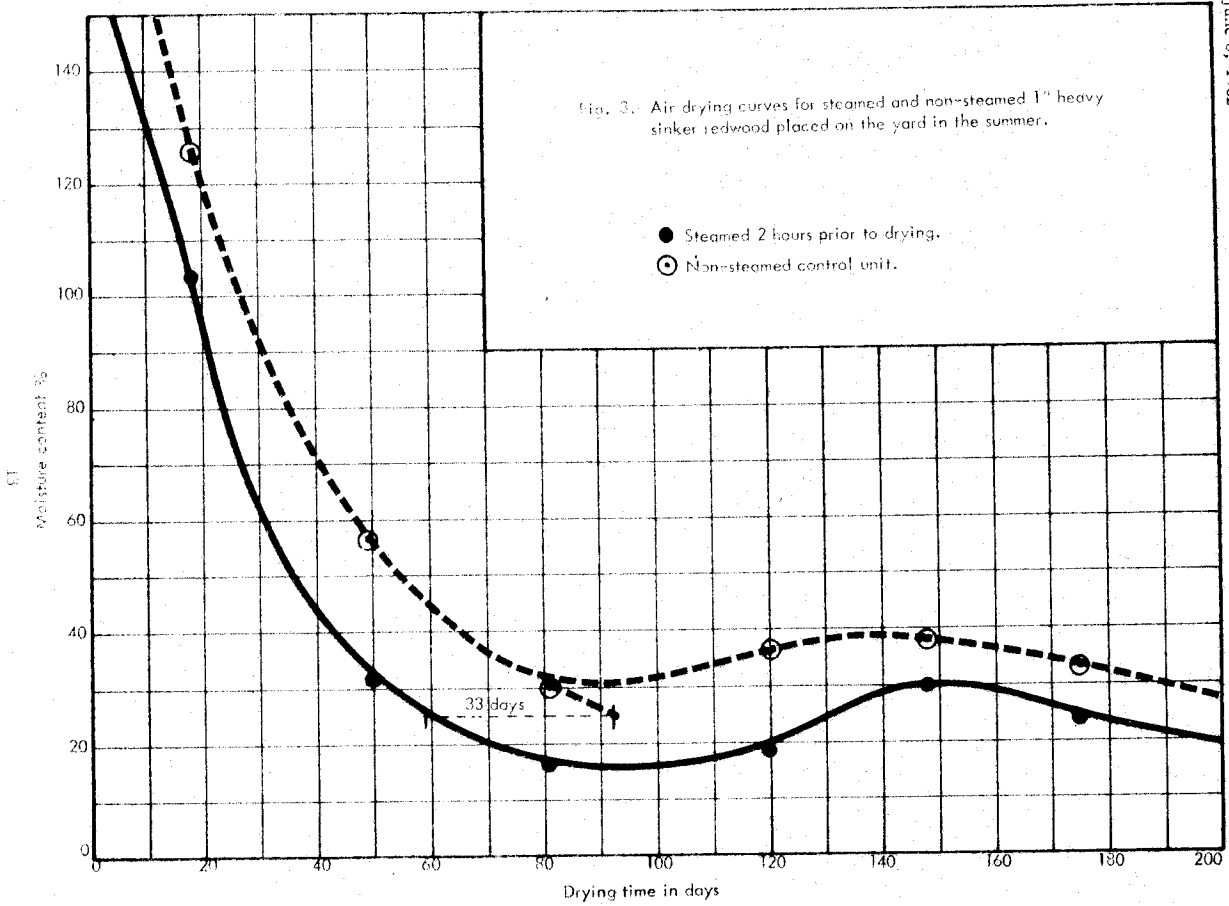


SERIES 14



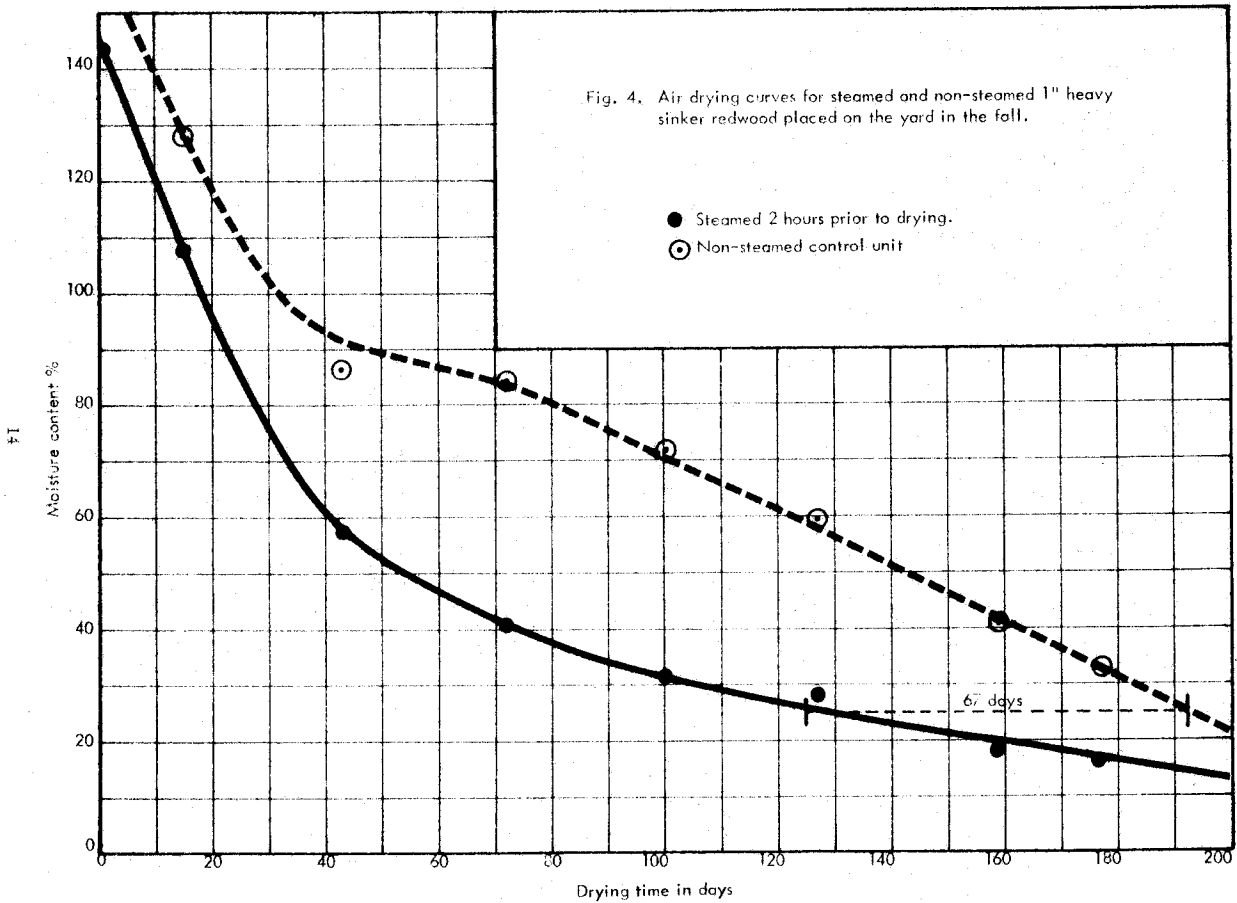
SERIES 15

Index No. 3,2420
June 6, 1962



SERIES 16

Index No. 3,2420
June 6, 1962

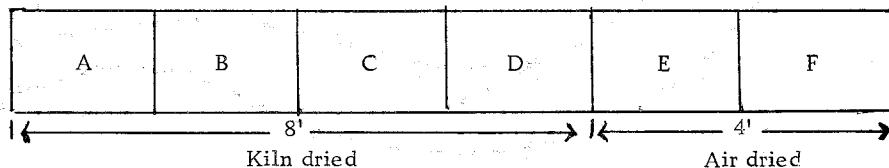


is spectacular and should make presteaming a worthwhile addition to the drying process, whatever its value as a stain reducing process.

With air drying too, the results are equally promising. Depending on the time of year when green stock is placed in the yard, and on the initial M. C., the savings in air drying time will vary from one to two months (Figs. 2, 4). This is based on air drying to 25 per cent moisture content. While steamed material dries faster than non-steamed material, it also tends to pick up moisture more rapidly once it is dried and when in the yard during the rainy season it loses some of its advantage (Fig. 4).

LONG-TERM EXPOSURE TESTS:

Short-term exposure tests to normal atmospheric conditions indicated that steamed boards remained lighter than matched controls. To further evaluate this and to determine the relative effect on subsequent staining of air drying plus kiln drying vs. air drying only, a long term exposure test was initiated in series 13-18. At the conclusion of air drying, five matched pairs of 12' boards were taken from each test series. An 8' section from each board was returned to the test unit from which it was taken, and kiln dried. Both sections of each board were cut into two-foot sections and distributed as shown:



- A Exposed on test fence at Cloverdale, California
- B Exposed on high humidity room (94% R.H.) at U. C. F. P. L.
- C Exposed on test fence at Richmond, California
- D Set aside for chemical analysis of extractive distribution
- E " " " " " " " "
- F Exposed on test fence at Richmond, California.

The samples set aside for chemical analysis of stain distribution were left rough. All other samples were surfaced just enough to clean one face, then planed to a 3/4" thickness on the reverse face. No results are available at this time.

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- Jack Mott - Kiln Assistant
- Delbert Kelly - Head grader, Korbelt
- Duke Register - Grade Superintendent

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TABLE 1
VARIABLES INVESTIGATED IN STUDY OF EFFECT OF
PRESTEAMING ON STAIN CONTROL AND DRYING RATE

Series	Duration of Steaming of Test Unit	Duration of Solid Piling Before Steaming	Drying Method
7	4 hours	None	Kiln drying
8	2 hours	None	Kiln drying
9	4 hours	45 days	Kiln drying
10	2 hours	45 days	Kiln drying
11	4 hours	90 days	Kiln drying
12	2 hours	90 days	Kiln drying
13	4 hours	None	Air seasoning kiln drying
14	2 hours	None	Air seasoning kiln drying
15	4 hours	45 days	Air seasoning kiln drying
16	2 hours	45 days	Air seasoning kiln drying
17	4 hours	90 days	Air seasoning kiln drying
18	2 hours	90 days	Air seasoning kiln drying
21	Test and control units steamed 4 hours	None	Air seasoning kiln drying
22	Test and control units steamed 4 hours	None	Air seasoning kiln drying
24	2 hours	None	Kiln drying

TABLE II
RESULTS OF PRESTEAMING ON STAIN CONTROL

Test Series Number	Time bulk piled	Time Steamed	Seasoning	Number of	Per cent of boards in each category				
					No stain	Sticker stain only	Stain occurring generally or in patches with or without sticker marks	Stain which down grades	
7	0	0 4 hrs.	Kiln Dried Green	332	43.7 60.0	15.6 25.5	33.5 13.9	7.2 0.6	
8	0	0 2 hrs.		350	35.2 28.2	10.8 42.5	43.8 25.9	10.2 3.4	
9	45 da.	0 4 hrs.		306	22.2 20.9	27.5 41.9	29.4 33.3	20.9 3.9	
10	45 da.	0 2 hrs.		338	17.2 18.9	26.0 37.9	30.2 32.0	26.6 11.2	
11	90 da.	0 4 hrs.		324	6.0 9.0	6.0 12.0	38.0 48.0	50.0 31.0	
12	90 da.	0 2 hrs.		322	14.0 15.0	6.0 8.0	50.0 53.0	30.0 24.0	
*13	0	0 4 hrs.		Air Yard and Dry Kilns	350	59.2 66.3	34.5 29.7	6.3 4.0	- -
*14	0	0 2 hrs.			316	55.6 66.7	35.1 24.8	8.6 8.5	0.6 -
**15	45 da.	0 4 hrs.	332		3.0 2.4	28.9 28.9	33.7 53.0	34.3 15.7	
**16	45 da.	0 2 hrs.	346		13.9 12.7	37.6 33.5	33.5 52.0	15.0 1.7	
**17	90 da.	0 4 hrs.	348		2.3 1.1	17.8 12.1	63.2 69.0	16.7 17.8	
**18	90 da.	0 2 hrs.	330		18.8 4.8	27.3 10.2	45.5 58.8	8.4 18.7	

* Examination conducted by Duke Register, S. T. C. Rwd. Div. Head Grading Inspector
All others conducted by Delbert Kelly S. T. C. Korbel Grading Inspector

** Examination conducted by close visual inspection (Hand grading procedure employed.)
All other examinations conducted by instantaneous inspection. (Non-stop chain grading procedure.)

TABLE III
EFFECT OF STICKER RESTRAINT* ON DISTORTION OF 1"
HEAVY SINKER REDWOOD STEAMED 4 HOURS PRIOR TO DRYING**.

Restrained	Type of Distortion***	Unrestrained No. of boards.
3	Crook	9
3	Bow	0
17	Snake	17
9	Cup	5
58	No distortion	59
<hr/> 90	Total No. of boards	<hr/> 90

* Restrained unit was stacked in conventional manner with stickers on four foot centers. Unrestrained unit was similarly stacked, but with spacers preventing stickers from bearing on the surface of lumber courses.

** Lumber was air dried for three months and then kiln dried for four weeks.

*** Evaluation of distortion made after surfacing.

TABLE IV
EFFECT OF STICKER SPACING ON DISTORTION OF 1" HEAVY
SINKER REDWOOD STEAMED 4 HOURS PRIOR TO DRYING.*

24" Sticker spacing	Type of Distortion**	48" Sticker spacing
19	Crook	16
45	Bow	2
25	Snake	5
1	Cup	2
90	No distortion	155
<hr/> 180	Total No. of boards	<hr/> 180

* Lumber was air dried for 2-1/2 months and then kiln dried for four weeks.

** Evaluation of distortion made after surfacing.