# A QUANTITATIVE INVESTIGATION OF TRIM LOSS CAUSED BY KILN DRYING

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## INTRODUCTION

This paper will present data collected from a study conducted at an interior mill in British Columbia, which produces kiln dried mix of spruce/pine/fir (SPF). The mill was experiencing high trim losses that were attributed to kiln degrade, and the title used reflects this presumption. The objective of the study was to quantify the impact of kiln drying on the trim loss and identify the process changes needed to prevent it. The total trim loss of the mill was known, records having been kept for many years. The name of the mill is withheld for commercial reasons.

## METHODS

To understand the causes - and quantify the costs - of trim loss due to drying degrade, we carried out an extensive trial with the goal of monitoring the condition of a large sample of the mill's production as it progressed through the normal mill processes.

To do so, we decided to establish the potential grade and yield of each individual piece of lumber in the sample in the green state, and its actual grade and trim after drying and planing. Three to seven percent of each of eight typical kiln charges of 150,000 board feet was selected, labelled, and graded on the green chain and each piece was tracked through the subsequent mill process. The total charge was stacked using normal 3/4 inch stickers, dried with the mill's conventional schedules, and graded again, noting trim and causes of degrade.

Every attempt was made to maintain the normal mill process unchanged, other than the added grading and marking stage. However, the additional data recording required a reduction by half in the usual rate of throughput during grading after planing.

### Scope and Lumber Mix

Eight tests were performed over a period of two months to evaluate the impact of kiln degrade on trim loss. These are shown in Table 1.

Table 1. Lumber measured in the eight tests.

| Test | Size (16' Long) | # Samples | Board Feet | Species |
|---|---|---|---|---|
| 1 | 2 x 4 | 475 | 5067 | spf |
| 2 | 2 x 4 | 475 | 5067 | spf |
| 3 | 2 x 6 | 320 | 5120 | spf |
| 4 | 2 x 6 | 317 | 5072 | spf |
| 5 | 2 x 8 | 375 | 8000 | spf |
| 6 | 2 x 8 | 400 | 8533 | spf |
| 7 | 2 x 10 | 375 | 10000 | spf |
| 8 | 2 x 10 | 375 | 10000 | spf |

## Green Grading and Natural Defects

Natural defects have a major impact on the grade of the green lumber, and they can be aggravated by kiln drying. Mills are taking a closer look at the state of their lumber before sending it to the kiln, to better adapt their drying schedules to the needs of the kiln loads.

The rough green lumber was graded according to NLGA grading rules. The grade of each board was marked on the end of the specimen, so that the sample and grade could be identified after planing.

The grades were for dimension lumber No.2 and better, No.3, Economy, and rejects. It was not always possible to judge accurately the extent of wane, shake, pitch, wormhole, white specks, decay or size of ends in the rough green lumber because the full extent of these defects were often revealed only when the specimens were planed.

In order to study specific trim loss carefully, one must define the initial grade of the material, and the defects that cause degrade. At this mill, the grader chose to designate the following natural defects: (1) shake, (2) compression wood, (3) loose knots, (4) checks, (5) grain distortion, (6) splits due to machining. These defects were noted for each specimen used in the testing procedure. Any machining defects were also noted.

## Drying

The lumber was stacked with 3/4 inch stickers. A computer-controlled, time- based kiln drying schedule was employed; the initial dry-bulb at 180°F and wet-bulb at 160°F, average air velocity 450 fpm, with fan reversal every four hours after initial start-up and six to seven hours before the end of the schedule. 2 x 4's and 2 x 6's were dried in 34 hours and 2 x 8's and 2 x 10's in 22-23 hours, dried to MC 16 percent. 2 x 4's and 2 x 6's, usually cut from sap wood, tended to have higher moisture content. The dry lumber was allowed to stand for a day or more before it was unstacked. It has been verified that there were no significant changes in drying practices for this trial.

## Planing and Final Grading

The kiln dried specimens were sent to the planer for dressing. After this process, the trim for each sample was specified, and the grade and any defects were noted. The planed lumber was graded by the same grader who had graded it in the rough green condition.

In tallying, a notation was made of the specific cause of degrade and trim. This information was used to compile the trim loss shown in Tables 2, 3, 4, and 5. The surfaced lumber was recorded by grade, and the volume trimmed from each specimen.

The surfaced lumber was graded according to NLGA grading rules. The dressed grade was marked on each piece of lumber, and the pieces which had not been trimmed adequately in the sawmill were pencil-trimmed by the grader. Natural defects, seasoning degrade and machining defects were noted. The natural defects were (1) wane, (2) slope of grain, (3) rot, (4) white specks, (5) compression wood. The seasoning defects noted were (1) seasoning splits, (2) end checks, (3) cup, (4) twist, (5) case hardening. The machining defects included (1) breakage, (2) damaged faces, (3) split knots, (4) rough grain due to planing, (5) knot holes.

Some of the specimens had been misgraded in the green condition. The grade of these samples was adjusted into the proper category as the green lumber grades contributed the base from which all grade recovery was calculated. For example, wane was treated as a natural defect in the final grading. The green grading assumed any wane which exceeded the permissible limits of the grade would be removed in planing. When the surfacing did not remove the excess wane, and when it was necessary to trim such lumber to retain the original grade, correction to the green grading was made to reflect the changes.

Table 6 summarizes the trim loss for the different dimension lumber and lists the mill's data for that specific period.

## TRIM LOSSES

### Summary

Tables 2, 3, 4, and 5 outline the trim losses for 2 x 4, 2 x 6, 2 x 8 and 2 x 10. Note that the data does not substantiate the initial premise that seasoning degrade accounted for most of the trim losses. Wane and warp contributed the largest amount of trim loss, i.e. for all dimensions. The maximum value of wane was observed in the 2 x 4 parcels with the minimum value for 2 x 10, perhaps reflecting their source within the log.

Table 2. Trim Loss Values for 2 x 4 (2 tests) SPF Lumber.

| Defect | Trim Loss (bdft) | % Trim Loss (based on total bdft 10134) |
|---|---|---|
| Wane | 608 | 6.0 |
| Skip | 303 | 3.0 |
| Warp (twist) | 102 | 1.0 |
| Knot (loose) | 10 | 0.10 |
| Grain Distortion | 71 | 0.71 |
| White Specks | 41 | 0.71 |
| Rot | 20 | 0.20 |
| Splits | 10 | 0.10 |
| TOTAL | 1165 | 11.82 |

Table 3. Trim Loss Values for 2 x 6 (2 tests) SPF Lumber.

| Defect | Trim Loss (bdft) | % Trim Loss (based on total bdft 10192) |
|---|---|---|
| Wane | 509 | 5 |
| Skip | 180 | 1.8 |
| Warp (twist bow, cup) | 176 | 1.7 |
| Knot (loose) | 31 | 0.31 |
| Grain Distortion | 2.0 | 0.02 |
| White Specks | - | - |
| Rot | 20 | 0.20 |
| Splits | 10 | 0.10 |
| Planer Offset | 3 | 0.03 |
| Break Skip | 51 | 0.5 |
| TOTAL | 983.3 | 9.66 |

## Degrade and Other Losses

Grade loss due to falldown was also calculated for the mill's information. The lumber values were based on the then current "random length" tables to evaluate the cost of degrade and trim. These results are outside the scope of this paper, but may be presented later after further data reduction and analysis.

Table 4. Trim Loss Values for 2 x 8 (2 tests) SPF Lumber.

| Defect | Trim Loss (bdft) | % Trim Loss (based on total bdft (16533) |
|---|---|---|
| Wane | 661 | 4 |
| Skip | 330 | 2 |
| Knot (loose) | 3 | 0.02 |
| White Specks | 3 | 0.02 |
| Grain Distortion | 31 | 0.19 |
| Bark Pocket | 4 | 0.03 |
| Warp | 16 | 0.10 |
| TOTAL | 1048 | 6.36 |

Table 5. Trim Loss Values for 2 x 10 (2 tests) SPF Lumber.

| Defect | Trim Loss (bdft) | % Trim Loss (based on total bdft (20000) |
|---|---|---|
| Wane | 600 | 3.0 |
| Skip | 400 | 2.0 |
| Warp | 100 | 1.0 |
| Loose Knots | 2 | 0.01 |
| Rot | 6 | 0.03 |
| White Specks | 2 | 0.01 |
| Bark Pocket | 4 | 0.02 |
| Surface Checks | 6 | 0.03 |
| Shake | 4 | 0.02 |
| TOTAL | 1124 | 6.12 |

Some degrade developed at the planer in the surfacing operation that could be attributed to kiln drying. These defects include planer splits, broken grain, and knot holes. Often these defects can be controlled by modifying the kiln schedules.

Other factors that reduce yield include inadequate quality control in the sawmill and breakage due to rough handling. Typical examples of the former are (1) pieces cut too thin, or too narrow to surface to the required final size. Since such pieces are not degraded by seasoning or surfacing, the resulting trim loss is treated as manufacturing defects. Elimination of such losses requires examination and improvement of the sawing operation. Mechanical damage, such as damaged faces and broken edges, can be minimized by well maintained equipment and care in handling.

Table 6.

| Type of Defect | Trim Loss (2 x 4) Ave 2 Test | Trim Loss (2 x 6) Ave 2 Test | Trim Loss (2 x 8) Ave 2 Test | Trim Loss (2 x 10) Ave 2 Test |
|---|---|---|---|---|
| Wane | 6 | 5 | 4 | 3 |
| Skip | 3.0 | 1.8 | 2 | 2.0 |
| Warp | 1.0 | 1.7 | .10 | 1.0 |
| Knot (loose) | .10 | .31 | .02 | .01 |
| Grain Distortion | .71 | .02 | .02 | - |
| White Specks | .71 | - | .19 | .01 |
| Splits (including surface check) | .10 | .10 | - | .03 |
| Rot | .20 | .20 | - | .03 |
| Planer Offset | - | 0.3 | - | - |
| Break | - | 0.5 | - | .02 |
| Bark Pocket | - | - | - | .02 |
| Shake | - | - | .03 | .02 |
| TOTAL | 11.82 | 9.66 | 6.36 | 6.12 |
| TRIM LOSS PRIOR TO TRIAL | 12.0 | 10.0 | 8.5 | 8.0 |

**Loss in Value Due to Trimming**

Trim loss due to seasoning defects was secondary to natural and machining defects. As indicated in Table 6, the major losses did not arise from inadequate seasoning practices, but degrade and trim due to wane. Note however, that the six percent loss in value calculated for wane in 2 x 4's, for example, may overstate the economic impact, as its elimination would probably reduce overall yield.

## CONCLUSION

This study was commissioned by the mill to quantify the trim losses because the initial assumptions were:

(1) Seasoning practices were inadequate;
(2) The potential existed for reducing overall trim losses; and
(3) Schedules could be modified to remove planer splits.

This trim loss analysis was carried out to quantify losses in value and to suggest where improvements in kiln drying could be made. Instead, the experiment pointed out that natural defects (wane) accounted for the major trim loss.

This study shows the importance of a systematic program of measuring important process variables at every stage of production, identifying the cause of variation and unsatisfactory performance prior to taking measures to correct suspected problems. In this way, scarce capital and management resources can be used effectively to improve product yield and quality.

Subsequent to this investigation, the mill is upgrading their optimizing equipment to address the actual cause of excessive trim loss, rather than the original anticipated kiln upgrade and schedule changes.