

## USE OF MC CONTROLLED SCHEDULES FOR QUALITY DRYING IN SOFTWOODS

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In this presentation, data from actual kiln runs will be shown. This data was given to us by companies which have been running MC controlled schedules for some time. I would like to take this opportunity to thank

Roseburg Forest Products  
Rosboro Lumber Company  
Malheur Lumber Company  
Bohemia Inc.

for their help to gather this data and, of course, for their permission to present this data to you at this meeting.

The data you will see, should demonstrate the feasibility of using a limited number of moisture measuring probes, which measure the moisture content of individual boards using the resistance method as basic information to apply a moisture content controlled schedule instead of a time controlled schedule.

During the course of this presentation we will test the performance of MC schedules in the area of

Final Moisture Content Distribution  
Drying time and  
Grade Recovery

in comparison with previously used TC schedules.

The following table outlines a brief description of the participating mills in regard to species, production, location and equipment being used.

Company	Species	Location	Production	Equipment
Roseburg FP	DF, SP, PP	Valley	144,000,000	Old Kilns, Steamheated
Rosboro	Hem, WF, PP	Valley	110,000,000	Old Kilns, Steamheated
Malheur	PP	E. Oregon	85,000,000	New Kilns, Steamheated
Bohemia	Hem, WF, PP, DF	California	55,000,000	New Kilns, Steamheated

All mills had in common that they wanted to improve on the utilization of a raw material which seems to be getting more and more scarce and expensive and had to respond to pressures from markets demanding improved quality like export and lam-stock markets.

These conditions of course have always been prevalent in the Hardwood Industry where the usage of MC controlled schedules has been the only way to dry lumber. The information about the Moisture Content of the wood was acquired by using the "Sample Board Method," where selected boards are gathered in the kiln operator on a daily basis and the MC of these boards was determined by weighing these samples consecutively.

This required that the kiln operator had to enter the kiln once a day, a procedure which is not easy for a kiln operator who is drying hardwoods and just

about impossible when softwood is being dried, because of the faster schedules and the higher temperatures applied.

So it is no wonder that the technique, whose application we are discussing today, has first found its entrance to the hardwood industry where today approximately 1000 kilns are equipped with kiln control systems to run MC controlled schedules and the MC information from the kiln is acquired with a probe system.

What is an MC Schedule?

Schedule #	5	Schedule type	MC
Date created	05/03/89	Operator	DAN
Species	CEDAR	Thickness	5/4
Species	2		

	EMC[%]	TEMP[F]	TIME[H]	EMC[%]	TEMP[F]
Heating up	18.0	100			
Warming through	18.0	100	12		
Drying	60%	16.0	100	55%	110
	50%	14.0	150	45%	125
	40%	12.0	132	35%	140
	30%	11.0	148	25%	155
	20%	9.0	160	15%	167
	10%	5.0	170	5%	170

The above screen shows an example of an MC schedule where the conditions in the kiln are changed depending on the decreasing average moisture content in the kiln. The operator enters the desired values in 5% decrements while the computer system, when running the kilns, interpolates linearly in between the moisture steps to create a stepless drying curve.

The average moisture content is calculated from selected moisture probes which are determined by the kiln operator from a total of up to 16 probe stations as shown in the following example.

Status for kiln # 1																	
Schedule #	5	Schedule type	MC														
Date loaded	06/12/90	Operator	DAN														
Species	CEDAR	Thickness	5/4														
Charge #	12345	Final MC[%]	8														
Heating up [H]	10	Warming through [H]	4														
Drying [H]	29	Conditioning[H]	0	Total [H]	43												
Probe	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Avg
Species	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Active	-	X	-	X	X	X	X	-	X	X	X	X	X	X	-	-	
MC [%]	36	57	34	45	64	53	68	23	45	49	50	53	52	54	79	80	54
Printed	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
desired A:active/inact.1      active/inact.2																	
EMC [%]	15.4	16.5 / 17.3															
TEMP[F]	111.0	100.2 / 92.6					100.1 / 94.6										
RPM [%]	100																

This screen shows the individual kiln status with all the important information from the kiln. The selected probes (active probes) result in an average moisture content of 54% which determines a desired value of 111 F for the temperature and an undesired EMC of 15.4% according to schedule 5 from above.

This example demonstrates the importance of an accurate measurement for the moisture content of the individual boards. Using the "resistance-type method", the resistance values have to be corrected for temperature and species in order to get a reliable reading for the actual moisture content. These two corrections are made in software by the microprocessor.

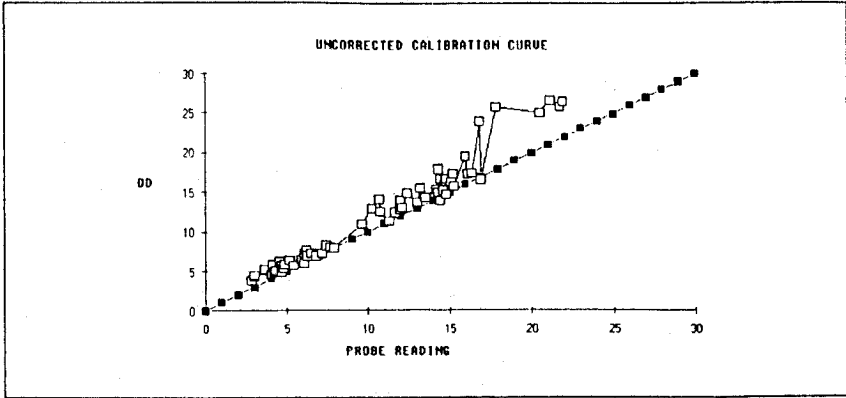


Figure 1

Figure 1 shows a series of data points before a correction of the calibration curve have been made. It can be seen that the readouts from the probe readings were too high.

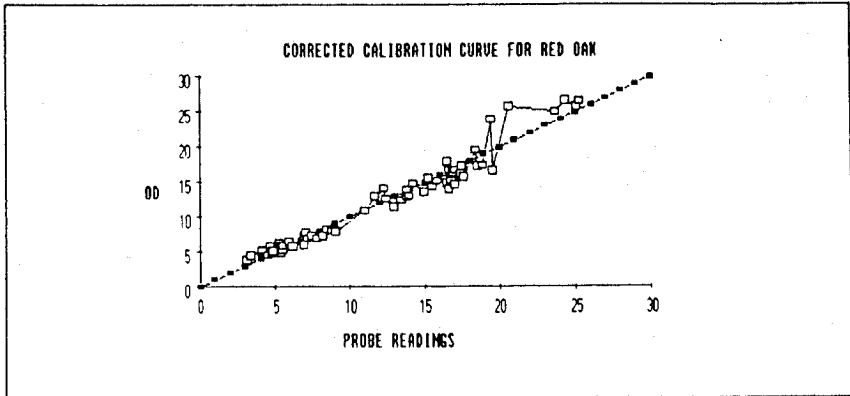


Figure 2

Figure 2 shows a series of data points after the correction for the calibration curve had been made. It can be seen now that the data points are closely distributed around the ideal "1 to 1" line.

The kiln charge we are discussing in this presentation consisted of one load of 7/4 ponderosa pine shop lumber and was run in one of the existing kilns at Roseburg Forest Products. The only change which was made to this kiln was that a new microprocessor-based kiln control system was installed which was able to run a moisture content controlled schedule, acquiring the MC information with probe stations using the resistance type method. Please note:

**No other changes were made to the Kiln Hardware**

The following graphic represents an actual recording of the kiln run to be looked at and was created with a unique datalogging system which allows the recording of up to 38 different variables from up to 64 kilns. It is meant to be not only a recording system since all the important data are available for further analysis in other programs. For example, spreadsheets for schedule optimization.

In addition to that, the complete kiln charge was checked with an in-line moisture meter after kiln drying to assure the correct final moisture content of the boards which was targeted at 8%-12%. This figure shows how the temperature is continuously ramped up and the EMC is continuously ramped down depending on the decreasing average MC and according to the MC schedule from above.

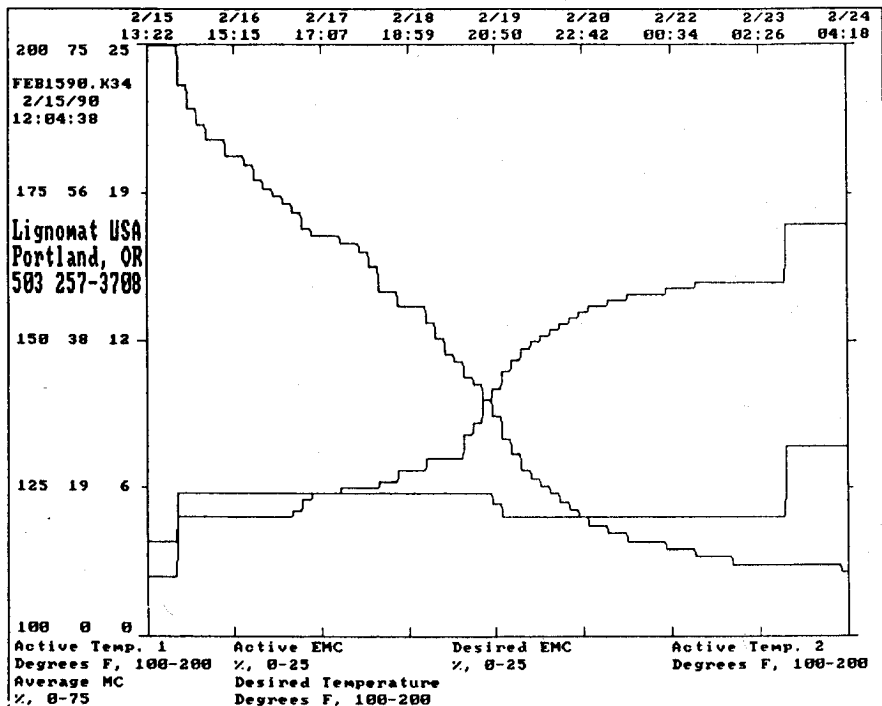


Figure 3

The next graph will show you how the 8 moisture probes which were used in the kiln come together at the end of the kiln run within a small range while they started out with a fairly wide range for the initial MC.

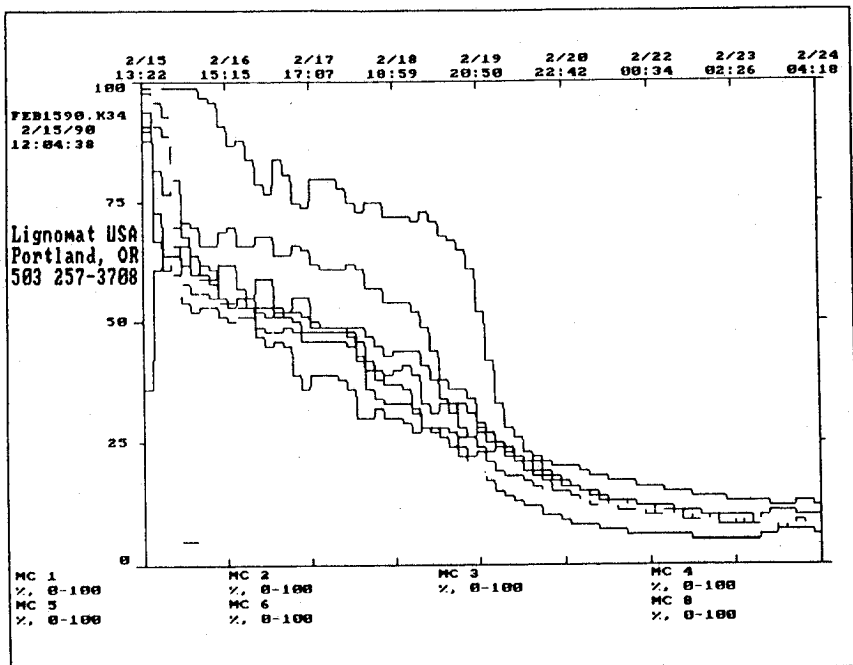


Figure 4

The lumber was considered to be dry when the probe readings were showing the following readings.

PROBES	1	2	3	4	5	6	7	8	AVERAGE
MC%	8	8	8	9	10	10	11	8	9

To confirm these readings, the kiln operator went into the kiln, and for each probe reading, took a total of 11 additional readings in the vicinity where each individual probe was located. The results of this test are shown in the following table.

PROBE	PROBE READINGS	MOISTURE METER READINGS IN VICINITY OF PROBES										
1	8	8	9	9	9	10	9	10	11	9	9	10
2	8	8	9	8	9	10	11	11	10	9	10	10
3	8	10	10	10	9	10	10	10	9	10	11	10
4	9	11	11	9	10	11	12	10	11	10	11	10
5	10	11	11	11	11	10	12	11	10	12	11	10
6	10	11	11	12	10	9	10	10	11	10	11	10
7	11	10	10	10	10	11	11	10	10	11	9	11
8	8	10	10	10	11	10	10	11	9	10	11	11

These results gave the kiln operator the confidence to unload the kiln, but, of course, the final test had to come from the in-line moisture meter where every single board is tested to see if its MC is within the desired target range.

The next table will show you the results coming from the in-line moisture meter.

MOISTURE RANGE	NUMBER OF BOARDS	PERCENTAGE WITHIN TARGET	MOISTURE RANGE	NUMBER OF BOARDS
< 6%	28	97.93	< 8%	2151
6% - 8%	2088		8% - 13%	4406
8% - 10%	3838		13% - 15%	100
10% - 12%	603		15% - 19%	10
12% - 14%	85		> 19%	-
14% - 16%	21		TOTAL	6667
16% - 18%	3		AVG MC %	8%
18% - 20%	1			
20% - 22%	-			
22% - 24%	-			
24% - 26%	-			
> 26 %	-			
TOTAL	6667			

This information is put in a graphical form and then looks as follows.

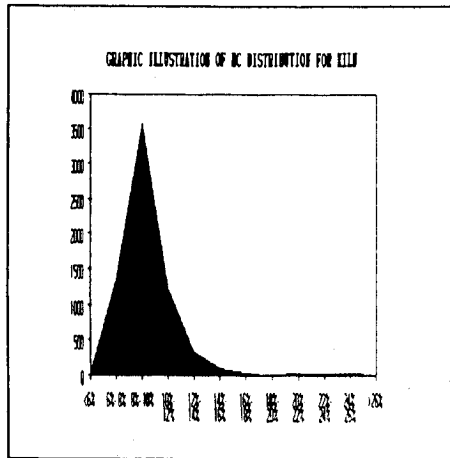


Figure 5

As a total we looked at 15 different kiln charges, all run with MC schedules, and the next chart will show the moisture content distribution of all boards for these kiln runs.

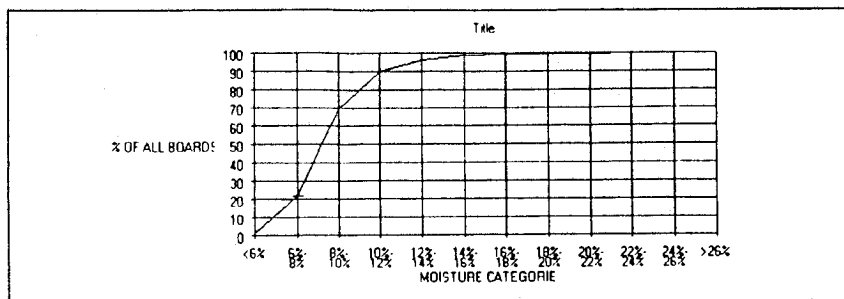


Figure 6 -- Cumulative curve for moisture content distribution for 15 kiln runs

These results show that with a total number of 8 probes it was possible to predict when the lumber was dried to a specific target moisture range and the boards as a whole were within this specified target MC when using MC schedules. This meant in this case for the customer a substantial decrease in lumber to be redried.

The next criterion we want to check the performance of when using MC schedules is drying time. Prolonged drying time of course improves final MC distribution as well as grade recovery while shorter drying time has a negative impact on these two criteria. Because of this interrelation it is an optimizing task to find an acceptable drying time which produces satisfactory results for both criteria.

In addition to that, drying times depend very much on other parameters like airflow, initial MC, general conditions of the kilns, etc. So the drying times shown on the following tables should be considered not as an absolute standard but just what could be achieved in this specific mill by just changing the control system to use MC controlled schedules.

#### Drying Time Improvements at Roseburg Forest Products

SPECIES	DRYING TIME TC SCHEDULES	DRYING TIME MC SCHEDULES	DECREASE IN PERCENT
4/4 PP COM	69	51.7	25
6/4 PP SEL	137.2	104	24
6/4 PP	251	204	18
8/4 PP	375	301	19
4/4 SP FLT	100.8	76.6	24
4/4 SP SK	190	150.9	20
8/8 SP SK	528	463	12
4/4 DF	83	55	33

**Drying Time Improvements at Rosboro Lumber Company**

SPECIES	DRYING TIME TC SCHEDULES	DRYING TIME MC SCHEDULES	DECREASE IN PERCENT
GENERAL LAM	(not available)	(not available)	24
HEM 2 X 10	(at customer request)	(at customer request)	39
DF LAM			32

These considerable improvements of the drying times were mainly the result of changing the setting for temperature and EMC on a continuous basis (24 hrs/day, 7 days/week) governed by the decreasing MC of the lumber in the kiln. We also found that using the knowledge of the initial MC of the lumber going into the kiln to adjust the setting of the schedule according to the initial MC which is done automatically made a major improvement to the drying time. When, in comparison, TC schedules were used, always the same schedules were applied regardless of the initial MC of the wood, which resulted in unnecessary prolonged drying times and sometimes overdrying of the lumber.

The last item we need to cover in this presentation is to show the impact on **grade recovery** by using MC controlled schedules. A study of this issue is being done now at Bohemia's Mill in Lincoln, California. At Malheur Lumber Company, where MC schedules have been used for more than 2 years, a grade recovery study showed an increase of 6% - 8% in #2 Common graded boards which previously had to be down graded to #3 Commons, mainly because the knots were falling out. In order to demonstrate to you the monetary significance of this result let me use a format which is used at Bohemia for grade recovery reports.

GRADE	FOOTAGE	RECOVERY	PRICE	VALUE
#3 CLEARS	250	.40 %	640.00	160.00
#1 SHOP	3,042	4.82 %	475.00	1,444.95
#2 SHOP	3,398	5.38 %	375.00	1,274.25
#2 COMMON	14,088	22.32 %	570.00	8,030.16
#3 COMMON	27,834	44.11 %	340.00	9,463.56
#4 COMMON	5,942	9.42	190.00	1,128.98
#5 & BETTER	798	1.26 %	110.00	87.78
SPECIALS	7,756	12.29 %	410.00	3,179.96
<b>TOTAL BFT.....63,108</b> <b>AVERAGE PRICE.....392.50</b> <b>TOTAL VALUE.....24,769.64</b>				

Please note the large price difference for the #2 Common and #3 Common grades.



If, as in the case of Malheur Lumber Company, an increase of 8% of #2 Common and a corresponding decrease of 8% in #3 Commons is realized, this table transforms into the following results.

GRADE	FOOTAGE	RECOVERY	PRICE	VALUE
#3 CLEARS	250	.40 %	640.00	160.00
#1 SHOP	3,042	4.82 %	475.00	1,444.95
#2 SHOP	3,398	5.38 %	375.00	1,274.25
#2 COMMON	19,134	30.32 %	570.00	10,906.50
#3 COMMON	22,788	36.11 %	340.00	7,748.02
#4 COMMON	5,942	9.42	190.00	1,128.98
#5 & BETTER	798	1.26 %	110.00	87.78
SPECIALS	7,756	12.29 %	410.00	3,179.96
<b>TOTAL BFT.....63,108</b> <b>AVERAGE PRICE.....410.89</b> <b>TOTAL VALUE....25,930.86</b>				

The value for this kiln charge has been increased by **US\$1161.22**. In the case of a similar hypothetical for the yearly production of 50,000,000 Bft/year this performance would generate an increased value of **US\$920,000** per year. This number is hypothetical, but it shows very drastically what tremendous impact grade recovery improvement has to the bottom line of a company.

### Conclusions

This presentation pointed out to you, by analyzing actual drying data from kiln runs where

- MC information has been acquired using a limited number of moisture probes
  - MC controlled schedules have been used to change the desired values for temperature and EMC depending on the decreasing average MC
- in the areas of
- Determining with a limited number of MC probes if lumber has dried to a specific MC target range MC
  - Distribution within this target MC range
  - Drying time
  - Grade recovery

considerable improvements can be achieved. This is especially significant in view of the fact that to the kilns in question only the kiln control systems had been changed to apply this technique.

These improvements meant for the different users a substantial advancement in their respective kiln drying operation and justified in a very short time the installation of this type of a kiln control system and subsequently changing from using time controlled schedules to using MC controlled schedules.