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**Follow-up on the Implementation of the 'Guidelines for
Heating up MPB Logs in Conventional Lumber Dry Kilns'**

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A handwritten signature in black ink, appearing to read "Luiz Oliveira".

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A handwritten signature in black ink, appearing to read "Peter Lister".

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Abstract

As requested by the Ministry of Forests and Range (MoF & R), FPInnovations – Forintek Division developed the guidelines for heating up mountain pine beetle (MPB) affected logs in conventional lumber dry kilns. As soon as the guidelines were implemented by mills throughout British Columbia, Forintek representatives visited fourteen operations to discuss process conditions indicated by the guidelines, monitoring schedule conditions, and to gather information regarding potential difficulties in applying any of the schedule conditions prescribed by the guidelines. In addition to the follow-up visits, two specifically designed workshops for MoF & R scalers and supervisors were carried out in Prince George (Feb 12th, 2008) and in Kamloops (Feb 15th, 2008).

In all the operations that were visited, kiln supervisors reported that the schedule conditions indicated by the guidelines were satisfactorily achieved. In some cases, especially for kilns not equipped with variable frequency drives (VFD), operators had to improvise air baffling systems or disable one of the shafts in a line-shaft kiln to obtain the required air velocity in the kiln. Thus, based on discussions with kiln operators and supervisors, observations of logs being unloaded immediately after the process ended, and discussions with scalers, it was clear the process of heating up MPB logs in kilns, according to the guidelines, did not produce or worsen existing checks observed before the process that is, there was no evidence that grade 2 logs were downgraded because of the process. In all cases, scalers reported that after kilning their ability to assess log quality accurately was substantially improved.

Based on the success of the results of the implementation of guidelines for heating up MPB logs in conventional kilns, it is recommended that the program be continued, without interruption, throughout the year. In addition, the following recommendations address the scientific aspect of the kilning of logs:

- Determine the kiln conditions under which checking would be created in green check-free logs
- Conduct a scientific study to prove that the present guidelines for re-drying logs in kilns do not create any risk of downgrading logs due to checking
- Conduct research to prove that green MPB logs and logs from other species do not downgrade due to re-drying according to the guidelines
- Carry out research to examine relationships between grading rules, actual log grades and the sawmill results (lumber and grade recovery)
- Establish maximum air velocities that can be used during the re-drying process

Acknowledgements

The authors would like to thank mill representatives for their time during the visits and the numerous discussions regarding the issues related to logs attacked by the mountain pine beetle (MPB) as well as to MoF & R representatives for their guidance throughout the project.

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1 Introduction

On January 14th, 2008, the Ministry of Forests and Range (MoF & R) issued a document outlining the decision for expanding the program related to heating up MPB logs in kilns throughout British Columbia until March 31st, 2008. The program had been previously approved for the districts of Quesnel and 100 Mile House on a trial basis and was being closely monitored by the regional offices of the MoF & R.

On-going discussions between the MoF & R and FPInnovations – Forintek Division, led to the development of **Information Sessions** which were designed to demonstrate the use of the guidelines for heating up MPB logs in conventional lumber dry kilns. The document was submitted to the MoF & R on January 22nd, 2008. Staff from FPInnovations – Forintek Division developed and delivered the material presented during the **Information Sessions** that were carried out at the following locations:

Date	Location
January 24 th , 2008	Williams Lake
January 29 th , 2008	Kelowna
January 30 th , 2008	Prince George

Representatives from the MoF & R estimated that about 150 people (industry and MoF & R representatives) attended the **Information Sessions**. Immediately upon the release of formal authorization to re-dry MPB in kilns, several mills started to use 'guidelines'. Initial feedback from operators was positive but, many operators expressed their interest in having FPInnovations visit mills to assist personnel on technical issues related to the implementation of the 'guidelines'. In view of the many different scenarios that presently exist such as age of logs, log sample sizes, initial wood temperature, outside temperature kiln sizes, type of kiln controller, type of energy system and level of existing initial checking, Forintek representatives would visit sites in different locations to discuss with kiln operators the selection of the most appropriate schedules based on the 'guidelines' for their specific situations. In doing so, the MoF & R and FPInnovations – Forintek Division would jointly offer the necessary assistance so that the implementation of the 'guidelines' could be properly and satisfactorily implemented throughout the industry in British Columbia. In addition, two workshops specifically designed for MoF & R representatives (scalars and supervisors) were carried out in Kamloops and Prince George.

2 Objectives

Project objectives were as follows:

- 1) Visit mills sites that were implementing the recommendations contained in the 'Guidelines for heating up MPB logs in conventional lumber dry kilns' and assist kiln operators in selecting heat up schedules suitable for their specific situations.
- 2) Discuss and clarify the information to be collected during the heating up of logs as well as suggest a standard schedule report to be presented to MoF & R representatives during their audit.
- 3) To gather information regarding technical difficulties, logistics and any other related issue to assist the MoF & R evaluate the program at the end of the present industrial experimental program schedule to end by March 31st, 2008.

3 Project Activities & Results

3.1 Weather Conditions – Impact on MPB Logs

3.1.1 The Year of 2007

According to the data collected by Environment Canada, the year of 2007 for the interior of British Columbia was considerably wetter when compared to 2006 and to the period 1971 – 2000. For Prince George, BC for example, the total rainfall precipitation for 2007 was 47% greater than the rainfall reported for 2006 and 4% greater than the average total precipitation for the period of 1971 – 2000 (Figure 1).

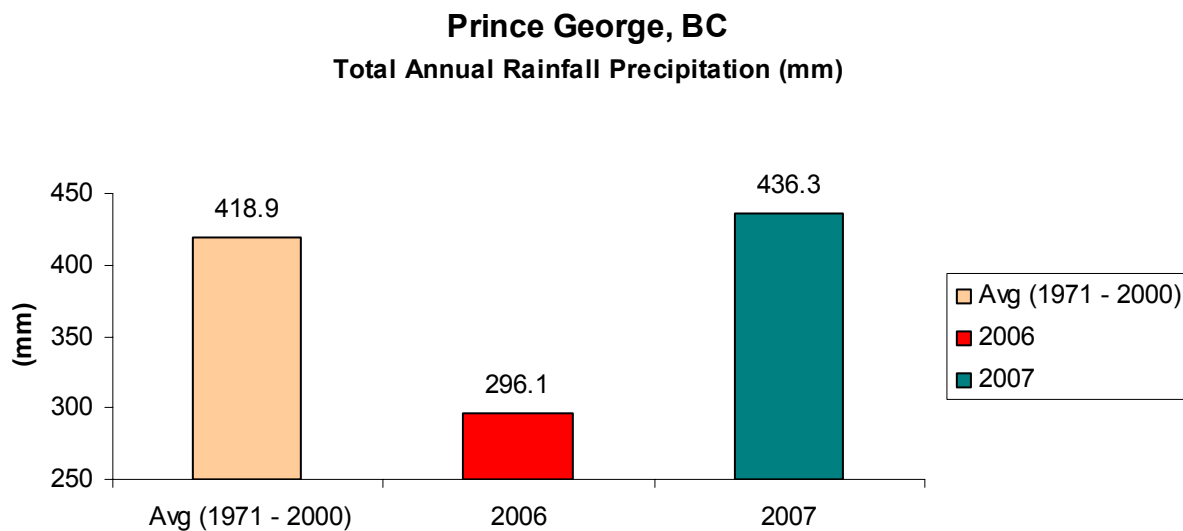


Figure 1 Rainfall precipitation for Prince George, BC

Figure 2 illustrates that except for the month of July, all other summer months in 2007 were wetter when compared to the same period in 2006.

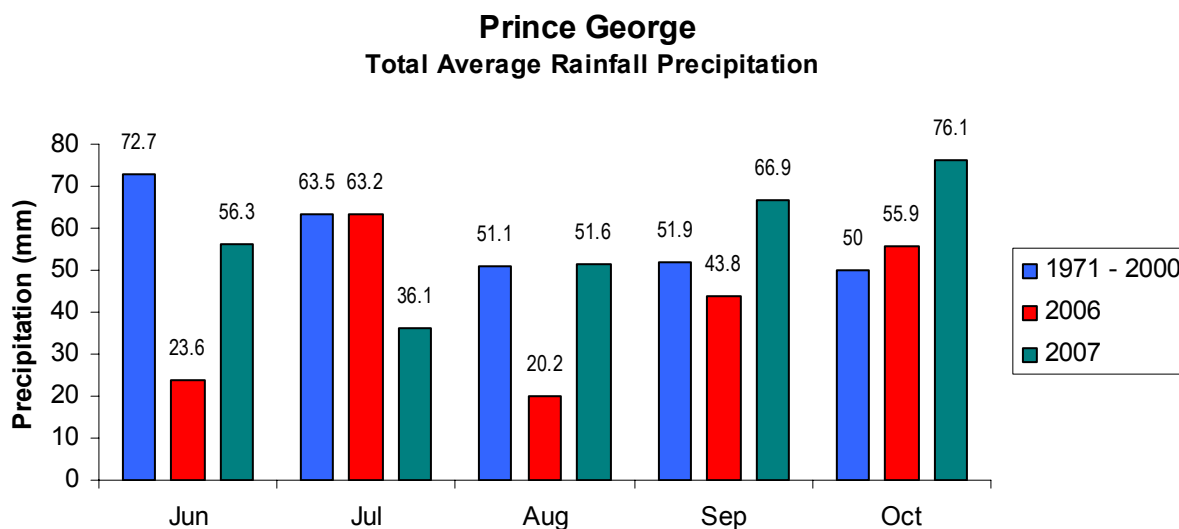


Figure 2 Rainfall during the summer months in 2007

For Williams Lake, BC, the total rainfall precipitation was also above normal. In relation to 2006, the amount of rain in 2007 was about 57% greater when compared to 2006 and 11% greater when compared to the period of 1971 – 2000 (Figure 3)

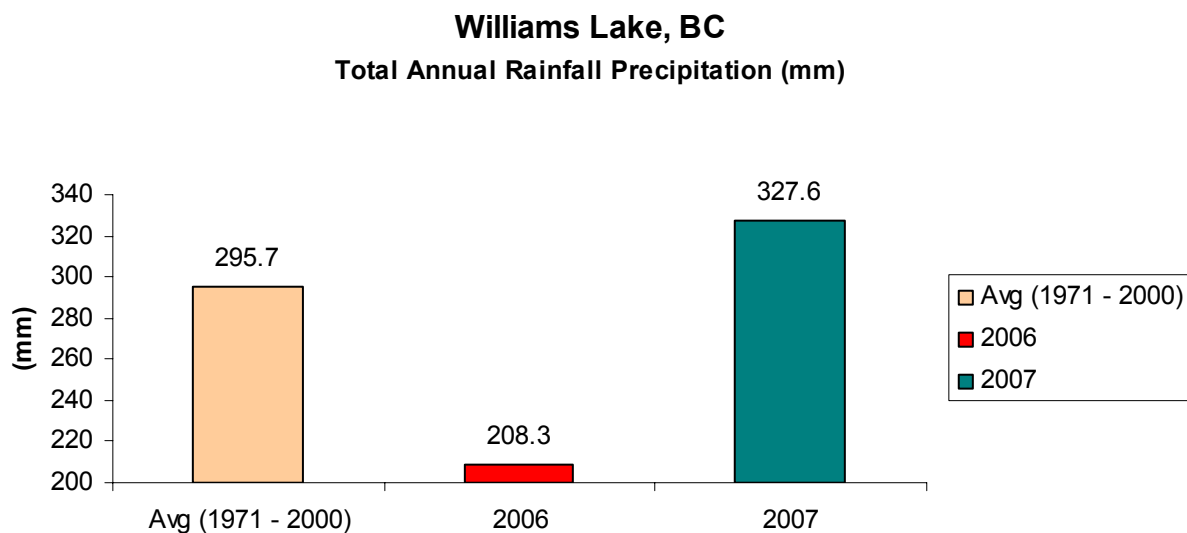


Figure 3 Rainfall for Williams Lake, BC

MPB logs are characterized by their lower moisture content and by the significant amount of *blue stain* (Photo 1).



Photo 1 *Significant amount of blue stain in a MPB log*

Recent studies carried out by FPInnovations – the Drying Group at Forintek Division) showed that permeability of blue-stained wood can be about seven times greater than the permeability for non-stained wood. Thus, MPB wood, with significant amount of blue stain and lower moisture content, will absorb moisture faster than normal wood and as a result its moisture content can be substantially increased. Logs with moisture content (MC) close to the fibre saturation point (30% MC) will be more susceptible to dimensional changes associated with variation of moisture content caused by weather conditions. Wetter weather conditions, such as those observed in 2007, will cause significant changes in moisture content. Under those circumstances, MPB logs will absorb moisture and swell. The swelling will eventually end up closing existing checks. Once closed, checks will be hardly noticed and assessing log quality will inevitably be inaccurate. Scalers in the Cariboo and Central British Columbia noticed a decrease in the amount of grade 4 logs throughout 2007, especially during prolonged periods of rain (Figure 2). Figures 1 and 3 illustrate the above normal rainfall that could explain the reduced amount of MPB logs exhibiting checks. As the logs being brought to the mills will get drier because of the age of infestation that is, moisture content for MPB logs will be even lower, the influence of weather conditions will be increasingly more critical with significant financial impact.

3.2 Workshops for MoF & R representatives

Two workshops specifically designed for scalers and supervisors were designed and carried in two locations as requested by the MoF & R. The workshops were carried out in Prince George on Feb 12th, 2008 and in Kamloops on February 15th, 2008. It was estimated that in total approximately 50 to 60 MoF & R representatives attended the workshops. The subjects presented and discussed were divided according to the following topics:

- Current issues related to MPB logs faced by the industry

- MPB wood – initial moisture content
- Equilibrium moisture content (EMC)
- Weather conditions affecting EMC
- CT Scanning technology for detecting checks in MPB logs
- CT scanner – exploratory tests and preliminary results
- The development of the Guidelines
- Industrial implementation of the guidelines

The set of slides used during the workshops is presented in Appendix 1.

3.3 Site Visits and Meetings with Mill Personnel

Meetings were held with kiln operators and with personnel in charge of assessing log quality during the site visits. The following mills were involved:

Region	Mill (sites)
Merrit	Tolko
Kelowna	Tolko
Armstrong	Tolko
Lavington	Tolko
Chasm	West Fraser
100 Mile House	West Fraser
Quesnel	West Fraser (1)
Quesnel	West Fraser (2)
Williams Lake	Tolko/Creekside
Williams Lake	Tolko/Lakeview
Williams Lake	Tolko/Soda Creek
Quesnel	Canfor
Quesnel	West Fraser
Prince George	Canfor / Rustad
Prince George	Lakeland
Prince George	Canfor /Clear Lake

The different options regarding re-drying schedules devised under the guidelines were discussed with kiln operators during the visit to the sites. In some cases, kiln operators were advised to use the 18-hr schedule under the modified operating area (Appendix 2). Issues such as reducing airflow and the impact of re-drying on kiln productivity were also discussed with kiln operators. The number of re-drying charges varied amongst the mills but in most cases mills processed between 40 and 60 kiln charges. The discussions held with log scaling supervisors involved the observed distribution of grade 4 logs before and after the re-drying process was authorized by the MoF & R.

3.4 Implementation of the Guidelines

3.4.1 Industrial Practices

Kiln operators from all sites reported no problems in achieving the conditions specified by the guidelines. The main difficulties that were experienced by most kiln operators were related to achieving the specified air velocity in the kilns. Kilns are normally designed to operate with air velocities above 400 ft/min and newer kilns normally operate with air velocities in the range 1,000 to 1,200 ft/min. Kilns equipped with variable frequency drives (VFD) have greater flexibility to reduce and adjust the air velocities to the value specified by the guidelines. On the other hand, kilns not equipped with VFD had to improvise baffling systems or disable one of the shafts (line-shaft kilns with sets of 6 fans per shaft) to achieve required air velocity.

In general, kilns are equipped with heating systems (in general 12 to 15 MMBtu per hour) capable of delivering enough heat and therefore achieving temperature set-points very rapidly. In some operations kiln operators set up heating up rates to achieve kiln temperature conditions very fast (less than 30 minutes) and in other cases, kiln operators opted for longer heat up times (up to 2 hours).

3.4.2 Re-drying MPB Logs in Conventional Lumber Dry Kilns

In all cases, logs are bundled and loaded longitudinally into the kilns. Airflow is perpendicular to the length of the logs



Photo 2 Log charge ready for re-drying



Photo 3 *Log charge before entering the kiln*

3.4.3 Results of the Re-drying Runs

Based on anecdotal information, scalers in all mills reported that:

- Bark did not fall as a result of the re-drying process; only due to handling,
- Logs were in general still moist right after the re-drying process,
- Logs were barely warm to the touch after the re-drying process
- Green logs (spruce and sub-alpine fir) that were mixed with the MPB logs did not exhibit checking at the end of the re-drying process
- Some mills marked visible checks before the re-drying process and did not observed additional checks after re-drying
- In some operations kiln operators believed that for certain hot summer days, logs are exposed to higher temperatures when exposed to ambient conditions compared to the conditions specified by the guidelines.

Thus, in general, kiln operators and scalers from all mills sites employing the guidelines for re-drying logs in conventional lumber dry kilns, found no evidence that the re-drying of logs produced additional checking or worsened the existing checks in the MPB logs. Due to the number of variables involved that is, age of infestation, storage history, region in the Province where the logs came from and log diameter, the amount of grade 4 varied from mill to mill. Nevertheless, in all cases, industry representatives reported the level of grade 4 logs returned to historical values observed during the summer months once the program was implemented.

In summary, the re-drying the logs in the conventional lumber dry kilns did not cause the development of additional checking in MPB logs and there was no evidence that grade 2 logs were downgraded because of the re-drying process (Photo 4). In addition to producing grade results compatible with historical data, scalers unanimously reported that the pre-drying improved their ability to 'see' defects and therefore improve the accuracy of their assessment. Although new costs due to processing and handling are incurred, mills expressed their commitment to the program of re-drying MPB logs in lumber dry kilns according to the MoF & R guidelines in order to increase the accuracy of the process of determining log quality. They also expressed their support to continue working with FPInnovations to fine tuning the current guidelines in order to eliminate any potential misinterpretation related to the objectives of the re-drying procedure.



Photo 4 MPB grade 2 and grade 4 logs after re-drying

3.5 Industry Recommendations for Future Research Work

The following recommendations for future research work were offered by mill personnel during the site visits:

- Determine the kiln conditions under which checking would be created in green check-free logs
- Conduct a scientific study to prove that the present guidelines for re-drying logs in kilns do not create any risk of downgrading logs due to checking
- Conduct research to prove that green MPB logs and logs from other species do not downgrade due to re-drying according to the guidelines
- Carry out research to examine relationships between grading rules, actual log grades and the sawmill results (lumber and grade recovery)

- Carry out research to replace current scaling and find more efficient ways to establish stumpage prices based on lumber volume and grade yield at the sawmill
- Establish grading rules that will take into account checks that are hardly noticeable due to weather conditions.
- Establish maximum air velocities that can be used during the re-drying process

4 Conclusions and Recommendations

Based on the observations, testimonials and available data, it is concluded that the MoF & R guidelines for re-drying MPB logs in conventional lumber dry kilns have been successfully implemented by the industry. The re-drying program has improved the accuracy of determining log quality which in turn contributed to similar results when mill scalers and MoF & R representatives assess log quality. It was clear during the site visits and during discussions with mill personnel that the re-drying process does not downgrade logs by either creating new checks or worsening existing ones. Thus, based on the success of the program designed to improve accuracy when determining log quality and therefore establish a fair price based on the assessment, the following recommendations are made:

(1) Extension of the practice of re-drying logs in conventional lumber dry kilns

Since no evidence could be found that indicated and/or suggested that the practice of heating up logs in conventional lumber dry kilns, as approved by MoF & R guidelines, created additional checking in MPB logs or worsened original checks that existed in some logs before re-drying and, based on the unpredictability of weather conditions, as illustrated by the atypical weather pattern observed for 2007, it is recommended that the program of heating up MPB logs in conventional lumber dry kilns (re-drying) **be continued, without any interruption, throughout the year**. Under those circumstances, mills would have the option of using the kilns whenever it is believed that the practice could yield improved accuracy when assessing log quality (for example for periods of prolonged and continuous rainfall independent of the time of the year).

(2) Monitoring mechanism

To ensure compliance with the guidelines, it is recommended the introduction of a ***strict control and reporting mechanism*** which would require all mills to report exactly the same type of information relevant to every kiln log charge. In addition, periodic inspection of mills sites should be conducted by the MoF&R or their designated agents with the following objectives:

- To ensure that the practices outlined in the guidelines are rigorously followed,
- To continue providing technical support and training to mill personnel,
- To collect information to support the development of a database with historical data that can assist the MoF & R regarding future strategies for dealing with the MPB resource.

(3) Developing the *science* to support the practice of heating logs in conventional lumber dry kills.

Since the developed guidelines were based solely on industrial experience and on some theoretical considerations regarding the dynamics of wood-water interactions, it is recommended that a scientific study be conducted to test the following null hypothesis that is, ***the conditions prescribed by the guidelines do not create additional checking in MPB logs and therefore do not alter log grade***. The results of such a study would be of primary importance to demonstrate that the industry is not being favoured in any way by the authorized practice of heating logs in conventional lumber dry kilns

Appendix I

Workshop for MoF&R Representatives



Guidelines for heating up logs in conventional lumber dry kilns

By Luiz Oliveira

Feb 2008

Outline

- Considerations for developing the Guidelines
 - ✓ MPB wood
 - ✓ Perception (outside our Province)
 - ✓ Understanding 'checking' dynamics
 - ✓ Impact of atmospheric conditions
 - ✓ Ensuring fair practices
 - ✓ Straightforward practice
 - ✓ Straightforward mechanism for monitoring practices
- 'Guideline'
 - ✓ Is it 'safe'?

Considerations – MPB wood

MPB Logs



Considerations – MPB wood

MPB Logs



Considerations – MPB wood

FACT (science) ➡

- MPB wood ... higher permeability which means...
 - **absorbs more moisture (blue stain)**

INDUSTRY

- Checks open and close depending on weather conditions
 - *Perceived grade changes*
 - *How can logs be fairly assessed if checks are no longer visible?*
 - *Is there a way to 'accurately' detect checks when they are no longer visible?*
 - *Is there a way to "bring back" the checks that were originally present but 'disappeared' because of weather conditions?*

Perception

Lumber Dry Kilns

Operating Conditions:

Up to 210 / 220 F
30% < RH < 70%, 80%, 90%

For SPF LUMBER



Fast Drying



Equilibrium Moisture Content



Understanding 'checking' dynamics

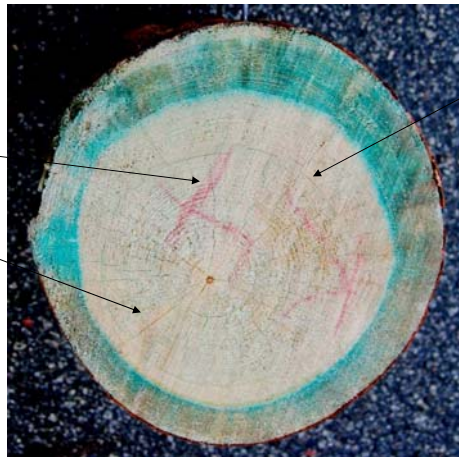


Understanding 'checking' dynamics

After re-wetting



Understanding 'checking' dynamics

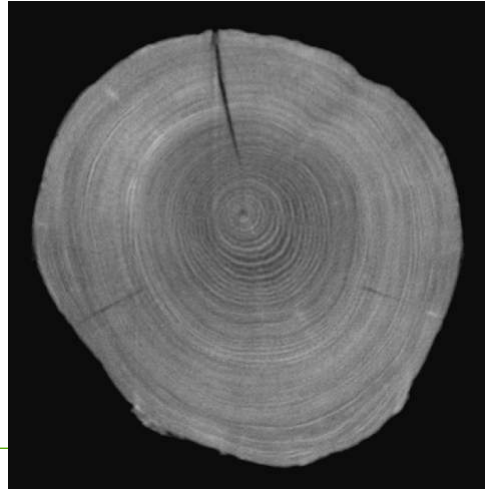


After 1.5 days – slow drying in the lab / ~40% RH, T= 23 C

Understanding 'checking' dynamics

"2" log at 1149mm position

1st SCAN

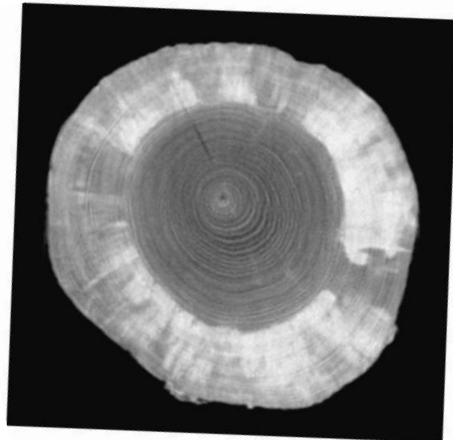


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Understanding 'checking' dynamics

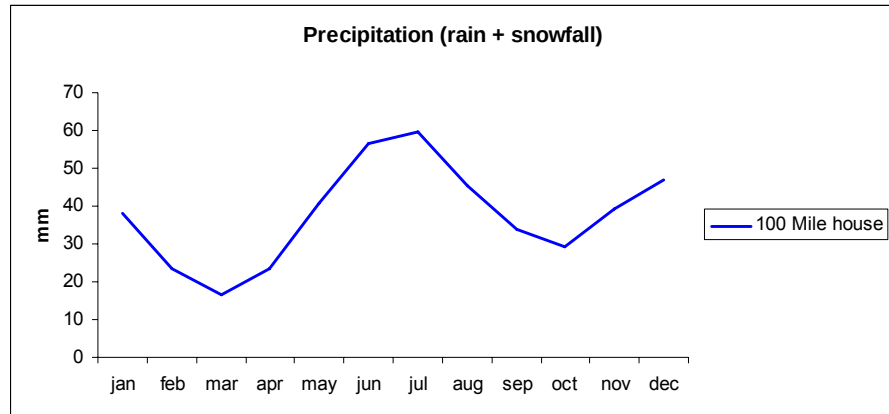
"2" log at 1149mm position

AFTER 1.5 DAY WETTING

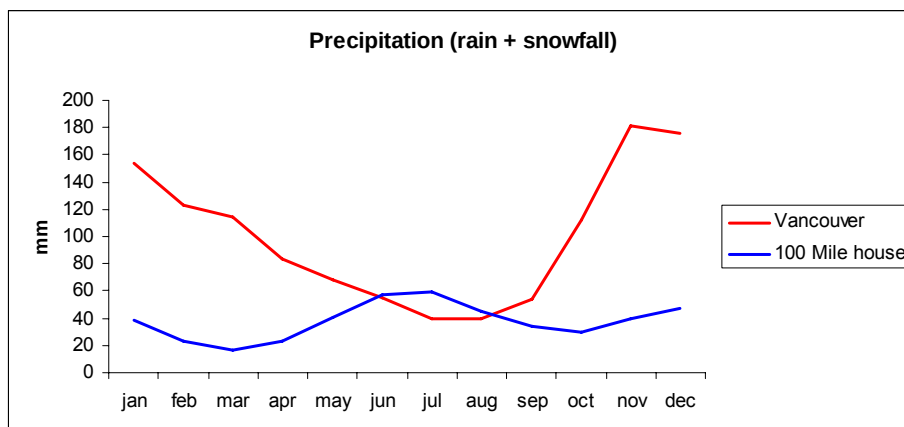


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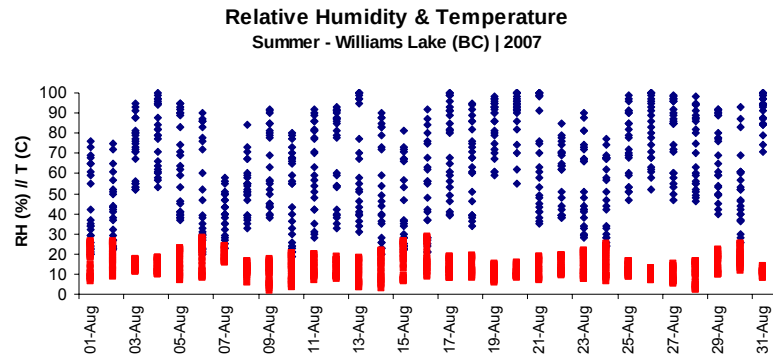
Atmospheric conditions that affect EMC



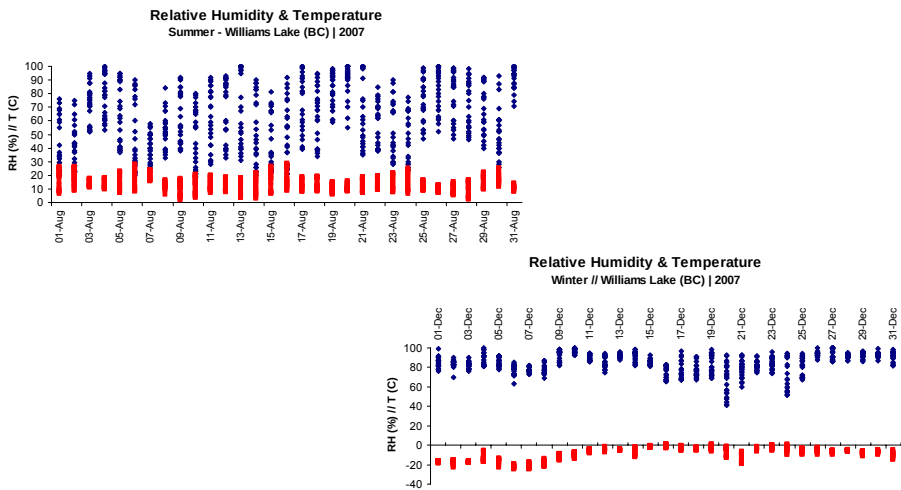
Atmospheric conditions that affect EMC



Atmospheric conditions that affect EMC



Atmospheric conditions that affect EMC



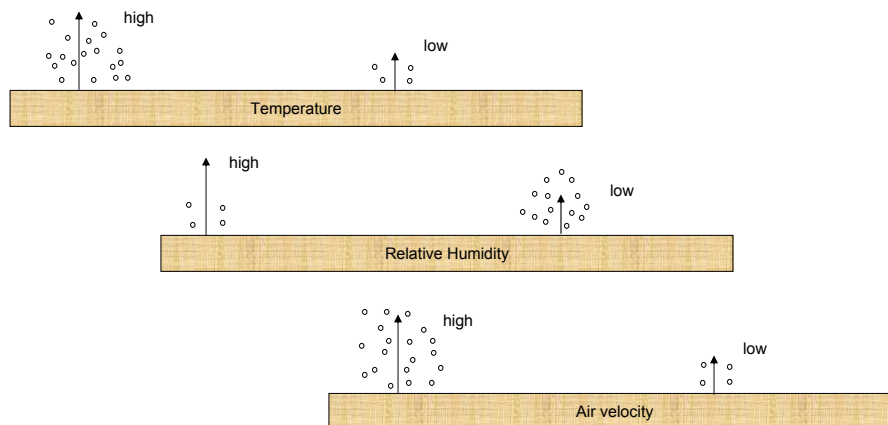
Most important variables that affect 'drying'

Temperature

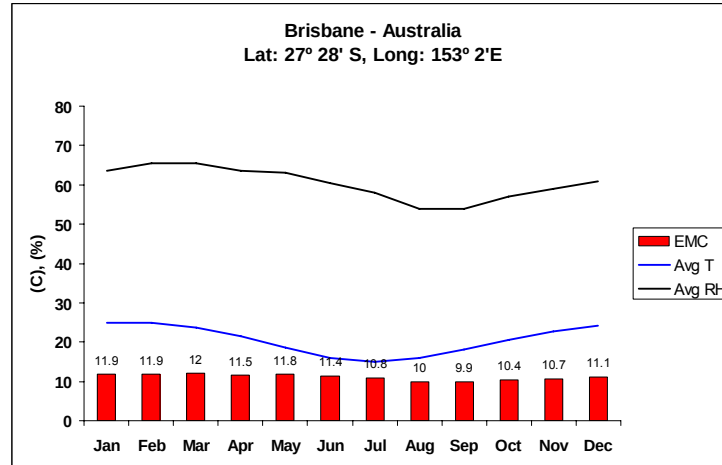
Relative Humidity

Air velocity (airflow)

Most important variables that affect 'drying'



Past Experience



Past Experience



Past Experience



Past Experience



Past Experience



Guidelines

Approach: how did I develop the 'guidelines'?

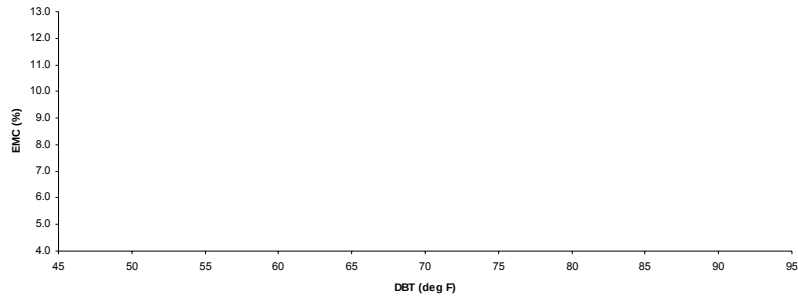
- 1) Climate data (regional)
 - http://www.climate.weatheroffice.ec.gc.ca/climateData/hourlydata_e.html
- 2) EMC (as potential drying intensity)



- 3) Qualitative analysis based on DBT, EMC & RH

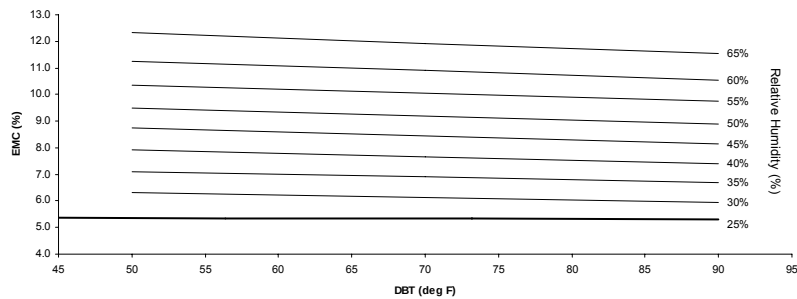
Guidelines

Heating up MPB Logs in Conventional Lumber Dry Kilns
Dependence of EMC(%) on DBT(deg F) & RH(%)
Guidelines for heating time (t_h in hrs)



Guidelines

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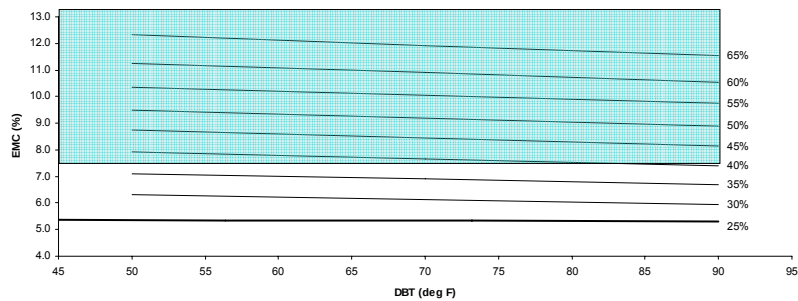


Guidelines

Month (Summer 2007)	Average temperature (°C) for the period 8:00 AM to 6:00 PM	Average relative humidity (%) for period 8:00 AM to 6:00 PM	Estimated EMC (%) Outside ambient conditions
June	15	54	10.1
July	21	42	8.0
August	19	46	8.6
September	17	41	9.4

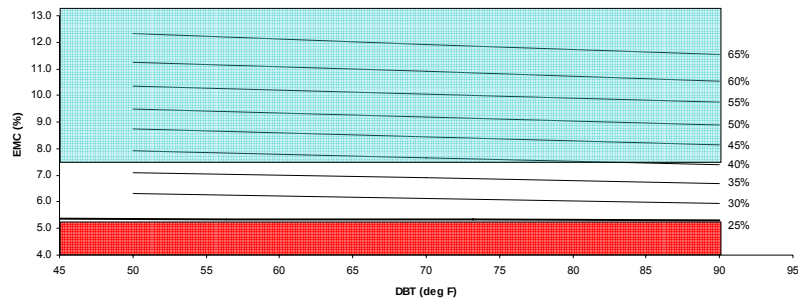
Guidelines

Heating up MPB Logs in Conventional Lumber Dry Kilns
Dependence of EMC(%) on DBT(deg F) & RH(%)
Guidelines for heating time (t_h in hrs)



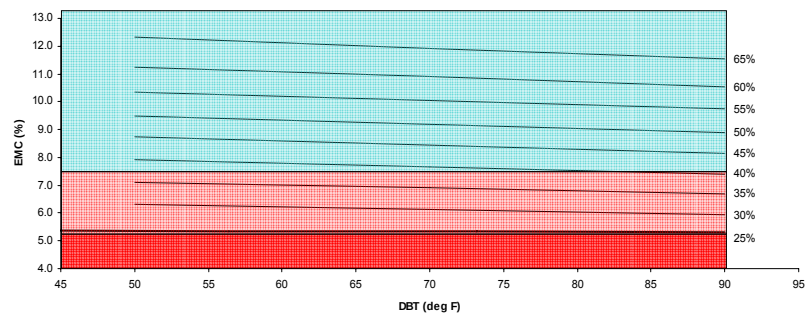
Guidelines

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Dependence of EMC(%) on DBT(deg F) & RH(%)
Guidelines for heating time (h, in hrs)

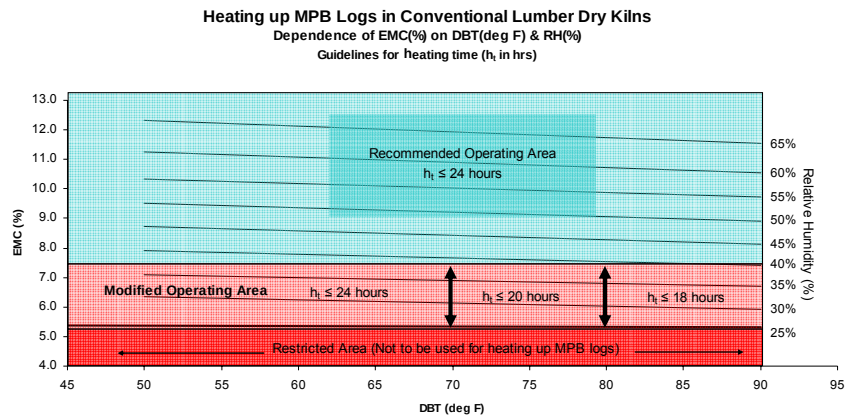


Guidelines

Heating up MPB Logs in Conventional Lumber Dry Kilns
Dependence of EMC(%) on DBT(deg F) & RH(%)
Guidelines for heating time (h, in hrs)



Guidelines



Straightforward monitoring mechanism

Information to be available at the end of each treatment

1. Load information
2. Date
3. Kiln #
4. Operator
5. DBT set point
6. air velocity (exit side of the load)
7. Actual DBT reached after 6 hours (ramp time)
8. Area (in the graph) selected
9. RH selected
10. Heating schedule duration

Straightforward monitoring mechanism

Information to be available at the end of each treatment

1. Load information
2. Date
3. Kiln #
4. Operator
5. DBT set point
6. air velocity (exit side of the load)
7. Actual DBT reached after 6 hours (ramp time)
8. Area (in the graph) selected
9. RH selected
10. Heating schedule duration

11. DBT at the end of the process
12. 'Graph' showing temperature, RH throughout the process



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Appendix II

Guidelines

Heating up MPB Logs in Conventional Lumber Dry Kilns

Dependence of EMC(%) on DBT(deg F) & RH(%)

Guidelines for heating time (h_t in hrs)

