WHY WE NEED TO MEASURE THE MOISTURE CONTENT IN WOOD

EMC varies by location, such as West Coast, Southwest, East Coast, Southeast, Europe. Figure 1 shows the recommended final moisture content for furniture. If the moisture content changes after a product is assembled, situations can arise such as those in Figure 2.

Figure 1. EMC by location in the U.S.

Figure 2. Moisture changes after a product is made results in shrinkage and pieces that don’t fit.
Moisture content also varies by usage. For example, door and window stock should have a higher moisture content than wood for furniture.

Determine the moisture content in the kiln for moisture content-controlled schedules. Figure 3 is an example of such a schedule.

<table>
<thead>
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<th>Schedule Edit Help</th>
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<tbody>
<tr>
<td>Date: 04/27/94</td>
</tr>
<tr>
<td>Operator: Bill</td>
</tr>
<tr>
<td>Schedule type: DM</td>
</tr>
<tr>
<td>Species: 26 - Spruce</td>
</tr>
<tr>
<td>Description: A modified sample DM schedule</td>
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<table>
<thead>
<tr>
<th>EMC %</th>
<th>F</th>
<th>Hours</th>
<th>Speed %</th>
<th>Reversing</th>
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<tbody>
<tr>
<td>Heating up</td>
<td>12.4</td>
<td>120</td>
<td>100</td>
<td>3:00</td>
</tr>
<tr>
<td>Warning thru</td>
<td>12.2</td>
<td>130</td>
<td>100</td>
<td>3:00</td>
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<tr>
<td>Drying - MC% &gt; 60</td>
<td>12.2</td>
<td>130</td>
<td>100</td>
<td>3:00</td>
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<td>MC% = 55</td>
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<td>130</td>
<td>45</td>
<td>3:00</td>
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<tr>
<td>50</td>
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<td>100</td>
<td>3:00</td>
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<tr>
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<td>9.0</td>
<td>130</td>
<td>100</td>
<td>3:00</td>
</tr>
<tr>
<td>40</td>
<td>7.8</td>
<td>130</td>
<td>100</td>
<td>3:00</td>
</tr>
<tr>
<td>35</td>
<td>6.6</td>
<td>130</td>
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<tr>
<td>30</td>
<td>5.6</td>
<td>140</td>
<td>100</td>
<td>3:00</td>
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<td>5.0</td>
<td>148</td>
<td>100</td>
<td>3:00</td>
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<tr>
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<td>150</td>
<td>100</td>
<td>3:00</td>
</tr>
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<td>160</td>
<td>100</td>
<td>3:00</td>
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<tr>
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</tr>
<tr>
<td>5</td>
<td>3.4</td>
<td>160</td>
<td>100</td>
<td>3:00</td>
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<tr>
<td>Conditioning</td>
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<td>160</td>
<td>100</td>
<td>3:00</td>
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</table>

Figure 3. Example of moisture content-controlled drying schedule.

Determine shut-off point of kiln.

Conduct quality control after drying (in-line meters).

Presort lumber.

**MOISTURE VARIABILITY**

**Variability Occurs**

From board to board, for example in heartwood and sapwood.

Within board
- wet pockets
- over the length of a board
- over depth of board (see Figure 4).

Within lot
- different air drying time
- seasonal
- species

**Drying rate varies with**

Sawing pattern, flatsawn boards dry faster than quarter sawn

Location in the kiln
- Uneven airflow along length and height of kiln
- Uneven airflow along length and height of kiln

90
We cut the hours per charge down to 270 hours. In doing this, we could dry 720M bd. ft. using 3,240 track hours. This decreased track time by 20.5%. We picked up an additional 7% re-dry. So we netted 540M bd. ft. This left three charges to be re-dried at 150 hours per charge or 450 hours. 3,240 hours plus 450 hours is 3,690 hours to dry the same 720M bd. ft for shipment. This gave us a net savings of 690 track hours or 15.75%. We eliminated the overdried lumber and saw much higher grade recoveries at the planer. The decrease in energy and track hours, and the increase in grade recovery paid for itself many times over the cost of rehandling the re-dry.

In essence, we created the third sort in the dry kilns that the mill was unable to give us. They simply didn't have the sorting capacity or ability to give us all the sorts we required.

In an operation that has the ability to drop out or sort wet lumber ahead of the planer, this method could be applied to other hard to dry species such as hemlock and white fir with considerable merit.

Some operations deem re-dry as degrade. This doesn't have to be the case. If we spend the time to develop drying schedules for re-dry and process it correctly the grade recovery will be as high, or in some cases higher than the first run stock. We proved this by tracking and recording grade recoveries from first run charges and runs of all re-dry stock.

Applying this procedure to a drying operation kind of goes against what we were taught or learned when we first started drying lumber. Basically, if we don't get it all dry the first time through, we are not doing our job properly. The comments we generally hear are, "That's the way we've always done it." "We have to do it this way, its the way the guy that taught me how to do it and the guy that taught him did it." 

In closing, hopefully, I've stimulated some thought as to how efficiently are we actually utilizing our dry kiln track hours. Managing and scheduling lumber through the dry kilns is much like playing a game of chess. The strategy is very similar. Making the wrong move or decision in loading sequence, you may very well find that you have trapped yourself, the kilns are not turning over, your green yard is growing, with that comes the potential of degrade, and your planer is running out of dry lumber to process. CHECKMATE !

When you go back to your operations, ask these questions, "Are we utilizing our kilns to their full potential?" "Are we satisfied that our drying program is on track?" "What changes, if any, can we make to achieve the results we are searching for?"
Disadvantages
Limited number of probes
Inaccurate above fiber saturation point

EMF-type probes

Advantages
Convenient and easy to use
Useful to determine shut-off time

Disadvantages
Limited number of probes
Reading not actual moisture content
Not usable to run moisture content-based schedule
Inaccurate above the fiber saturation point

Temperature drop across the load (TDAL)

Advantages
Convenient and easy to use
Provides readings above the fiber saturation point

Disadvantages
Affected by many parameters such as stacking, airflow variation, and steam pressure variation.
Only average moisture content readings

Load cells

Advantage - accurate above fiber saturation
Disadvantage - only an average moisture content reading

Quality control

In-line moisture meters
Transverse or longitudinal
Resistance-type, EMF-type, Weight-based systems

Presorting

Weight-based systems
Laser-based systems
Infrared systems

MEASURING MOISTURE CONTENT ABOVE FIBER SATURATION

Measuring the moisture content above the fiber saturation point is required when:
Presorting; methods include laser, weight, infrared
During drying; methods include oven dry tests, TDAL, weight systems, resistance probes combined with ovendry tests.

Resistance probes combined with oven dry tests

The technique (Figure 5) is to:
- insert probes into lumber
- cut specimens to determine moisture content with oven dry test
- before kiln is started take a resistance readings
- calculate new A and B values for each probe
- use these new A and B values for species correction when the moisture content is above 25%.
- use the original A and B values when the moisture content is less than 25%.
<table>
<thead>
<tr>
<th>Kiln 1</th>
<th>Probe</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<td>1</td>
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<td>1</td>
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<tr>
<td>MC old</td>
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<td>56.7</td>
<td>67.3</td>
<td>44.8</td>
<td>56.1</td>
<td>41.6</td>
<td>68.3</td>
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<td>51.9</td>
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<td>48.2</td>
<td>36.1</td>
<td>61.7</td>
<td>33.9</td>
<td></td>
</tr>
</tbody>
</table>

![Calibration Procedure](image)

Figure 5. Calibration procedure.
An application of this technique is shown in Figure 6.

Figure 6. Readings before and after calibration.

**Efficacy of Method**

Deviation of moisture content above the fiber saturation point before and after applying this technique is shown in Figure 7.
Figure 7. Moisture content readings before and after calibration.