Lumber Drying for the Small Producer

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Wood Products Extension

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Wood Education and Resource Center

- Is the center of the US Forest Service effort of support of the hardwood forest industry in the states east of the Great Plains
- Located in Princeton, West Virginia, [www.fs.fed.us/werc](http://www.fs.fed.us/werc)
- WERC project’s websites = [www.cnr.ncsu.edu/woodworkshops](http://www.cnr.ncsu.edu/woodworkshops) and [www.cnr.ncsu.edu/usalocalwood](http://www.cnr.ncsu.edu/usalocalwood)

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Downloadable References

- Go to www.fpl.fs.fed.us
- Look under publications
- Drying hardwood lumber
- Dry Kiln operator’s manual
- Dry kiln schedules for commercial woods
Hard References

• Go to www.forestprod.org
• Look under publications
• Drying hardwood lumber
• Dry Kiln operator’s manual
• Dry kiln schedules for commercial woods
Goals In Lumber Drying

- Cost effectively lower the moisture content of wood to the moisture content it would equalize in end use without damaging it
- Wood used in the interior of a house should be dried to a target range from 6 to 8 percent moisture content
- Wood to be used by industrial secondary processors should be free of drying stresses
Goals In Lumber Drying

- To eliminate the chances of insect problems we would like to have the interior of the piece of lumber reach 133°F for at least 1/2 hour.
- To set the pitch on pine we would like to have a maximum temperature of 160°F for several days.
Types Of Lumber
Refractory Woods

• Easy to check, split, or honeycomb
• We want to slow down the initial drying rate to protect the wood from shrinking too fast and tearing itself apart
• Drying schedules usually start out at low temperatures and high humidities
• Common refractory woods are red oak, white oak and hickory
Types Of Lumber

White Woods

• Lighter colored woods that have a tendency to discolor or stain
• We want to lower the humidity during initial as rapidly as possible drying rate to eliminate the chances of stain
• Drying schedules usually start out at low temperatures and low humidities
• Common whit woods are ash, basswood, hickory, hard maple, soft maple, yellow poplar and white pine
## EMC% Green Wood

<table>
<thead>
<tr>
<th>DB °F</th>
<th>WB °F</th>
<th>RH%</th>
<th>EMC%</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>97</td>
<td>89</td>
<td>19.0</td>
<td>Mold City</td>
</tr>
<tr>
<td>100</td>
<td>94</td>
<td>80</td>
<td>15.0</td>
<td>Drying</td>
</tr>
<tr>
<td>100</td>
<td>83</td>
<td>49</td>
<td>8.5</td>
<td>Aggressive Drying</td>
</tr>
<tr>
<td>100</td>
<td>72</td>
<td>24</td>
<td>4.9</td>
<td>Check City</td>
</tr>
<tr>
<td>140</td>
<td>137</td>
<td>92</td>
<td>18.6</td>
<td>Jungle Atmosphere</td>
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<tr>
<td>140</td>
<td>134</td>
<td>84</td>
<td>14.8</td>
<td>Drying</td>
</tr>
<tr>
<td>140</td>
<td>123</td>
<td>60</td>
<td>9.0</td>
<td>Aggressive Drying</td>
</tr>
<tr>
<td>140</td>
<td>112</td>
<td>41</td>
<td>6.2</td>
<td>Check City</td>
</tr>
</tbody>
</table>
We dry lumber based on species, thickness, final product and moisture content of the wood

- **Control Surface Checking**
  - Have a high RH%
  - Establish moisture gradient
- **Control MC% loss**
  - Control Internal Checks Such As Collapse and Honeycombing
  - Initial Temperature Control - Dry Bulb
- **Speed Drying**
  - Lower W.B.
  - Raise D.B.
- **Uniform MC%**
  - Equalize
- **Stress Free**
  - Conditioning
Commercially we dry using samples

- Clear, sound wood
- Sections 1 inch, samples 24 to 36 inches
- Put sections in plastic bag right after cutting
- End coat samples
- Sample placement
- Samples should reflect what charge is doing
- Center package lags behind (use matching samples)
Samples

• At least 4 per charge or lumber type, 1 per 10 mbf
• Mostly the wettest, hardest to dry samples, but 1 or two easy to dry
• Wettest, hardest to dry think - species, history, thickness, quartersawn
## Lowland Oak 4/4 & 5/4 Oak

<table>
<thead>
<tr>
<th>MC%</th>
<th>DB°F</th>
<th>WB°F</th>
<th>EMC%</th>
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<tbody>
<tr>
<td>&gt;40</td>
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<td>97</td>
<td>19.5</td>
</tr>
<tr>
<td>40 -35</td>
<td>100</td>
<td>96</td>
<td>17.6</td>
</tr>
<tr>
<td>35 -30</td>
<td>100</td>
<td>94</td>
<td>15.3</td>
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<tr>
<td>30 –25</td>
<td>110</td>
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<td>20 -15</td>
<td>130</td>
<td>90</td>
<td>4.0</td>
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<tr>
<td>15-11</td>
<td>150</td>
<td>105</td>
<td>3.8</td>
</tr>
<tr>
<td>&lt;11</td>
<td>160</td>
<td>110</td>
<td>3.4</td>
</tr>
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</table>

**Equalize Condition**
# Hard Maple 4/4 & 5/4

<table>
<thead>
<tr>
<th>Old Maple Schedule T8-C3</th>
<th>White Schedule</th>
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<tbody>
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<td><strong>DB°F</strong></td>
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<tr>
<td>&gt;40</td>
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</tr>
<tr>
<td>40 - 35</td>
<td>130</td>
</tr>
<tr>
<td>35 - 30</td>
<td>130</td>
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<td>30 – 25</td>
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<td>25 - 20</td>
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<td>20 - 15</td>
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<tr>
<td>&lt;15</td>
<td>180</td>
</tr>
<tr>
<td>&lt;12</td>
<td>160</td>
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</table>
## White Pine 4/4 & 5/4

<table>
<thead>
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<td>14.0</td>
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<td>40 - 35</td>
<td>150</td>
<td>140</td>
<td>11.8</td>
<td></td>
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<tr>
<td>35 - 30</td>
<td>150</td>
<td>135</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td>30 - 25</td>
<td>160</td>
<td>140</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
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<td>&lt;15</td>
<td>180</td>
<td>130</td>
<td>3.5</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>FPL Anti Brown Stain 4/4</th>
<th>MC%</th>
<th>DB°F</th>
<th>WB°F</th>
<th>EMC%</th>
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<tbody>
<tr>
<td>&gt;100</td>
<td>120</td>
<td>105</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>100 - 85</td>
<td>120</td>
<td>105</td>
<td>9.6</td>
<td></td>
</tr>
<tr>
<td>85 - 60</td>
<td>120</td>
<td>100</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>60 - 45</td>
<td>130</td>
<td>105</td>
<td>6.7</td>
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</tr>
<tr>
<td>45 - 30</td>
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<td>30 - 25</td>
<td>140</td>
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<td></td>
</tr>
<tr>
<td>25 - 20</td>
<td>150</td>
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<td>5.0</td>
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<tr>
<td>20 - 15</td>
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<td>&lt;15</td>
<td>180</td>
<td>152</td>
<td>6.0</td>
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</tr>
</tbody>
</table>
Additional Equipment

• Controls to measure and control temperature and humidity
• Equipment to measure moisture in lumber
  – Moisture meter (not for commercial use)
  – Oven dry method (recommended)
• Small bandsaw
Auxiliary Equipment

• [www.nyle.com](http://www.nyle.com) go to accessories

• [www.conway-cleveland.com](http://www.conway-cleveland.com) go to associated products
Warning: Decide if it is a hobby or a business?

- Don’t be cheap
- Do things right
- Go to a kiln operator’s short course
Log Protection

• Log protection is critical to avoid stain and splits
• Rapid log turnover is one of the most cost effective ways to avoid problems
• End coating logs with wax or anti stain chemical will help if longer storage is used
Quality Stacking

- Uniform sized lumber
- Uniform sized, dry sticks
- Cross outs and sticks should be in vertical alignment
- Protect the ends
Hot Room Drying

- Air dry or shed dry first
- Move lumber to progressively warmer and dryer environment
- End up in a heated part of your house for at least one heating season for 4/4 lumber
Solar Drying

• Sounds like a good idea (using the sun, etc)

• Need production all of the time

• Can get expensive with all the bells and whistles

• Need to be selective on what you dry (stain & checking)
Solar Drying

- Solar collectors gather approximately 1000 to 1200 BTUs per square foot.
- As a general rule have the solar collector at an angle from horizontal as the collector is located north or south of the equator.
- In this hemisphere face it south.
- It takes approximately 1000 BTUs to evaporate one pound of water.
## Solar Drying

<table>
<thead>
<tr>
<th>Species</th>
<th>Daily MC% Loss Target</th>
<th>Weight Per 1 MBF Dry</th>
<th>Weight Of Moisture Loss</th>
<th>MBTUs/MBF/Day or area in square of solar collector</th>
</tr>
</thead>
<tbody>
<tr>
<td>SYP</td>
<td>30.0%</td>
<td>2710 lbs.</td>
<td>813</td>
<td>813</td>
</tr>
<tr>
<td>Poplar</td>
<td>30.0%</td>
<td>2315lbs.</td>
<td>695</td>
<td>695</td>
</tr>
<tr>
<td>H. Maple</td>
<td>5.0%</td>
<td>3045lbs.</td>
<td>152</td>
<td>152</td>
</tr>
<tr>
<td>Cherry</td>
<td>4.5%</td>
<td>2692lbs.</td>
<td>121</td>
<td>121</td>
</tr>
<tr>
<td>Red Oak</td>
<td>2.75%</td>
<td>3270lbs.</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>
Solar Drying

• For slow drying species the solar collector ratio of 100 ft$^2$ per MBF can be used

• For faster drying species the solar collector ratio of 200 ft$^2$ per MBF should be used
Solar Drying
Dehumidification Drying

- No boiler needed
- No vents, closed loop system
- Energy efficient but you are using electricity
- No heat up system or humidifying system
Solar Drying - Poplar to Oak
Suggestions

• Start with an easy to dry wood and learn your kiln
• Top vent is for overheat (can get up to 140°F)
• Bottom vents are to allow moist air to escape and bring in fresh air
• Baffle well
• Can add small dehumidifier and or heater
Dehumidification Drying

- Compressing gas heats the gas up, which in turn can heat the air
- Expanding gas cools the gas down, which is used to lower the air temperature or condense water out of the air stream
Dehumidification Drying

- Slow drying species, oak – 0.50 to 0.75 hp/mbf
- Moderate, ash – 1.00 hp/mbf
- Fast drying, pine – 1.50 to 2.00 hp/mbf
- Better to slightly undersize than oversize
Dehumidification Drying

- Compressor and electrical outside the kiln
- Stainless steel coils
- Ability to reach higher temperatures (160°F)
- Enough airflow
- Well insulated
- Auxiliary heat and humidification system
Cost

- Energy Cost reported to be between $50 to $80 per MBF
- Need a well insulated building!!!!
Using a reefer
Conventional Steam Kiln

Figure 2-8—Package-loaded kiln with fans connected directly to motors. (MLSS 5598)
Conventional Steam Kiln

• My former student, Miguel Angel Camara Rubio, as part of his Master’s project built a kiln at his family business in Mexico City.
• He wanted a kiln that was highly flexible in terms of ability to dry different species and thicknesses
Pine lumber – notice the quality of stacking
Hardwoods

Lysiloma spp. – T’zalam
Variable speed fan control gives a lot of flexibility
Notice what gives him good results—good sample techniques and records.
Small kilns can also be used to heat treat pallet material as well as dry lumber.
Wood Fired Steam Generation

• The most expensive to install if you are going to have the lowest production cost
• Minimum of 240,000 BF of kiln capacity with a wood fired boiler
• However, small wood fired, hot water systems are an economical alternative
Other Alternatives
Other Alternatives (Small)

- 7000 BF capacity
- Direct fired
- Computer controlled
- Optional 6 MC% resistance sensors
- Five 20” fans, 2HP
- Bi-fold doors
Other Alternatives (Larger)

- 16,000 to 24,000 capacity based upon height
- Direct fired, optional steam or water heat, water misting system
- Computer controlled
- Optional 6 MC% resistance sensors
- Six 30” fans, 3HP
- Bi-fold doors
Good luck – don’t get hurt!

Joe, Stoffel & James Rosenfels, Chenje