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USAID KOSOVO PRIVATE ENTERPRISE PROGRAM (KPEP)

Kosovo Lumber Drying Training

June 1 - 20, 2009

JOSEPH DENIG

Implemented by
Booz Allen Hamilton

Contract No. EEM-I-07-00007-00
Task Order No. 2

JUNE 30, 2009

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The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government

KOSOVO LUMBER DRYING TRAINING

TRIP REPORT OF JOSEPH DENIG, JUNE 1-20, 2009

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PURPOSE OF ASSIGNMENT

Importance of Kiln Drying

The proper kiln drying of lumber is one of the first critical steps in producing value added wood products. Without proper kiln drying, wood products will shrink or move in their service environment, resulting in the product splitting and or warping. Also wood products at higher moisture contents are more prone to attack by fungi and insects. Kiln drying also reduces the weight of lumber for transport. If kiln drying is not done properly, the value of the raw material is destroyed through surface and internal checking and splitting, warping, staining, and machining and gluing problems.

Adoption of proper drying practices such as the proper care of the raw material prior to kiln drying can immediately improve the profitability of companies through decreased raw material cost due to increased yield, decreased inventory cost due to faster inventory turns, decreased production costs due to fewer failures, fewer in-service failures and access to markets that demand lower moisture contents for finished products.

By adopting proper lumber drying methods Kosovo wood products producers will benefit by expanded market opportunities both internal and export.

The assignment objectives included:

- Train key employees of up to 15 wood processing industries that gave installed dry kilns to achieve wood drying processes that meet international standards.
- Identify appropriate institutions to continue the training on a sustainable basis and provide recommendations on a course of action to develop a program.
- Provide observations to KPEP for additional interventions that address competiveness potential of the Kosovo forestry and wood processing sector.

BACKGROUND

The USAID Kosovo Private Enterprise Program's strategy for the wood processing sector is to improve the industry's ability to meet recognised international standards and designs, this in turn ensuring that future wood products will be compatible with market requirements. This goal is in keeping with KPEP's overall strategy to increase sales (with a focus on exports), while at the same time increasing employment in the industry.

According to the Ministry of Trade and Industry there are 1,299 enterprises that are registered as wood processors in Kosovo, employing 3,379 workers. The Kosovo Association of Wood Processors (AWPK) accounts for some 80 of the most important companies, employing more than 1,800 workers.

Due to the forest species mix, Kosovo wood processing companies mostly use Beech (Fagus) and Oak (Quercus). Beech is the main specie. AWPK believes more than 20 association members have installed drying kilns with a total capacity of approximately 700 m3. There are plans to expand or refurbish existing facilities to include an additional 300 m3.

A previous consultant to KPEP identified the improper drying of wood as a major problem of the industry, resulting in damage to the quality of the wood products produced. To produce quality wood products requires that wood be properly dried so that the wood products can withstand the climatic conditions where they will be put into use. KPEP has found that the wood drying processes used in Kosovo are inadequate and needed to be greatly improved.

EXECUTIVE SUMMARY

In June 2009 a three week program was conducted in Kosovo to improve the product quality of the local secondary wood producers by improving their lumber drying knowledge and operations so that they could expand both their internal and export markets and improve their profits through better manufacturing practices.

The state of the art drying technology (dry kilns) and drying practices were found to be very basic. Major emphasis was thus put on caring for the raw material prior to kiln drying and explaining the very basics of lumber drying.

During the drying improvement program 17 individual companies were visited and drying improvement suggestions were made.

Two drying workshops were held. A one and one-half day workshop was held at the University of Prishtina, Ferizai/Uroševac Campus, Wood Products Department attracted 8 industry personnel, 2 faculty members and 29 students (many of the faculty and students hold part time jobs with the wood products industry). The other workshop was one day long held at Kosovo Wood in Pejë/Peć attracted 8 industry personnel and 2 wood products instructors.

Recommendations for institutionalizing the progress made include hiring a faculty member at the University of Prishtina, Ferizai/Uroševac Campus, Wood Products Department to work with industry in an extension role, placing the material translated for the workshops on the web, further visits to continue training as the industry progresses, and develop a joint program between the University of Prishtina, Ferizai/Uroševac Campus, Wood Products Department and the Wood Products Program at North Carolina State University to train graduate students in wood products marketing and export opportunities.

FIELD ACTIVITIES TO ACHIEVE PURPOSES

Daily Log

May 29, 2009. I left my office for the Raleigh Durham International Airport at approximately 2PM to begin my journey to Kosovo.

May 30, 2009. I arrived at approximately 2:25 PM local time and greeted by the Blerim Perquku, one of the project's drivers. He drove me to the office where I met Violane Konar-Leacy, Operations Director, Kosovo Private Enterprise Program (KPEP). Then the two of them showed me the apartment I was staying in and gave me a briefing on the local area.

At dinner I met David Cowles, Chief of Party, KPEP and John MacKillop, Competiveness Director, Agriculture Sector Specialist, KPEP, also present was
Violane Konar-Leacy.

May 31, 2009. Off.

June 1, 2009. I met Burim Meqa, Wood Processing Specialist with KPEP who spent the day with me familiarizing me with the Kosovo Wood Industry. Our first visit was with Arieta Vula the Executive Director of the Kosovo Association of Wood Processors (AWPK). Her organization has over 80 members. She stated her members' two major problems are 1.) General bureaucracy in procuring raw material; and 2.) Access to international markets.

Ms. Vula joined us for the rest of the day and our next stop was with Sheqer Ukaj, General Manager and Owner, Elnor Furniture. He said that lumber is normally dried to 10% plus or minus 2%. He would like it to average 8%. He has one small kiln at another site but showed us lumber from some outside suppliers. His main problem with his 50mm beech lumber was internal gray stain. That is the surface is white, the inside has a slight gray stain. He reported it takes approximately 8 to 10 days to dry.

We also observed his new CNC machine center at the operation. His monthly labor cost is reportedly EU$400 per person.

Next we traveled to the University of Prishtina to meet with the Dean of the Wood Products Program, Agron Bajraktari and his faculty.

Dr. Bajraktari's assistant Rrahim Sejdiu joined us. Burim Meqa had informed me that they would like to hire someone to shadow me during my visit in order to train them and develop their local talent. Mr. Sejdiu was bright, outgoing, and intelligent.

We traveled to a firm, Design and viewed their dry kilns. They were manufactured by SOP Krsko from Slovenia. They were of aluminum design with moisture probe controls. The top baffles in the kiln did not touch the lumber, creating the possibility of the air short circuiting over the top of the lumber versus through the lumber. They reported drying 50 mm beech it takes from ten days to two weeks.

At lunch we met Muhamet Ymeri, Executive Director of the Galanteria Group. With him we visited Fabrika e Mobileve R.M. KOCAK who produced upholstered furniture. We discussed there steaming operation to darken the wood and kill any insects present in the wood. As we were visiting the plant they were loading an export container with furniture.

June 2, 2009. Rrahim Sejdiu joined the team today. The first company we visited was Gacaferi Mobile in Pejë/Peć. Naim Gacaferi the general manager showed us around. Before

the war the company specialized in solid wood products including stairs, windows and doors. During the war the company was destroyed and reborn after the war as manufacturing firm specialized in kitchen cabinets made from fiber board and particle board.

They still do make some wood products and use a home made kiln to do their kiln drying. At one time it was a dehumidification kiln and now it is basically a hot box. Mr. Gacaferi asked about North American suppliers of hardwoods.

Next we visited with Kosova Wood. We met with Visar Krasniqi, Manager of Sales and Marketing and several of his production supervisors and engineer. The care of the lumber was the best we had seen in Kosovo so far. We discussed several issues including the importance of airflow in a kiln and how to maximize it. We promised we would be back in two weeks.

The last firm we met with was Agroproducts. This firm was also concentrating more on vinyl products such as windows and doors. They however were making beech children's furniture to Germany. They dried the material, including squares, in a homemade dry kiln.

June 3, 2009. The first operation we visited was Deva, a small well run shop. At first our discussion centered around the gluing operation including moisture problems, glue problems, etc. The owner asked about my opinion of radio frequency gluing. Then we moved to the dry kiln which consisted of a homebuilt building and heating coils, fans, vents and the controls supplied by Termosistem. The owner had many questions that we answered including if he should advance the schedule, how checks are formed, how to prevent checks from forming, how to air dry, etc?

Next we visited Modeli a former state owned plant. The facility was outstanding and at one time the company reported making a go of it making log cabin homes. Due to the world wide downturn in the housing market the company was struggling and was looking for any type of business. Despite these concerns the owner was interested in how to improve his air drying (shed) practices for beech. One complaint he had was the lack of raw material (logs). He was end coating the ends of his lumber to prevent checking.

Next we toured Korenica which was manufacturing engineered flooring. Often a complaint of engineered flooring is high moisture content which leads to in service failure. They had set a conditioning room to bring the plies to the correct moisture content prior to gluing and after gluing. The product looks great but manufacturing looks expensive. We discussed pre-heating the veneer logs in hot water to improve veneer quality and yield and possible alternative methods of drying the veneer.

Our last stop was with Termosistem who manufacture heating and cooling systems and packaging them with the required kiln components to build a kiln.

June 4, 2009. Our first meeting was with Avdi Haziri, Manager of Mobileria e Kosoves. His current operation is located on what looks like an old government chicken farm where he is producing both upholstered and wooden furniture. He is in the process of moving his business to a piece of land that he has control of. We reviewed his current operation and discussed many suggestions with him including processing fresh logs, producing more 25 mm stock (which he uses in large quantities) versus thick stock, stacking procedures, air drying procedure, possible building a fan shed at his new facility and dry kiln operation.

Our second visit was with Adili, a sawmill and lumber drying yard. Of all the operations visited they had the largest and freshest log inventory. They showed us the sawmill, cutting procedures, the air drying yard and dry kiln. The meeting ended with them promising to be at the seminar next week.

June 5, 2009. At the office we worked with team getting the seminar material translated. Burim sent out an announcement of the planed seminars to the Wood Industry Association.

June 6, 2009. I worked at my apartment reviewing the seminar material.

June 7, 2009. Off.

June 8, 2009. Visited with Ismet Asllani from Kashtanjeva Dekor, a stairs and turnings workshop. Their processing included a small traveling band saw, and a dry kiln in addition to a secondary woodworking shop. Lumber care, attacking and kiln loading were very poor. Kiln controls consisted of one thermocouple.

Dardania Model a door manufacturer was visited next. Lumber handling and kiln practices were sib-standard. Our final visit of the day was Kosova Model another door manufacturer. They were having problems with their electrical supply so we did not see the kiln.

June 9, 2009. Prepared seminar material. Reviewed with translators.

June 10, 2009. I presented a day long seminar at the University of Prishtina, Wood Products Department. In attendance we eight industry personnel, two faculty members and 29 students.

June 11, 2009. During the morning we finished or seminar at the University of Prishtina. Most of the attendees today were students, bachelors and masters candidates.

In the afternoon we visited Promoplast, a furniture manufacture. The owner showing us around had attended the seminar yesterday. He was already trying to protect his green lumber inventory from degrade.

He had just built a homemade kiln which he showed us. When he opened the door he we saw a kiln of mold covered lumber with water on the floor. The conditions inside the kiln were too wet (we also felt the temperature was too high but he did not have any way to measure it or control it). We talked about how to solve his immediate problem by opening some of the manual vents but left him with the following suggestions. 1.) He should purchase some controls for the kiln since he had no way of measuring the conditions inside the kiln or the moisture of the lumber, and 2.) We discussed proper loading techniques that will allow better airflow through the lumber.

June 12, 2009. We conducted another drying workshop for the wood products industry in the town of Pejë/Peć at Kosovo Wood. The workshop was attended by 6 individuals from the industry and two wood products instructors. The workshop seemed well received. What worked well was the workshop was held around a large conference table in a relaxed atmosphere. The attendees were uninhibited to ask questions.

Training session at Kosova Wood

June 13, 2009. I reviewed field notes and progress of the project. Also I put together my initial thoughts for my out briefing with USAID.

June 14, 2009. Off.

June 15, 2009. We returned to Kosova Wood in Pejë/Peć to answer further questions and look at there operation. Observations include: 1. Saw shop equipment is excellent, 2. Dirt and stones are a problem dulling the saws, 3. Saw feed and speed calculations should be done to evaluate sawing efficiency, 4. The addition of conveyors could greatly help the efficiency of the sawmill, 5. The green chain roof should be extended or moved to protect the green lumber, 6. More air circulation is required for the short sapwood pieces drying in the air drying shed, and 7. The water spraying system inside the kiln was not functioning correctly.

June 16, 2009. Today we spent the morning with Tefik Qanga Design a privatized former government plant. They are the only former government plant that we visited that looked like it had an order file and was processing these orders. We started of discussing with the manager some design changes he had made in outdoor furniture to account for wood movement. We then toured the plant and ended up discussing drying procedures with the manager and three students from the University of Ferizaj who were working. We discussed protecting the lumber in the air drying yard, loading the dry kiln to insure uniform drying conditions, selecting in which board and where on the board they were going to put there moisture probes, kiln drying procedures, equalizing and conditioning.

After lunch we visited Promoplast (see June 11) to see his progress. The mold had been killed off, most likely because of the high uncontrolled temperature. We said at this point

because he could not control the temperature keep the humidity high trying to retard drying. We also encouraged them to follow up and purchase some controls.

June 17, 2009. In the morning we visited a small flooring manufacturer, Lidhja. The firm had a very simple product line and seemed to be profitable. There manufacturing line consisted of a miniature band mill and carriage for breaking down bolts into short flooring blanks, a homemade dry kiln (no heat control and a manually operated vent to control the humidity) and a single machine that shaped the piece, trim and profile the end. Even though the dry kiln was primitive they seemed to be having good success because they rapidly converted the logs, the small pieces the dried and the system was balanced.

They have purchased a parquet flooring machine from Weinig in Germany and plan to be manufacturing this product soon.

This business seemed to be well balanced in terms of market, production capability and raw material. In other terms, simple and well-run.

In the afternoon we strategized over how to continue the efforts and institutionalize them.

The owner explaining the operation of a homemade dry kiln

June 18, 2009. In the morning I met with Dr. Agron Bajraktari, Dean of the Faculty of Technical Applied Science, University of Prishtina, Ferizaj/Uroševac to discuss trying to institutionalize 1.) An extension position in which a faculty member would serve as a resource for the wood products industry (see recommendation 1) and 2.) Develop an exchange program to develop expertise in wood products marketing (see recommendation 5).

Next we visited Playground Industry to discuss pressure treating lumber for playground applications. I suggested instead of them investing in the treating process (the volume of wood they use would not justify the investment) they look at purchasing lumber that has been treated with some of the non-traditional chemicals. I showed Rrahim on the internet the contact information for these firms.

In the afternoon we had scheduled an out briefing for USAID at 3:30 pm. At the last minute they had a schedule change so John MacKillop, KPEP, Burim Meqa, KPEP, Rrahim and myself discussed the results and recommendations of the project.

June 19, 2009. In the morning we met with two foresters with the Ministry of Forestry near Ferizaj/Uroševac and proceeded to briefed by them on their forest management practices. The majority of the forest we saw was beech forest managed on a selective cut basis. That is they individually selected trees that were starting to decline in vigor due to age, poor form, rot or other damage. They also discussed problems they had with illegal logging, road construction, road access and etc.

The above tree was selected for cutting due to the rot in the base of the tree

June 20, 2009. Reviewed my field notes and started writing my trip report.

June 21, 2009. Departed for the United States.

TASK FINDINGS

In general, Kosovo wood products manufacturers can be categorized into two different groups. One group is made up of small manufacturing firms, with relatively poor kiln technology (home made kilns, etc.). The produce a diverse product range, and have a relatively low productivity when compared to world standards, yet at the same time they are financially successful due to their sales. The other group of manufacturers consists of those that bought privatized government operations that have relatively good physical plants. These firms sometimes may not be as successful financially as the smaller firms due to weaker order files (sales).

Overall the level of drying technology was at a very basic level. Many of the operations cut thick stock (more difficult to dry), little protection of logs or lumber from degrade prior to kiln drying, homemade kilns with no monitoring or control systems and little knowledge of kiln operation. At the larger operations too much trust was put into the computer controls.

It was amazing to see the progress the firms have made developing their business, starting from zero seven to eight years ago. Due to the environment they have operated in they are job shops, accepting a wide range of orders and doing all the work in house from sawing, to drying, to secondary machining, to finishing, ending with the showcasing and marketing of their products. One has to realize this has allowed them to develop, survive and prosper under very difficult circumstances. It has however prevented them from specializing and gaining the efficiencies and controls over there operations, and targeting specific markets, that other manufacturers around the world have.

I asked Arieta Vula the Executive Director of the Kosovo Wood Association what the major concerns of her members were. She stated her members' two major problems are 1.) General bureaucracy in procuring raw material and 2.) Access to international markets. In other words the biggest current problems or constraints are the lack of orders due to the current economic downturn and access to raw material. As orders increase, the problem with the lack of raw materials will increase.

Many of the wood products business are at a dangerous crossroads, having to decide what directions they want to go in. They operate without the help of a proper accounting system. They use what is known as the cookie jar accounting method. If the cookie jar is full (if the bank account or wallet is full) they are making money, if it is empty they aren't. Many I talked to had no idea of their per unit cost of production and how these costs are driven. If they are going to be successful in the future they will need some idea what these costs are.

Therefore instead of thinking strategically of what investments need to be made to expand markets, improve quality and lower cost they are often tempted to buy technology for the wrong reason. Continued assistance would greatly benefit the firms.

CONCLUSIONS AND RECOMMENDATIONS

1. **Institutionalizing Technology Transfer in Wood Products.** The University of Prishtina's Wood Products Department has a growing and vibrant program. It would be helpful both to the industry and the Wood Products Program if they developed an extension program similar to those found in Land Grant Universities in the United States. These programs provide outreach education by the University for select clientele groups, especially in agriculture and forestry areas.

   The tradition of extension is taking research based information, developing demonstrations (show places) with cooperators, and the using these demonstration sites to conduction educational programs for the client group.

   The benefit to the University is that because of the interaction with industry, the teaching and research components remain very relevant in relationship to the needs of the industry. For example, an individual with a combination teaching and extension appointment can involve their students in solving real industry problems. Also in return for the University's support of the industry, the University gains the support of industry.

2. **Maintaining the drying program and moving forward**. From my perspective I think in the three weeks of my visit we made excellent progress in explaining to the wood products industry the need for proper kiln drying techniques and the major principles driving these techniques. Rrahim Sejdiu would be an excellent individual to continue supplying technical assistance, especially if he was connected with the University of Prishtina.

   As companies try to implement improvements, they would greatly benefit from more technical and financial analysis assistance. From my perspective I would be happy to serve as a mentor for Rrahim and in addition would be will to follow up this fall, or next summer or both with another assignment. Those companies benefiting from this one on one consultation should agree to serve as demonstration sites. That is, the Association of Wood Processors of Kosovo and Rrahim Sejdiu would be allowed to host an afternoon visit for members of the industry to view the improvements at the cooperating firms.

3. **Maintaining the drying program.** Rrahim Sejdiu, my assistant on the project is intelligent and has a good background in wood technology. He is very capable of learning the finer points in lumber drying and teaching the industry. During my stay he translated my conversations during our industry visits; he also translated a part of the first workshop and the entire second workshop. Translating technical terms and complex thoughts is not an easy task even for a well seasoned translator. To further his career as the Kosovo lumber drying resource I suggest that he receive further training in English. This will allow him to easily reference a great deal of lumber drying information.

4. **Maintaining the drying program**. For the workshops I prepared a number of Power Point presentations in English. These were translated in Albanian. As we conducted the workshop, we found better terms which were more familiar to the audience and that translated the ideas more clearly. It is suggested that one of the tasks to be given to Rrahim Sejdiu is to review these translations, correcting and updating them. Professor Osman Osmani, Rrahim's professor, would be and excellent individual to help review these presentations for technical correctness in Albanian. After the

review, the material can be given to the Kosovo Wood Processors Association so that it can be put on their Web site for use by their members.

5. **Training in wood products markets.** Arieta Vula the Executive Director of the Kosovo Wood Processors Association (AWPK) identified that one of the major problems for her members is access to international markets. A suggestion is to develop a program in conjunction with the AWPK and the University of Prishtina to send two students for a master's degree in wood products marketing to North Carolina State University to conduct their studies. Their wood technology training, as well as intensive training in English, would be accomplished in Kosovo. Their training in wood marketing and their project would be conducted at North Carolina State University.

   The participating students as well as their research projects would be chosen by the AWPK (in agreement with their major professor at NCSU and the University of Prishtina). USAID would provide the funding and the students would have to meet the admissions standards of North Carolina State University. The students would be required to perform a six month internship assisting the industry upon their completion of the training.

ANNEXES

1. Power point presentations:

    - Air Drying Through Pre drying Lumber
    - Applying Schedules
    - Moisture Measurements
    - Proper Kiln Sample Selection Techniques
    - Quality Handling Proper Moisture Control
    - Stacking Techniques to Improve Flatness

2. Evaluations from participants

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Air Drying Through Predrying Lumber

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Flat Lumber

- Uniformly sized lumber
- Quality sticks – full sized, dry
- Bottom cross pieces, sticks and bolsters should form a continuous column of support
- Weighted stacks
- Avoid overdrying

Types Of Lumber
Refractory Woods

- Easy to 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

Severe initial drying equals checks:

Avoiding Checks

- Avoid exposing lumber to direct sunlight and rain
- Avoid low initial humidities
- Use end coating
- Use sheds, fan sheds or cross flow predryers instead of air drying lumber
- Avoid higher than recommended dry bulb temperatures

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

Avoid Air Drying

- For refractory woods protect from the sun and the rain during all handling operations and use sheds, fan sheds or predryers
- For white woods – all effort should go into stickering and placing in the kiln as soon as possible

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

Log Storage & Wet Decking

- Helps prevent fungus stain, splitting & checking
- Perfect environment for gray stain to develop and bacteria to multiply

Log Storage & Wet Decking

- Limit your log inventory
- No longer than 2 weeks in summer
- First in, first out – keep logs rotated
- Low grade versus high grade strategy

Log Storage & Wet Decking

- Use good log inventory practices -
  - Control log inventory
  - Log inventory rotation
  - Water
- Limiting log inventory and end coat or end treat logs may be a much better alternative

Lumber Dipping And End Coating
(Needs to be done before defects form)

Coordinating Lumber Delivery

Preventing Stain

- Stack lumber within 12 hours of being sawn
- Coordinate cutting, stacking, kiln availability and drying
- One advantage of two smaller kilns versus a large kiln is faster loading

Receiving, Grading And Stacking

- Insure you are getting what you paid for
- Lumber should be stacked within 24 hours of receipt
- White woods – white hard maple – should be stacked and placed in the kiln immediately

Stacking Practices

The devil is in the detail:

Quality Stacking

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

Stickers

- Use dry stickers – stickers need to be able to transfer water
- Use stickers that are no more than 1-1/4-inches wide, by 3/4- or 7/8-inches thick
- Stickers should be of uniform thickness and width for their full length
- Use grooved or routed stickers, which allow some air movement under the sticker

Preventing Stain

- Put lumber in a fast drying location so the chemical reaction can't occur
- Some operations use blow boxes (fan sheds) to place lumber while waiting for a kiln to empty
- Load the kiln with the fans operating

Know Your Enemy

- Enzymatic, Oxidative, Gray Stain or Sticker Stain
- Fungus
- Bacteria Infection
- Iron Stain
- Other

Enzymatic, Oxidative, Gray Stain, or Sticker Stain

- Aggravated by log storage, including wet storage, and poor drying conditions such as dead piled lumber
- Dipping does not help, may aggravate
- Need rapid drying

Avoiding Brown Stain In White Pine

- Research, and more importantly practical experience, has shown the most important factor in eliminating brown stain is minimizing the time from when the tree is felled to when the lumber sawn from it is put in the kiln.

Fungus

- Needs air, water and food
- 80 to 100ºF prime growing temperature
- Dipping – can often create additional color problems
- Water storage of logs
- Log and lumber inventory management
- Rapid drying

Fungus

- Low airflow and high humidity contributed to the mold on this lumber

Bacteria Infection

- Found in weaker and damaged trees, often transferred by roots, timber that has been cattle grazed
- Weakens wood
- Often identified by smell
- Often associated with a higher moisture content that is more difficult to remove

Bacteria Infection

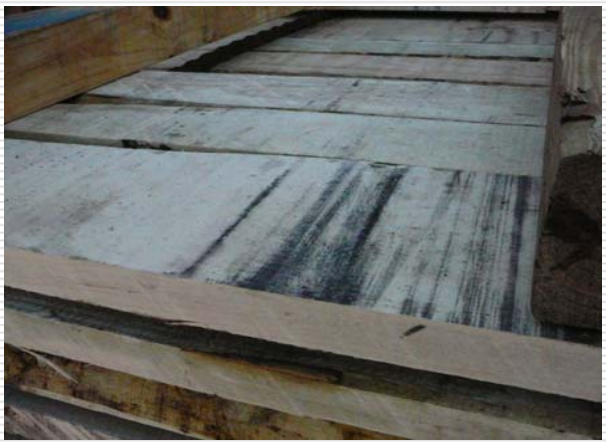
- Some bacteria does not need oxygen to survive
- Pre-dry at low temperatures to avoid checks
- Can cause dulling of color in kiln dried lumber
- Some aerobic bacteria cause sticker shadow

Iron Stain

- Caused by wet lumber coming in contact with iron resulting in a blue-black discoloration
- Wood is a good absorber of iron
- Prevention is to minimize or avoid contact with iron
- Dip treatment after contamination can reduce the visibility of the problem

Iron Stain

- Effective control measures are based on limiting the contamination of wood by iron
- Look for contamination such as high iron water, iron pipes in log yard spray system, components of the dip tank, contaminated sawdust in tank



Other

- Keep your operation free of wood debris to help avoid insect infestations

Preventing Stain

- Avoid situations that require dipping if at all possible – put “white woods” into kiln as quickly as possible

- Dip as soon as lumber is sawn, if lumber cannot be immediately stacked and dried

Preventing Stain

- Dip tank quality control
- Species change
- Your dip supplier can be a great asset in providing information

Preventing Stain

- Keep lumber out of the rain

Drying too slow results in stain:

Purpose of Pre-drying

- Reduce moisture content so kiln drying time can be reduced (for this to happen need uniform moisture coming from the shed or pre-dryer)
- Reduce drying degrade by drying under more controlled conditions

T-Sheds

- Roof supported by columns in the center ridge
- Can reduce drying loss compared to air drying
- May be more expensive than pole shed
- May dry to rapidly – use shade cloth
- Lumber exposed to blowing rain

Pole Shed

- Slower drying
- Stain may be a problem
- Good 6/4 to 8/4 solution

Fan Sheds

- Fan Sheds
- Limit thickness on oak to 4/4 and 5/4
- Watch humidity
- Keep fans turned off initially

Operation Recommendations

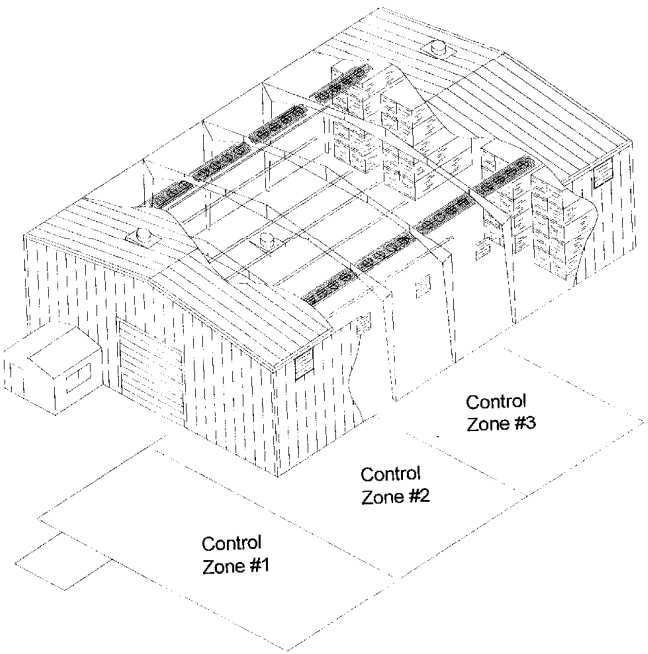
- Use shed samples
- Check for mold using flashlight
- Use sling psychrometer to keep track of EMC inside the shed as well as outside
- Use of a humidistat that can turn fans on and off based on humidity

Typical drying rates for lumber dried in fan shed in the Appalachians

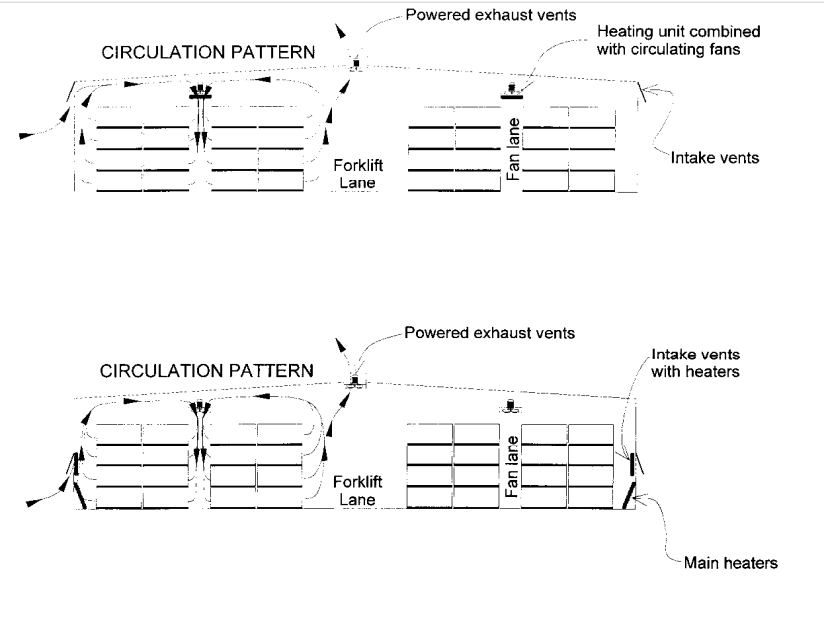
Species and thickness	Time initially piled in shed	Drying time (days)	Change in MC (%)
4/4 red oak	End of January	56	80 to 28
4/4 white oak	Middle of January	38	60 to 35
5/4 red oak	Beginning of October	114	96 to 28
5/4 white oak	Beginning of October	40	52 to 31

Warehouse Predryers

- Most predryers are laid out into zones for better control, not for running different schedules
- Look at your control chart to see how well you can control

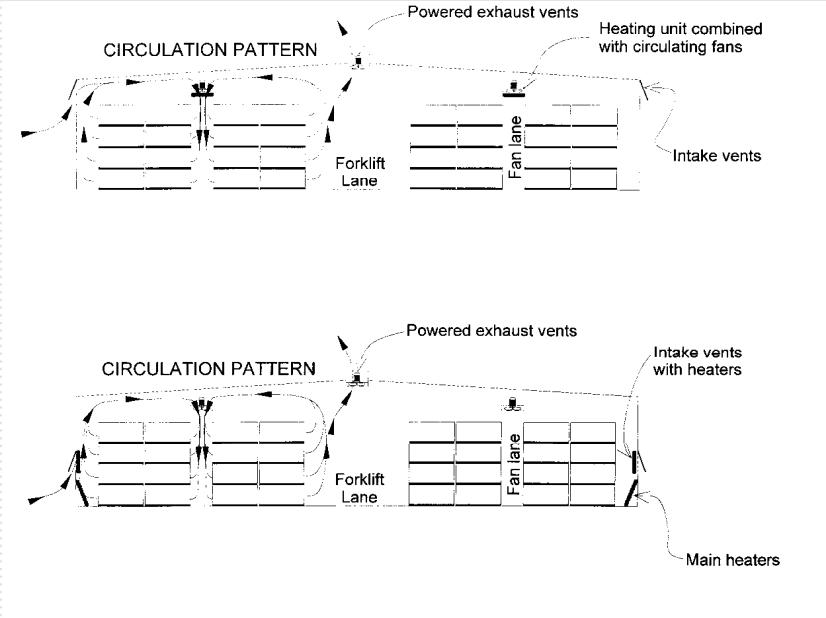


Points To Consider



1. Location of dry bulb and wet bulb sensors (humidity)
   - Are you measuring the hottest air, lowest humidity etc?
2. Control zones
   - How is the pre-dryer divided up into control zones
   - Which temperature sensors control a zone

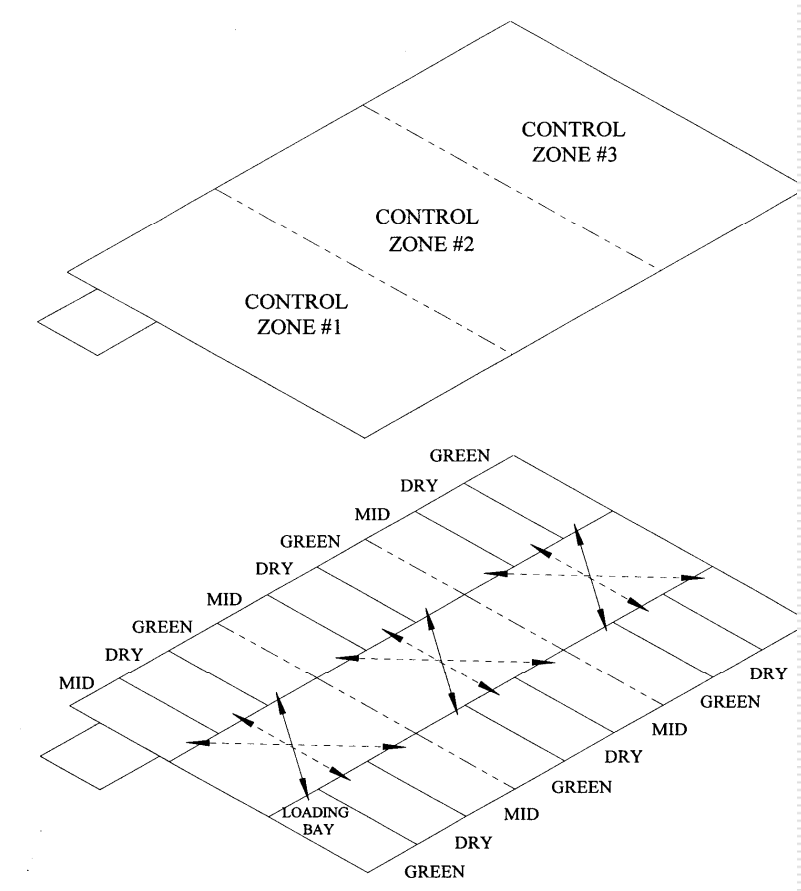
Points To Consider



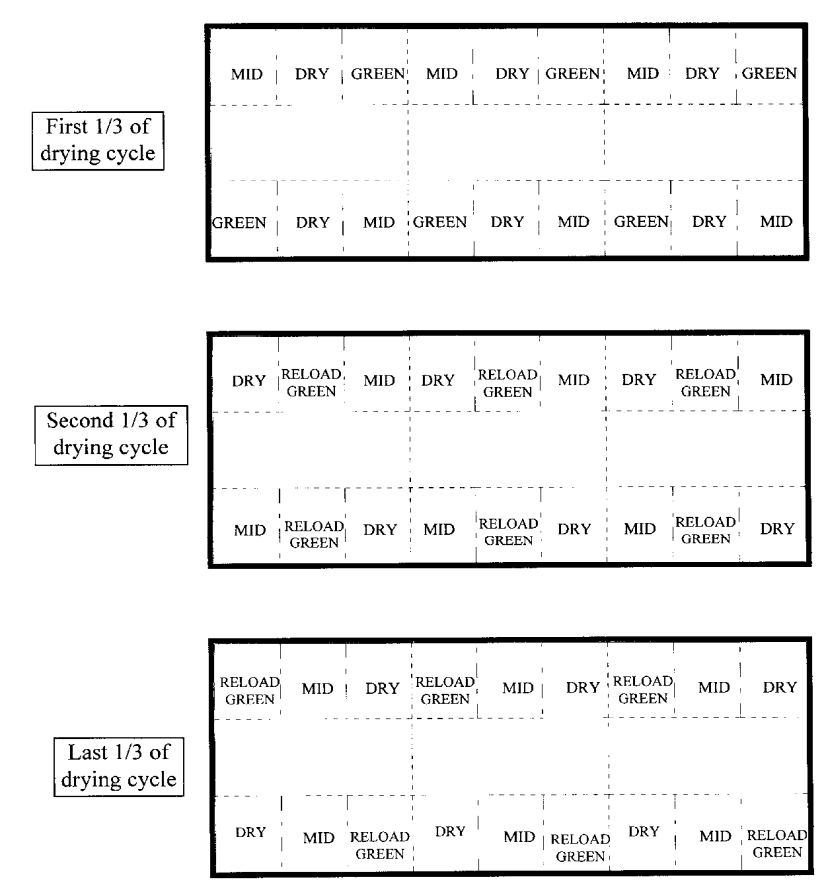
2. Control zones (continued)
   - Ability to control heat and humidity in a zone (heating and venting capacity versus the amount of green lumber
3. Calibration of controls
   - Humidity wafers – maintenance (new wafers and clean off contacts with steel wool or fine emery paper)

Loading and control strategy is critical

- Load by zone and control by zone, in theory the best, but you can overwhelm venting and heating capacity
- Maintaining a lumber mix in a zone is a compromise, it may however give you the best control.



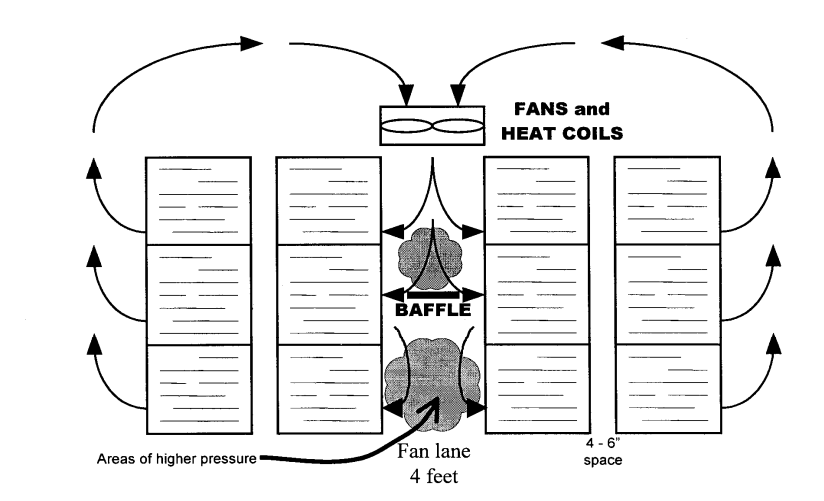
Warehouse Predryers



- Keeping a balanced mix in each zone

Airflow

- Usually not uniform from top to bottom
- Higher airflow on the bottom
- Lower or negative airflow on top
- Goal is to have uniform airflow top to bottom of 125 to 150 fpm
- Keep 4 to 6 inches between packs
- Use of end baffles and between zones



Predryer Operation

- Check temperature and humidity every day with sling psychrometer or hydrometer (remember, you need enough air flowing past a wet bulb to be accurate)
- Look for mold, stain and checking
- Use samples both on the hot and cool side
- Use lower temperatures, wood is strongest at low temperatures and low moisture contents
- Protect green lumber, put it in the pre-dryer
- Do not add moisture back in on to the surface during kiln start up
- Keep the predryer clean

Cross Flow Predryer

SII Cross Flow Predryer

- Kaufman Stairs (Visador), Muligan Flooring, Piedmont Flooring, Edwards Wood Products
- Controls
  - Temperature in each zone
  - Wet Bulb via venting
  - Airflow – variable speed
- Construction
  - Center fans and heater means clear span building not needed
  - Re-heat coils above
  - 18 to 24 feet of lumber each side, 30 foot forklift aisle each side (120 feet width versus 100 feet for a conventional pre-dryer)

Advantages and Costs

Advantages

- Better control
- More uniform & higher airflow

Cost

- Equipment $0.50 to $0.55 per board foot
- Building and concrete $0.50 to $0.55 per board foot
- Total $1.00 to $1.10 per board foot
- Equipment $0.32 to $0.35 per board foot for conventional predryer

Good luck – don’t get hurt!

Joe, Stoffel & James Rosenfels, Chenje

Applying Schedules

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Points to consider

- Wood is stronger (more resistant to checking and warp) at lower temperatures
- For green lumber the drying rate is controlled by how fast moisture can go from the surface of the lumber to the air, so the lower the RH% or EMC%, the faster drying will be
- During the later stages of drying, the drying rate is controlled by how fast the water molecules can migrate from the interior of the piece to the surface, heat becomes the controlling factor

Modification of kiln schedules

1. Changing resource quality is and quality-conscious hardwood lumber users
2. Customer are looking for:
   - Lumber with the color appearance of green wood
   - Need for flatness (overdrying hurts)
   - Machining problems increase with overdrying

Modification of kiln schedules

3. Changes suggested for the basic schedules include:

- Do not use more heat than is required to get the job done. Try to limit the maximum temperature of the schedule prior to equalization and conditioning should be no higher than 160°, the previous recommendation was a maximum of 180°F.
- In practice, some operators will raise the temperature no higher than that needed to achieve acceptable drying rates; in some cases, this means a maximum temperature of 140°F. Drying schedules for lower quality lumber can use 180°F for faster drying.

Modification of kiln schedules

- Use a maximum wet-bulb depression of 45°F (an EMC of 3.7%) or better yet 40°F (an EMC of 4.4%). Some are using a maximum wet bulb depression of 35°F (for a minimum EMC of 5.0%)
- Avoiding high depression values improves lumber machinability and reduces cup. These suggestions have been incorporated into the schedule recommendations.

Sterilization

1. Sterilization is a procedure to kill any noxious insects and their eggs (and perhaps any fungi) in the lumber. The objective of sterilization is to prevent forest pests from spreading from one geographic location to another.
2. It is required for lumber being exported to certain countries. All research indicates that when wood is thoroughly heated to 130°F, this treatment will kill all existing insects, their eggs, and any fungi associated with wood.

Sterilization

3. Typically requires the center of all the lumber in a kiln or sterilization chamber to be heated to 133°F (56°C) for at least 6 hours (shorter times are certainly quite effective, ½ hour at 133°F internal temperature for meeting international standards).
4. To ascertain the exact sterilization time, a company must consider the lumber MC, lumber thickness, type of heat used, and kiln or chamber characteristics.

Sterilization

5. Usually, temperature measurements are made within pieces of lumber (in the slowest, coolest part of the kiln) to develop a specific procedure and confirm that the required procedure is adequate. The dryer is then “certified.”

Sterilization (*notes*)

1. For green lumber the temperature of wet lumber is closer to the wet
2. Because the steam temperature exceeds 212 ^{o} F and because steam condensation on cold lumber provides excellent heat transfer, steaming times seldom exceed 1 hour for most products and species.

Sterilization (*notes*)

2. Lumber that is sterilized can be reinfected if not dried to below 20% MC for fungi, and below 10% MC for many insects.
3. Always check for special sterilization regulations when the lumber is to be shipped to another country to make sure that the procedures discussed here are considered adequate.

Warp and Shrinkage Reduction

1. The basics always apply including uniform thickness of lumber and sticks, length sorting, good stacking practices including perfect vertical alignment of stickers, pile foundations, and bolsters. For warp prone lumber and lower grade lumber use 1 foot sticker spacing.
2. Use weights on top of loads.

Warp and Shrinkage Reduction

4. Research on red oak has shown that shrinkage is reduced by using lower temperatures and rapid reduction of relative humidity (McMillen 1963).
5. Rapid initial drying by natural air drying or by accelerated air drying
6. The effect is uniform from 140°F to 95°F. From 95°F to 80°F the effect is greater because more of the wood is affected by tension set. Tension set tends to resist shrinkage of the board and thus reduces warp.

Warp and Shrinkage Reduction

6. Experiment with lower RH schedules by using slightly higher initial wet-bulb depressions. Changes from recommended or basic schedules should be slight at first, and the kiln operator needs to observe the stock in the kiln frequently to see whether any surface checking is developing. Get the consent management.
7. Do not overdry. Use an EMC no lower than the target moisture content minus two percent.

Redrying (lowering the moisture content)

1. Redrying kiln-dried lumber that has been kept in uncontrolled storage requires great care. Surface checks that were tightly closed may become permanently opened or internal hairline checks can occur.
2. If the storage period has been short, tightly bundled lumber can be redried in the bundles because most moisture pick-up will have been on the board ends and the surfaces of exposed boards. For longer storage or for lumber that has been kept outdoors on stickers, the lumber must be stickered. Sample your lumber before you decide what to do.

Redrying (lowering the moisture content)

3. Use the following thoughts in redrying:
   - At least two temperature steps are suggested for the redrying operation. The first step should be about 1 day long at 120 to 130°F. The second step should be at the final temperature of the drying phase of the basic schedule usually 160°F.
   - The second temperature can be achieved by using several smaller steps, rather than making a 20°F or greater jump in temperature.

Redrying (lowering the moisture content)

- Do not use steam spray during kiln warm-up. Surface checks already present may open, but they will close again as the wood dries. When the first kiln temperature is reached, set the wet-bulb controller to achieve a start-up EMC that is numerically halfway between the current MC of the lumber and the MC desired.
- For the final step, set the controller to give an EMC 2% below the desired MC. When the wettest kiln sample reaches the desired MC, stop drying.
- Check and see if you need to re-condition the lumber.

Kiln operational techniques using a kiln schedule

- Always make sure to “get what you set.”
- “Don’t let lumber regain moisture.” Regain of moisture, especially at about 20% MC, will accentuate warp, cracks, and checks and may result in stain.
- Check the lumber in the kiln daily to stop any problems before they become catastrophic. This inspection includes measuring the MC and evaluating the daily rate of moisture loss.

Fine tuning schedules using drying rates

- Kiln schedules are intended as guidelines
- Use common sense to fine tune them.
- Schedules should act like highway speed limit signs. The signs indicate the maximum speed, but the driver should not go that fast when common sense indicates that it isn't safe.

Fine tuning schedules using drying rates

- Experience is an important factor in drying hardwood lumber.
- Visually inspect the samples, watching for staining or checking and measure the drying rate of the samples and compare the actual rate to the safe rate.
- For every species and thickness, there is a safe rate of drying (percentage of MC loss per day) that will result in high quality dried lumber.

Fine tuning schedules using drying rates

- Exceeding this rate greatly increases the risk of quality loss. Likewise, going considerably under the safe rate can increase the risk of staining and can be quite expensive.
  - Daily rates and are daily maximums and not the average of several days
  - Individual sample should exceed the safe rate.

Other thoughts (equalizing)

- For energy savings procedure and avoiding discoloration by spraying try to achieve the correct EMC by lowering the dry-bulb temperature.

Other thoughts (conditioning with steam)

- The key for efficient stress relief or conditioning is to rapidly add moisture back to the surface of the lumber.
- Dry bulb temperature override
- Solutions
- Stress samples
- Uneven conditioning results

What to do when drying apparently stops

- Drying will never actually stop if the EMC of the kiln atmosphere is lower than the core MC of the lumber, but the drying rate is extremely slow. So either the EMC in the kiln is not what you believe or your sample inaccurate.
- Look and see what your other samples are doing. If the other ones are falling cut an intermediate sample. Check the EMC in the kiln using a hygrometer.

What to do when drying apparently stops

- To correct this problem of “slow drying,” the dry-bulb temperature can be slightly increased (perhaps 1 to 5°F during the intermediate stages of drying. Higher increases are not recommended because of the risk of degrade.
- If a kiln operator decides to increase temperature above 30% MC, the operator should make sure that the kiln controller is properly calibrated.

Moisture Measurements

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Moisture Content

The ratio of the weight of water versus the oven dry weight of the wood, expressed as a percentage. Dry basis.

$$MC\% = \frac{\text{Weight of water}}{\text{Oven dry weight of wood}} \times 100\%$$

Moisture Content (continued)

- Oven dried:
- 103 +/- 2°C
- 101 to 105°C
- 214 to 221°F
- Until constant weight is reached (at approximately 4 hour intervals)

Moisture Content (continued)

Given that the weight of water in a piece of wood is the difference between the green weight and oven dry weight:

$$MC\% = \frac{(\text{Green Weight} - \text{O.D. Weight})}{\text{Oven dry weight of wood}} \times 100\%$$

Moisture Content (continued)

- Other suggestions:
- Make your samples large enough so that errors from drying, fiber loss etc. have little impact (I-inch in thickness across the grain)
- Rub off fibers after the sample is sawn
- Use plastic bags to limit moisture loss between sample preparation and weighing.

Microwave

- Same concept and math as conventional samples
- You must dry to a constant weight
- Danger of scorching the sample or not getting all of the moisture content out is a problem
- Quicker in results, but takes more baby sitting by the operator.
- Not as accurate as using the conventional oven

Microwave

- Consider cutting your samples slightly thinner than the conventional method, but no less than 13 mm to 19 mm (½ to ¾ of an inch). The reason behind not going too small is errors from drying out prior to initial weighing increases, etc.
- Microwave should have rotating carousel
- Try 10 minutes initially for dry samples, 20 minutes for wet samples
- You must dry to a constant weight
- When you are starting off with the micro-wave plot your data

Experience has shown

- Less chances of mistakes with a conventional oven
- Less operator time with conventional oven

Proper Kiln Sample Selection Techniques

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Why do we take samples?

1) Reduce drying degrade
2) Better control of final moisture content
3) Reduce drying time and increase quality
4) Develop time schedules
5) Locate kiln performance problems
6) Run temperature and wet-bulb schedules

More Thoughts On Samples

- Reflect the performance of the kiln
- Care should given to selection (some wet, some dry)
- Care needs to also be used in selecting samples for remote sensors (pin moisture detectors, etc.)

Variables To Consider When Selecting Kiln Samples

1) Species
   - specific gravity
   - shrinkage
   - species characteristics
2) Thickness - thicker lumber dries slower, twice as thick will take four times as long to dry.
3) Drying history - how much air-drying?

Variables To Consider When Selecting Kiln Samples

4) Heartwood vs. Sapwood
   - MC
   - Tyloses, resins, or tannins make heartwood slow drying

5) Quartersawn vs. Flatsawn

6) Width

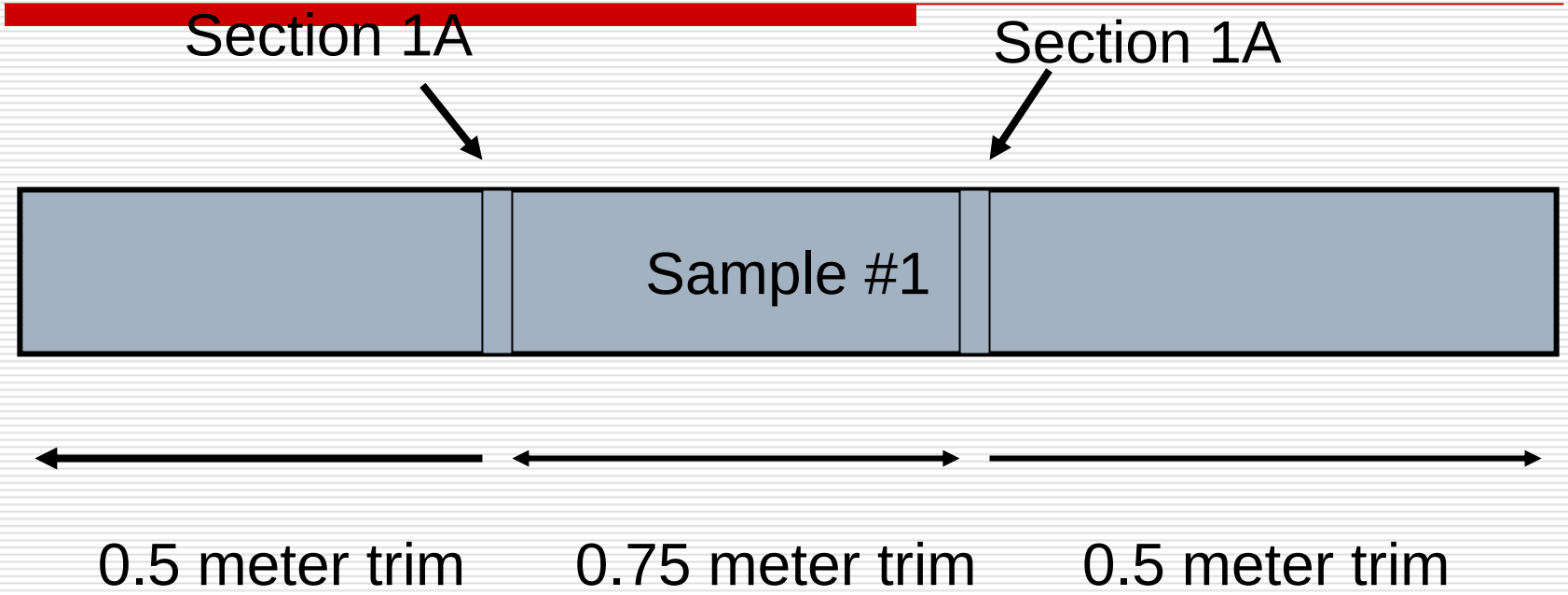
Why It Is Important To Take Samples From the Inside Of A Pack

- Samples were selected from predried material from the outside edge of a pack with a moisture meter
- The sample selected read 50.3% on the moisture meter, in actuality the moisture content was 38.7% by the oven dry method.

Why It Is Important To Take Samples From the Inside Of A Pack

- In the pack, using the oven dry method the following moisture contents were found 53.0%, 44.9%, 32.9% and 30.5%
- What would happen to the wetter pieces if we ran the kiln on the dryer sample?
- Spend the time and effort to pick good samples, especially on partially pre-dried or air dried material

Sample Preparation



Sample Preparation

- Clear wood, no large knots, rot
- 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)
- Look at samples every day so that you can maximize kiln productivity

Selection of Samples

- Train your people at the stacker
- One sample per board
- Look for boards that are heavier, wetter, thicker, wider, higher percentage of heartwood - but remember to get a few dryer, lighter boards to tell you when to equalize.

How Many Samples

- It depends on .....
- Statistics indicate 20 or more
- Rules of Thumb
  - a minimum of 4 samples for 20 MBF kiln charge
  - 10-12 samples for 100 MBF kiln charge
- Consider cost of ruining a kiln charge and the variability of the charge

QUALITY HANDLING OF WOOD FOR PROPER MOISTURE CONTENT CONTROL

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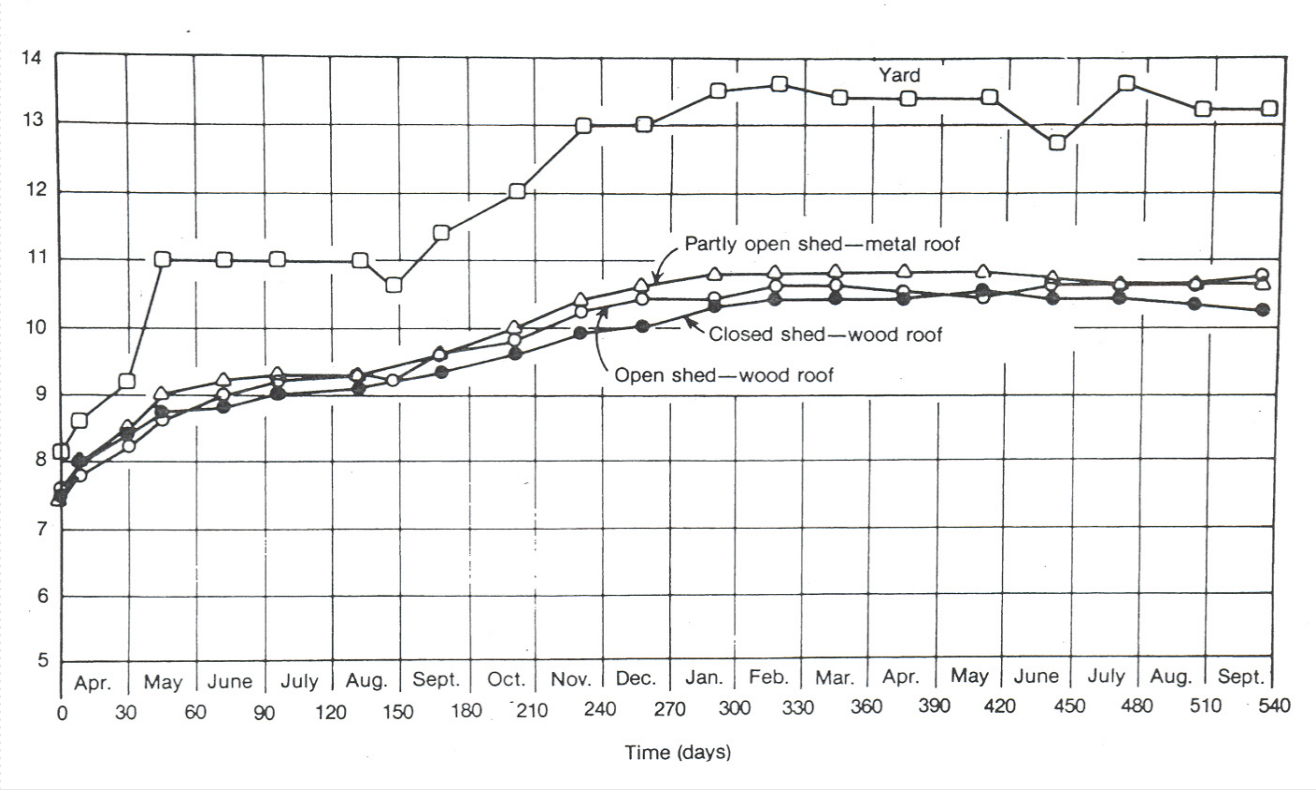
Correct and uniform moisture content

- Use enough samples
  - One per 10,000 Bf
  - A minimum of 4 per lumber type
- Use good sample selection procedures
  - Choose slow drying, wet sample
  - One or two dry samples
- Insure you are using good equalizing procedures and that you are equalizing long enough (check for moisture content uniformity)

Lumber picks up moisture if not properly stored



The outside of a lumber pack picks up moisture first

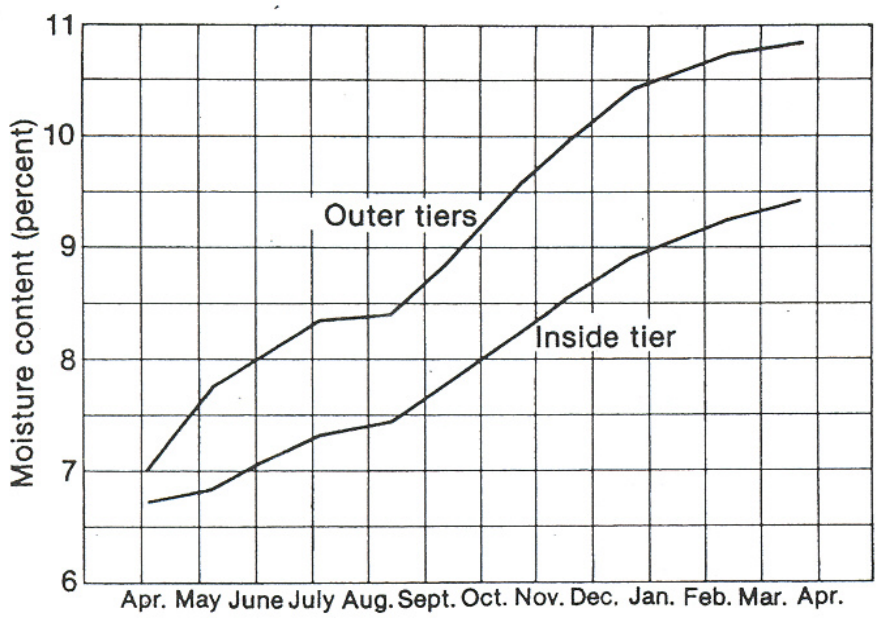


Figure 10-13—Change in average moisture content of solid-piled, surfaced 1- by 8-in Douglas-fir boards stored in an open shed. (ML88 5556)

Vapor barriers only retard moisture gain and sometimes hinder its exit

Table 1.—Average moisture content of study lumber piles.

Cover treatments	Days from initial moisture content readings					
	0	20	40	60	80	188
	%	%	%	%	%	%
Solid-stacked lumber, polyethylene shroud on top, sides, and ends	8.2	8.7	9.6	10.7	12.5	17.0
Stickered lumber, polyethylene shroud on top, sides, and ends	8.8	8.4	9.0	9.7	11.2	14.8
Solid-stacked lumber, polyethylene-wrapped entirely	8.5	9.1	10.3	11.5	12.9	19.2
Solid-stacked lumber, Kraft paper wrapped entirely	7.6	7.7	8.1	8.9	10.6	12.9
Stickered lumber, metal-roofed only	7.9	10.6	11.4	12.0	13.8	14.5

"Moisture Changes In Dry Lumber Storage" by Milton Applefield, SE Forest Experiment Station using 4/4 kiln dried soft maple stored outside.

To maintain MC of kiln dried lumber

- the best course of action is to use a heated shed. In order to maintain the desired EMC% of the lumber use heaters with circulating fans and a differential thermostat.

Steam heat hot air heater

Maintaining desired EMC

	Desired Equilibrium Moisture Content		
	6%	7%	8%
Outside RH%	Required temperature differential (°F)		
90	33	29	23
80	30	25	19
70	25	20	15
60	20	15	9
50	15	10	5

Redrying (lowering the moisture content)

1. Redrying kiln-dried lumber that has been kept in uncontrolled storage requires great care. Surface checks that were tightly closed may become permanently opened or internal hairline checks can occur.
2. If the storage period has been short, tightly bundled lumber can be redried in the bundles because most moisture pick-up will have been on the board ends and the surfaces of exposed boards. For longer storage or for lumber that has been kept outdoors on stickers, the lumber must be stickered. Sample your lumber before you decide what to do.

Redrying (lowering the moisture content)

3. Use the following thoughts in redrying:
   - At least two temperature steps are suggested for the redrying operation. The first step should be about 1 day long at 120 to 130°F. The second step should be at the final temperature of the drying phase of the basic schedule usually 160°F.
   - The second temperature can be achieved by using several smaller steps, rather than making a 20°F or greater jump in temperature.

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- Do not use steam spray during kiln warm-up. Surface checks already present may open, but they will close again as the wood dries. When the first kiln temperature is reached, set the wet-bulb controller to achieve a start-up EMC that is numerically halfway between the current MC of the lumber and the MC desired.
- For the final step, set the controller to give an EMC 2% below the desired MC. When the wettest kiln sample reaches the desired MC, stop drying.
- Check and see if you need to re-condition the lumber.

In-plant moisture control

- in the summer the problem is usually high humidity
- in the winter low humidity.

Shipping

- If you don’t have good storage it will cost you in terms of kiln productivity because you will have to redry.
- Sales needs to forecast what lumber is to be shipped.
- Three or four days prior to shipping, shipping supervisor needs check lumber for moisture content and redry as necessary.

Imported Wood Products

- The problem needs to be solved at the source
- There are no good options for redrying finished product
- If you receive wet finished products I recommend
  - Report it to management so that they can review their claims procedure
  - Inform management that there are serious dangers, cracking and checking, warp, loose joints, and quality problems with the finish
  - Keep a record for management of rework, late shipment, and other costs due to the problem
- Use low temperatures and non-drastic humidity changes when trying to redry

Heated room option

- Final drying should be to exposing wood product to 2 percent below desired EMC
- If difference is large between final desired MC and current MC, dry in several stages
- Lower the EMC by raising the temperature
- Typically 20 to 30°F above the outside temperature
- Use a fan to get uniform temperature distribution
- Monitor with a hygrometer

Shipping

- Just prior to shipment check moisture content . . . almost too late at this point.
- Kiln dried lumber should be tarped during shipment. Establish a procedure . . . so you don't end up being the boogie man to the truck drivers. For example a sign reading, "All kiln dried lumber must be tarped prior to leaving the premise" is pretty clear.

Stacking Techniques To Improve Flatness

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Stacking Practices

The devil is in the detail:

Quality Stacking

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

Quality Stacking

- Uniform lumber and sticker thickness
- Good alignment

Quality Stacking

- Length sorting insures that the sticker is supported by a piece lumber underneath

Quality Stacking

- High foundation
- Pile cover

Quality Stacking

- What can I say
- Good alignment between foundation, stickers and cross outs
- Roof cover keeps rain and sun off top

Stickers

- Use dry stickers – stickers need to be able to transfer water
- Use stickers that are no more than 1-1/4-inches wide, by 3/4- or 7/8-inches thick
- Stickers should be of uniform thickness and width for their full length
- Use grooved or routed stickers, which allow some air movement under the sticker

Stickers

- Insure flat stickers are not contaminated and can absorb water
- Grooved and profiled stickers can help

Sticker Spacing

- For warp prone species and low grade material stickers should be placed every 12 inches

Add weight to the top

- Concrete weights used in pine drying
- Put a bundle of a non warp prone species on top of the stack for warp prone species (i.e. poplar on top of sapgum).

Good luck – Shoot for the best!

EVALUATION FORM

Hardwood Dry Kiln Operator's Course
June 10, 11, 12
Ferizaj & Peja, Kosovo

Part 1. Workshop Content and Structure

I. Workshop Topics
Please circle the number that best represents the usefulness of each topic.

				Nr. of evaluations	**Result (1- poor- 5 excellent)**
Wood moisture relationship's				11	4.27
Air drying				11	4.45
Drying schedules and applications,				11	4.54
Lumber protection				11	4.27

II. Instructional Methods
Please circle the number that best represents the usefulness of the instructional methods.

				Nr. of evaluations	**Result (1- poor- 5 excellent)**
Presentations by instructors/trainers				11	4.63
Group discussions				11	3.8
Questions and answer periods (formal and informal)				11	4.27
Handouts				11	4.27

Part 2. Program Scope and Content
Please answer the questions below to help us improve our future offerings.

What were your training objectives?
-Proper stacking procedures,
-Protection of wood,
Proper drying procedures,
-All mistakes during drying to eliminate,

Were your objectives fulfilled? If **Yes**, please explain how. If **No**, please explain why not. Yes, but we need more. Yes, We got proper suggestions, It was very attractive seminar, Yes, to a some level, It was very understandable, It was a short time to cover all requested, No, I need more time to learn how to eliminate bad practices.	**Yes**	**No**
Did you acquire new skills or knowledge through this training? If **Yes** or **No**, please describe. Yes, we gain more skills on wood drying, Yes, yes Yes, more skills on proper drying procedures and protection of lumber,	**Yes**	**No**
Will you be able to use this new knowledge in your current responsibilities? If **Yes**, please explain how you will use this new knowledge. If **No**, explain why you will not be able to use knowledge when you return to your responsibilities. Yes,yes, Yes, we have to implement all suggested if we want to be competitive in market, For sure I will be able to transmit learned to others,	**Yes**	**No**
What was the most beneficial part of the training? **Please describe** **Lumber stacking**. Dry kiln schedules, **Kiln schedules and lumber protection,**		
Can you suggest any improvements for future training? **Please explain**. More practical work, We need more this type of training's We have to learn a lot		
Additional comments. This nature of training are needed, not only in theory but also on practice manner, We need more this type of training's I am satisfied with the presentation		
Thank you for your time in completing the evaluation!		