Installation and Operators Manual for Lignomat's PK System
In-Kiln-Moisture-Monitor

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Contents:

Installation Manual

The PK system (in-kiln-moisture-monitor) gives reliable and easy obtainable information about EMC (equilibrium moisture content) and MC (wood moisture content) from several different probes distributed throughout the kiln. Moisture readings can be obtained at the switch box outside of the kiln. The kiln operator can take readings whenever necessary. After evaluation of the moisture readings against the predetermined drying schedule, necessary changes in the climate settings can be made. Thus the kiln operator will be able to run the kilns following the changing moisture content; there will be less degrade, output and quality can be optimized.

1.1 Layout

The switch box mounted outside the kiln is connected with teflon cable to a series of angle connectors mounted inside the kiln wall are permanently installed. A set of removable cables is used inside the kiln to make the connection from angle connectors at the wall to the probes in the lumber.

First, the location of the switch box and the location of the angle connectors should be determined. The switch box should not be more than 60 feet away from the kilns. Usually the angle connectors are mounted in pairs, referred to later as one measuring station. The drawing on page 4 shows possible arrangements for MC and EMC angle connectors. When determining the cable routing, consider that all permanently mounted cables should be installed where no damage from lumber packages being moved in and out of the kiln may occur.

1.2 Installation of Angle Connectors

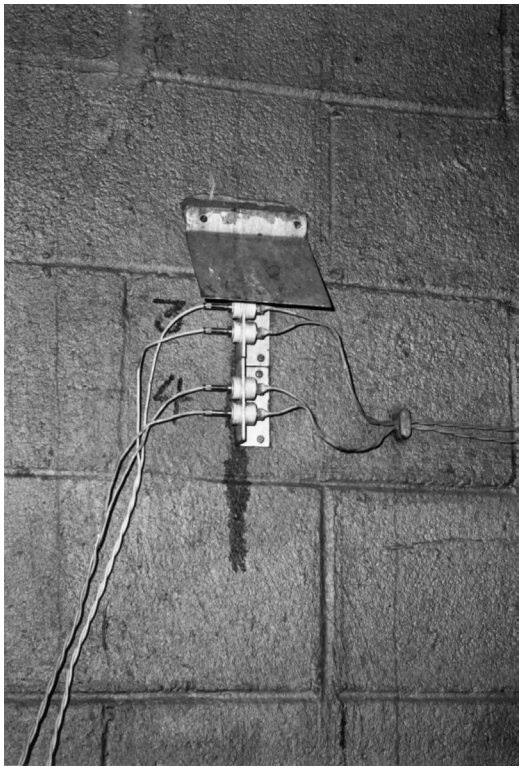
Once the layout has been determined the angle connectors should be mounted first - directly to the walll with plastic anchors on cinder block kilns or sheetmetal screws on metal kilns. All screws must be stainless steel. A silicon base caulking should be used to seal all holes including screw holes. Most silicon caulks have acetic acid bases, which will cause masonry to deteriorate. There are caulks available with non corrosive bases.

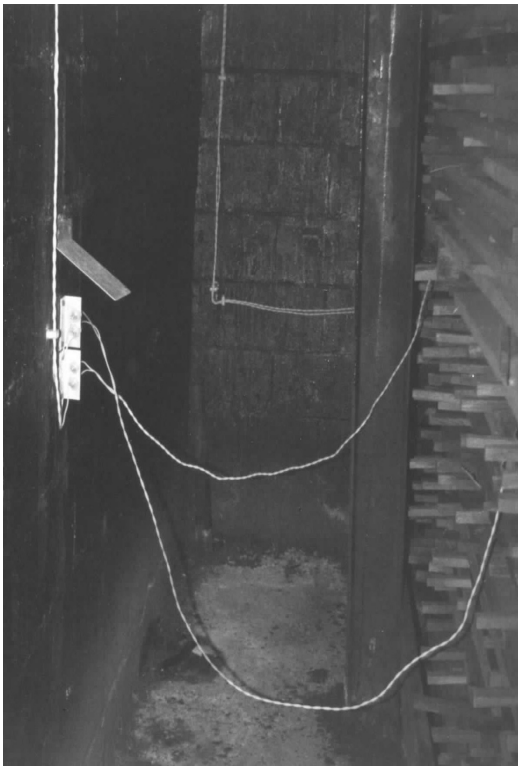
Possible groupings for MC and EMC are shown on page 4. For EMC points an extra angle might be necessary to point EMC holder towards the interior of the kiln. The EMC holder should be mounted in the air stream before the air enters the stack of lumber. An aluminum drip shield should be mounted above each measuring station to prohibit condensed water, pitch, acids, or boiler chemicals from falling on the measuring station.

1.3 Installation of Cable Clamps

Before the cables can be installed, the cable clamps must be mounted. Each clamp can hold several cables. Plastic wall anchors or No. 6 sheetmetal screws can be used. The first clamp should be about six inches away from the measuring station.

Working toward the switch box and the the next station continue to mount the clamps about 3 ft apart. If another station is encountered, place a clamp directly over the station, then continue with normal spacing. Clamps for cables around door frames, corners, or for exits should be positioned as shown on page 4.





Photos show double angle connector installation with drip shield.

When routing cables in a metal kiln, columns are an obvious obstacle. Drill a 3/4 inch hole in the column and place a bushing in it to protect the cable. The cable exit hole to the switch box or from one kiln to the next should be only slightly larger than the diameter of the cables. By keeping the hole as small as possible it will be easier to seal.

1.4 Cutting and Hanging Cables

Special teflon cable is used to make the connections from the measuring stations to the switch box. The cable comes in 100 meter rolls. The cable is twisted, as a result of this it always comes off the roll with twists and kinks. To avoid this problem, first place the roll in one hand and pull the cable directly off the free side. Take off about 10 coils, then switch the roll to the other hand and pull off 10 more. Most of the tangles that do occur can be taken care of when the cable has been cut to length.

Always start to cut the longest cable first. Never cut any cable exactly to length, leave at least three feet extra on both ends (for extreamly long runs leave even more extra). cables in it and hand tighten the clamp screws. Hang all the cables for the entire kiln all the way back to the switch box. Once the measuring stations are properly connected, the excess of the cables will be pulled back toward the switch box.

1.5 Completion of Measuring Station and Cable Run

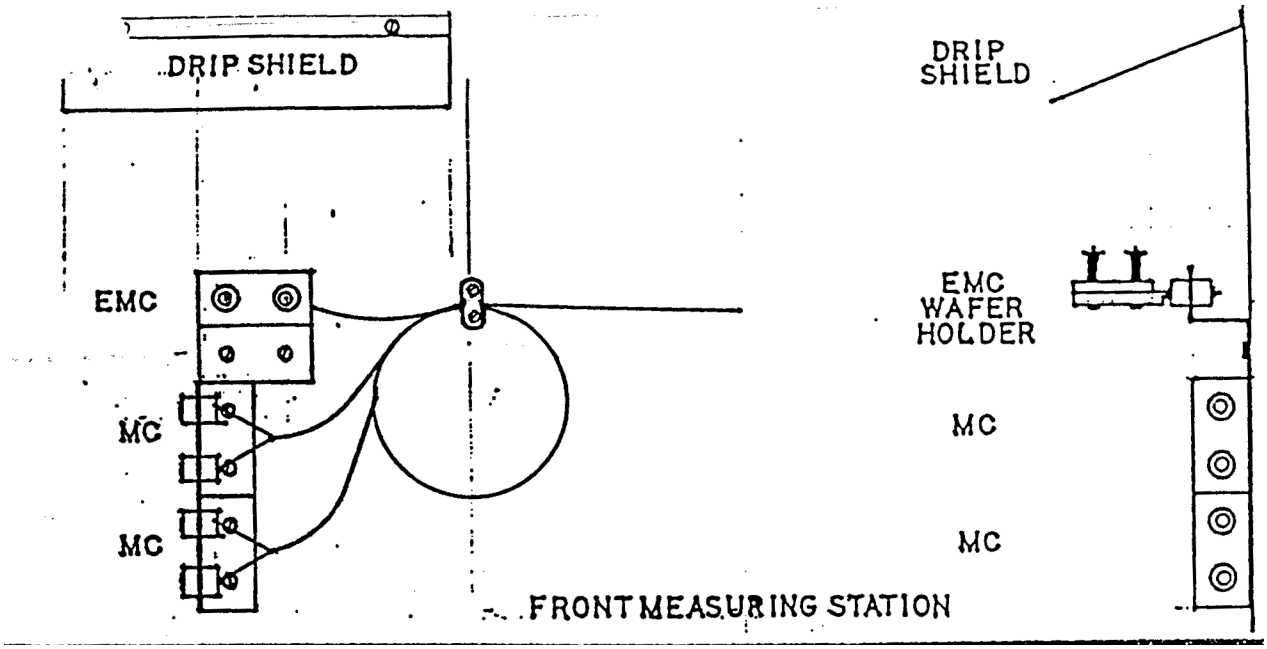
Start with the longest cable run first. If there is more than one kiln, start with the kiln that is the furthest away from the switch box. The conections between the angle connectors and the cables are the next step. Use three pieces of shrink tubing for each cable - one piece about six inches from end to prohibit untwisting, two pieces to cover soldering point and cable insulation at ring connectors. The tubing can be shrunk by heating it with a heat gun. Be carefull not to damage the insulation.

After soldering and placing the shrink tubing, the ring connector can be secured to the stainless steel lugs at the appropriate angle connector. Repeat for each angle connector until the measuring station is completed. Then tighten the first cable clamp so the cables are held secure but so that they can be pulled through the clamp without damaging the insulation. Working back to the next station, secure each clamp leaving about a two to three inch sag in the cables between clamps. Cables around corners, door frames, and exit points should never be pulled tight, but have small loops to allow expansion in the hot kiln.

An aluminum drip shield should be mounted above each measuring station to prohibit condensed water, pitches, acids, or boiler chemicals from collecting on the EMC holder or connections.

1.6 Completion of Exit Points

Once the measuring stations are completed and all cables suspended and clamped throughout the interior of the kiln(s), the exit points to the next kiln can be sealed. All exit holes should be sealed.

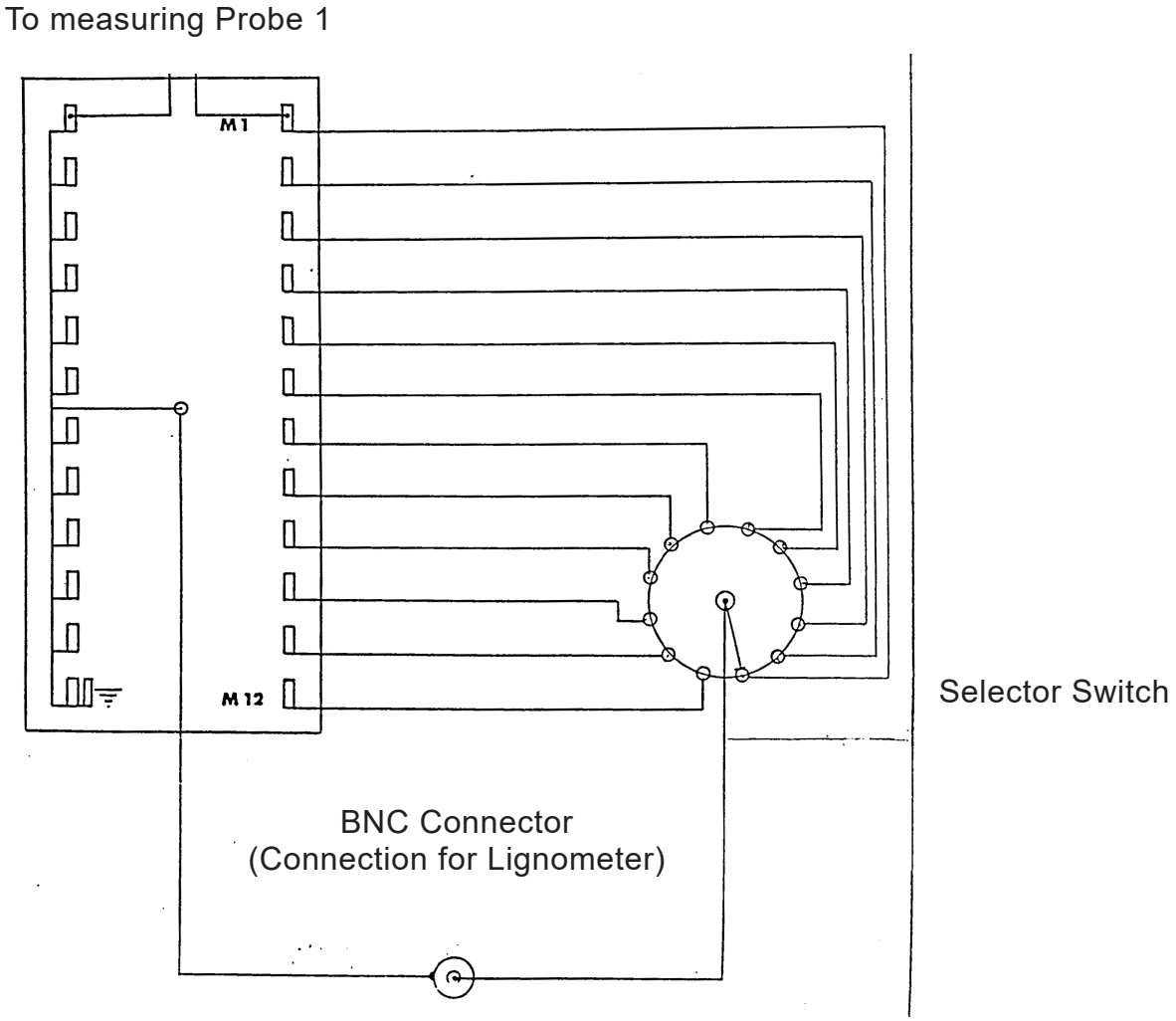


1.7 Installation of Switch Box

All cables coming from the inside of the kiln(s) to the switch box are pulled through the exit hole which should be made as small as possible. The exit hole should be sealed completely. Allow the caulk to dry before completing the connections, thus, maintaining a good seal in the hole. Pull cables inside of switch box and mount the box. Use shrink tubing on each cable, strip and presolder each individual wire and connect each pair to the appropriate point inside the box. See drawing bellow.

1.8 Checking Cables and Connections

To check, connect the moisture meter to the BNC connector on the switch box and dial all measuring stations. Short one measuring station at a time and take a reading at that switch position; this will verify all conections and cable continuety. At this time it is recomendable to note which angle connector (location of measuring station and kiln) is connected to which dial at the selector switch.



2.1 Probing Packages

Usually the packages are probed while loading the kiln. This way while unloading the kiln the measuring cables and probes can be retrieved from the packages coming out of the kiln and used for the next kiln charge. This way only one set of measuring cables and probes is necessary. If production flow requires probing the package earlier, two sets of measuring cables might be required.

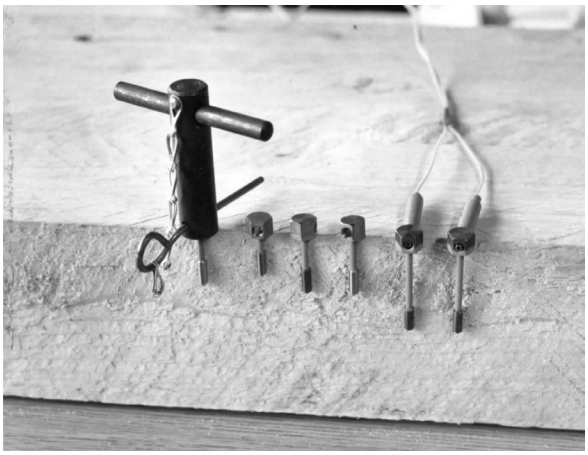
If certian boards in a stack should be probed, an easy way to identify the selected board within the stack is to put an “X” on the layer in which the board is, and an “X” on the end grain of the board. The probed board should never be located close to the “edge” of the package because the outer zone might dry faster and not be representative for this package.

There are two ways to probe a package:

1. Part of the package is lifted with a forklift. If the row is marked with an “X”, lift everything above the “X”. Pull out the marked board and place the probes.

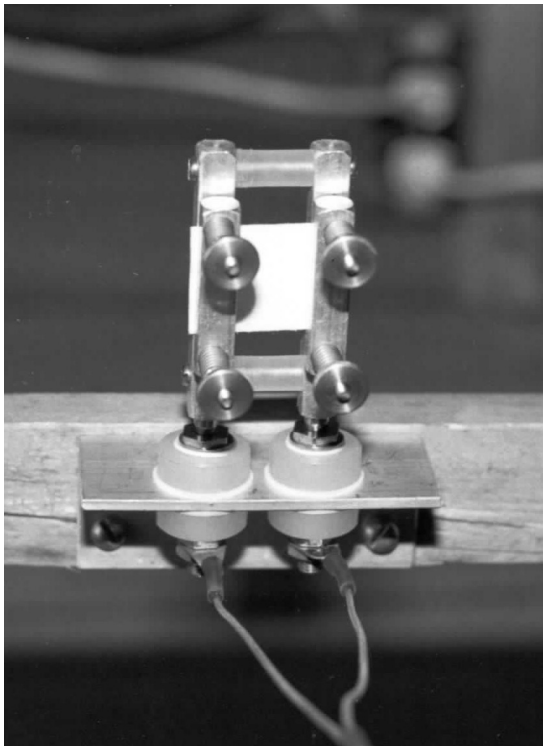
2. From the top of the package the upper layers of boards are put aside and a board in the center of the layer is equipped with probes.

Two holes have to be drilled for the probes with a 5/32 inch drill bit 1 1/4 inches apart, making sure the probe will bottom out in the hole. To hammer the probes into the board put the pulling tool on the probe head. Do not put pin through holes. Hammer on top of the pulling tool until the tool touches the wood. The probes are now placed correctly so that the probe head does not touch the wood and prohibit the drying process just above the measuring point. The tip of the probe should at least penetrate 1/3 of the board. Attach the cable to the probes and and put the package back together making sure the cable is not squeezed by lumber or stickers. The other end of the cable is left hanging outside the package. Once a row is completely loaded, cable(s) from that row are plugged into the nearest angle connector(s). Now check that probes and cable(s) are producing a reading.

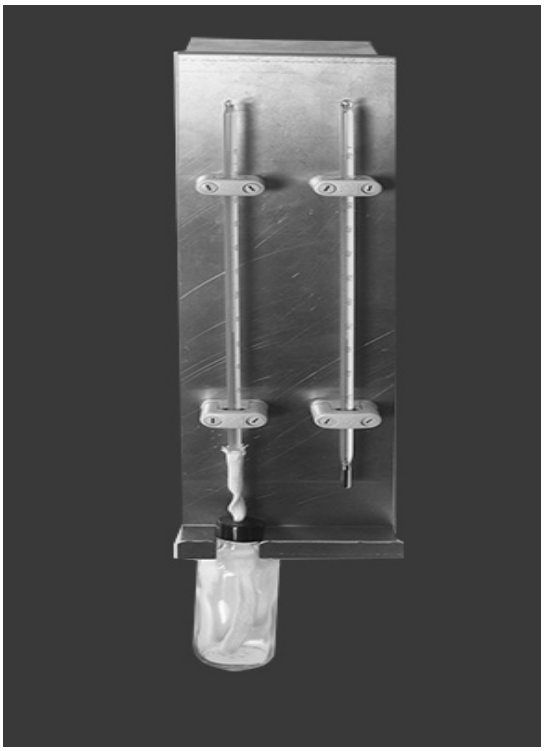


2.2 EMC Measuring Station

Once the kiln has been loaded the last thing to do is place the EMC holders. A new cellulose wafer should be used for every kiln charge. Check and clean the EMC station if necessary. Dirty angle connectors and EMC holders affect the EMC readings. EMC readings are also used to check a dry-bulb-wet-bulb measuring station.



Angle connector with EMC holder and EMC wafer for direct measurements of EMC.



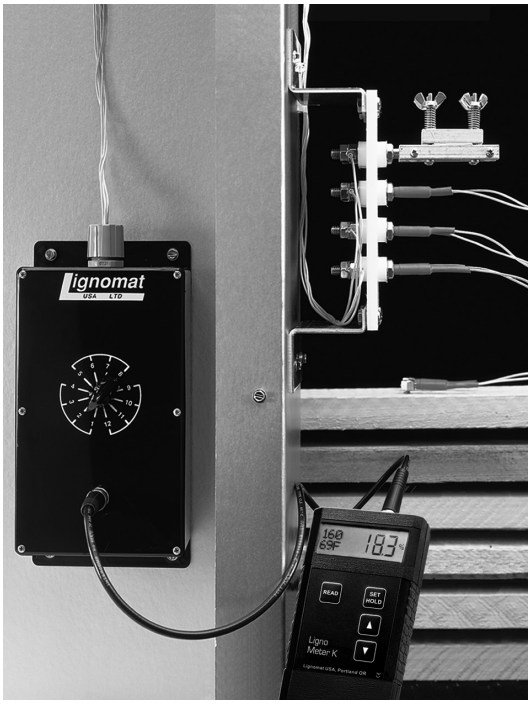
Dry-bulb-wet-bulb thermometers with measuring plate and wet sock bottle.

2.3 Obtaining EMC Readings

The EMC can be read with the Lignometer K and the Ligno-VersaTec directly in percent. For EMC readings the meter should be set to the setting specified on the wood group card for EMC. All EMC values should be temperature compensated by dialing the drying temperature inside the kiln at the moisture meter Lignometer K or Ligno-VersaTec.

After dialing the wood group and the air temperature in the moisture meter and selecting the corresponding station at the selector switch, the EMC can be read at the moisture meter directly in percent. Conversion charts are not necessary. 2 Charts are included showing the relation between EMC/MC and relative air humidity (see page 9), and dry bulb-wet bulb temperature (see page 10).

2.4 Obtaining Moisture Readings



Once the kiln has been brought up to temperature, accurate moisture readings can be taken. Set the wood group switch as indicated by the specification chart provided. Find the actual temperature inside the kiln after heating-up has been completed and the temperature inside the kiln is stabalized; the drying temperature is the same as the wood temperature. All MC values should be temperature compensated by dialing the drying temperature inside the kiln at the moisture meter (Lignometer K or Ligno-VersaTec).

After dialing wood group and temperature at the moisture meter, temperature and wood group compensated moisture readings can be obtained directly in percent. Connect the meter with the BNC connector at the switch box and dial each station seperatly at the switch.

To fully benifit the PK system, readings should be taken every day and recorded with the climate conditions present in the kiln at the time. Before each change of climate settings the readings should be evaluated against the predetermined drying schedule.

Evaluation of recordings throughout several drying cycles is an important tool for the kiln operator to work towards the most efficient and economical drying cycle for their kilns.

2.5 Optimization of Kiln Performance

Due to the flexibility of the PK system, the location of probed packages can be changed with each kiln charge to determine if there is a difference in the drying process between top, bottom and center packages. Monitoring different loactions in your kiln will help evaluate overall kiln performance and show slow drying areas.

Specific boards can be selected for probing with high initial or low initial moisture content. Comparing measurements will indicate which boards should be probed in the future for an optimized kiln schedule.

If too much lumber is degrading, the drying schedule should be changed and a moisture content based schedule can be applied to be assure high lumber quality at the end of the drying.

With the PK system the kiln operator has a tool on hand to optimize kiln performance and to produce high quality, perfectly dried lumber.

2.6 Maintenance and Check-Up

Before every kiln charge a visual check should be performed to see if the permanently installed cables are intact. The measuring stations and the EMC holder can be cleaned with alcohol or aceton. The cables going from the measuring stations to the wood probes should also be visually checked for worn or broken insulation.

For a thorough check, all measuring cables should be tested as follows: Plug the cable into a measuring station and take a reading from the moisture meter with nothing connected to the probe end of the cable. Now emerse the whole cable into a bucket of water making sure the cable ends are not shorted or in the water. Take another reading; if that reading is higher then the first, the cable is bad. If the damaged part of the cable can be located heatshrink could be applied to fix the insulation. If not, the bad cable needs to be replaced.

	Relative Humidity EMC Table																		
T °F	5	10	15	20	25	**30**	**35**	**40**	**45**	**50**	55	60	65	70	75	80	85	90	95
30	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.8	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3
40	1.4	2.6	3.7	4.6	5.5	6.3	7.1	7.8	8.7	9.5	10.4	11.3	12.4	13.5	14.9	16.5	18.5	21.0	24.3
50	1.4	2.6	3.6	4.6	5.5	6.3	7.1	7.9	8.7	9.5	10.3	11.2	12.3	13.4	14.8	16.4	18.4	20.9	24.3
60	1.3	2.5	3.6	4.6	5.4	6.2	7.0	7.8	8.6	9.4	10.2	11.1	12.1	13.3	14.6	16.2	18.2	20.7	24.1
70	1.3	2.5	3.5	4.5	5.4	6.2	6.9	7.7	8.5	9.2	10.1	11.0	12.0	13.1	14.4	16.0	17.9	20.5	23.9
80	1.3	2.4	3.5	4.4	5.3	6.1	6.8	7.6	8.3	9.1	9.6	10.8	11.7	12.9	14.2	15.7	17.7	20.2	23.6
90	1.2	2.3	3.4	4.3	5.1	5.9	6.7	7.4	8.1	8.9	9.7	10.5	11.5	12.6	13.9	15.4	17.3	19.8	23.3
100	1.2	2.3	3.3	4.2	5.0	5.8	6.5	7.2	7.9	8.7	9.5	10.3	11.2	12.3	13.6	15.1	17.0	19.5	22.9

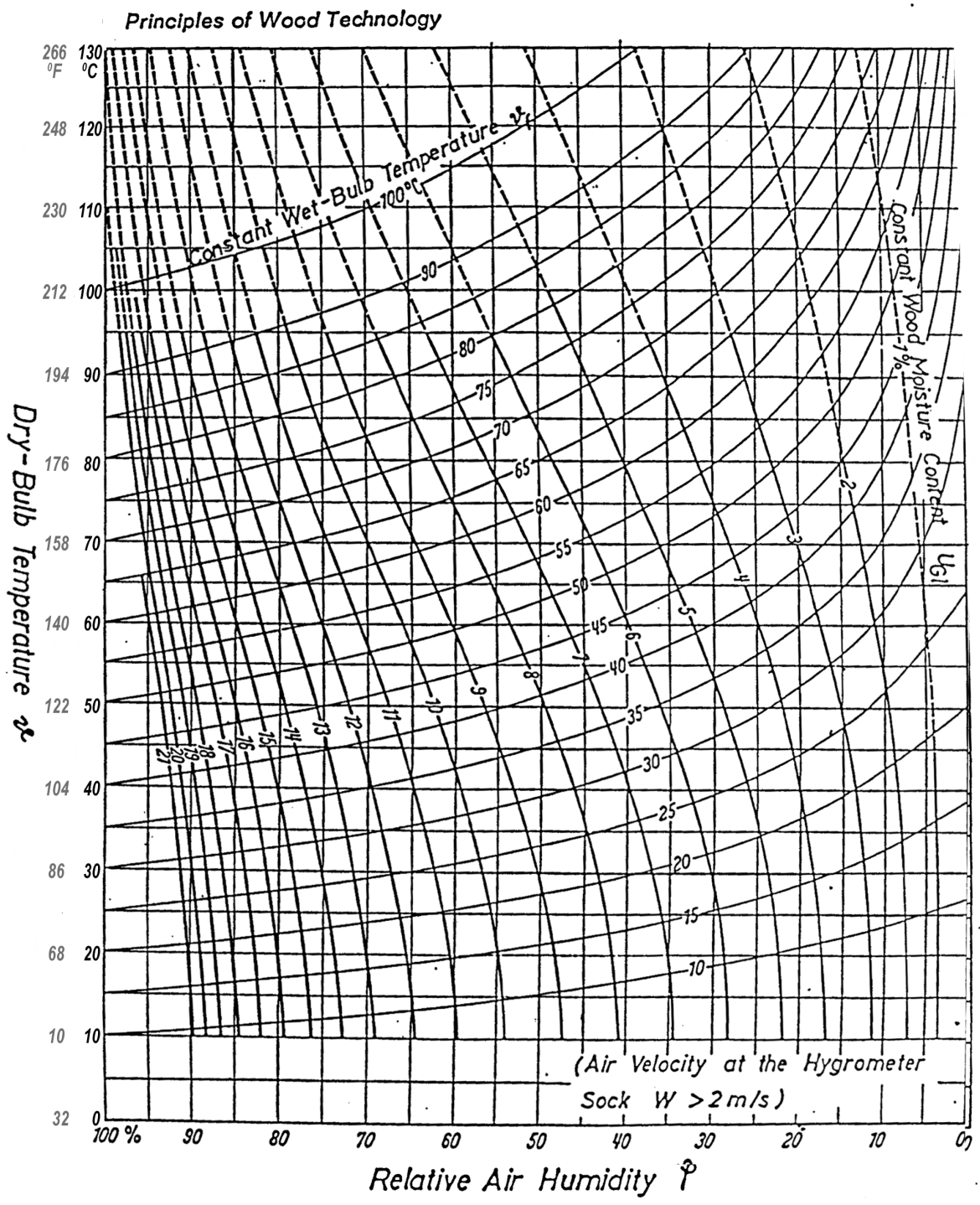


Fig. 19: Moisture content equilibrium of timber (according to R. Keylwerth and data from the U.S. Products Laboratory, Madison 1951). Example:
With a dry-bulb temperature of 45 degrees C and relative air humidity of 55% respectively a wet bulb temperature of 36 degrees C, the wood equilibrium moisture content is 9%.