OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche

09099

DP/ID/SER.A/210
21 August 1979
English

RESTRICTED

DEVELOPMENT OF THE FURNITURE AND JOINERY INDUSTRIES AND CREATION OF A CENTRE *,

DP/YUG/73/006,

YUGOSLAVIA.

Technical report: Yard, Kiln and Rough Mill Standard Practice Manual

Prepared for the Government of Yugoslavia
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of Vincent R. Ross, expert in industrial engineering

United Nations Industrial Development Organization
Vienna

*This report has been reproduced without formal editing.

V.79-6709

Explanatory notes

References to dollars ($) are to United States dollars.

The monetary unit in Yugoslavia is the dinar (Din). During the period covered by the report the value of the dinar in relation to the United States dollar was $US 1 = Din 19.00

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

OOUR stands for Osnovna Organizacija Udruženstvenog Rada (Basic Associated Labour Organization).

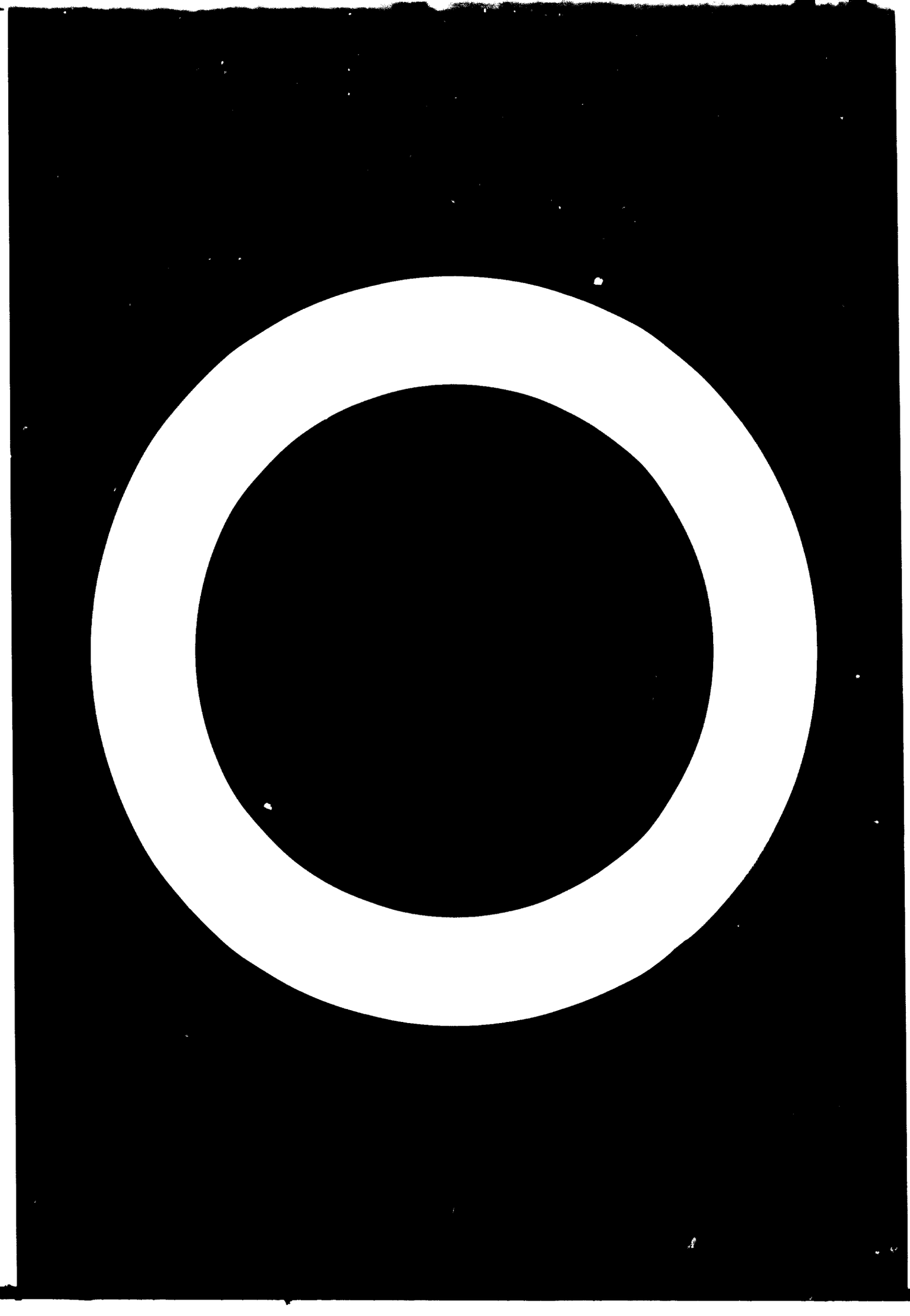
RO stands for Radna Organizacija (Working Organization - association of OOURs).

Abstract

The mission covered by this report formed part of a larger project entitled "Development of the furniture and joinery industries and creation of a centre" (DP/YUG/[illegible]/OC[illegible]), which was requested by the Government of Yugoslavia in December 197[illegible] and approved by the United Nations Development Programme in August 1974, with the United Nations Industrial Development Organization (UNIDO) designated as executing agency and CIPAD, a co-operative forestry organization, as government co-operating agency.

The services of the expert were commissioned in March for the purpose of visiting Yugoslavia to meet with CIPAD officials so as to develop a practical manual for COUR "VARDA" to be used as a training manual in such areas as the procurement, handling, seasoning and manufacture of lumber for the Yugoslav furniture industries.

A follow-up exercise by the expert and an assistant is scheduled to take place shortly for the purpose of holding seminars for the benefit of CIPAD's directors, technical staff and factory floor staff, in line with contents of this manual, prior to completion of the mission.



CONTENTS

Introduction

The mission covered by this report was part of a larger project entitled "Development of the furniture and joinery industries and creation of a centre" (DP/YUG/[illegible]/006), which arose from a request submitted by the Government of Yugoslavia in December 197[illegible] and approved by the United Nations Development Programme in August 1974. The United Nations Industrial Development Organization (UNIDO) was designated as executing agency and SIPAD, a co-operative forestry industry organization comprising 126 factories, employing 55,000 persons and accounting for [illegible]% of the saw-milling and 35% of the final products of the wood industries of the Republic of Bosnia and Herzegovina (BiH), as government co-operating agency. The project was initiated in September 1974, with a budget involving a contribution of $ 585,825 by UNDP, and of Din 19,247,900 by the Government of Yugoslavia. This manual is the result of a mission which commenced in March 197[illegible] within the framework of the larger project.

The long-range objectives of the project are to enable the furniture and joinery industries in BiH initially, and in all of Yugoslavia eventually, to make a greater contribution to the economy. Immediate objectives are to help the industries to increase the value of their products, to improve quality, to reduce production costs, to design new products and to forecast market requirements.

The furniture and joinery industries in BiH contribute about [illegible]% of the goods and services produced in that Republic and represent [illegible]% of its exports. An ambitious five-year development plan is being implemented to double the production of furniture to attain a value of Din [illegible],000 million and to increase the work force from [illegible],000 to [illegible],000 persons. This plan calls for an investment of Din [illegible] million. Joinery production will increase from a value of Din [illegible] million to Din [illegible]50 million, and the work force will triple to reach [illegible],500 persons. Investment of Din 250 million is foreseen for joinery plants.

The main objective of the mission was to develop a practical manual for training purposes relating to the procurement, handling, seasoning and manufacture of lumber for the benefit of the Yugoslav furniture industry. A follow-up exercise by the expert and an assistant is scheduled to take place shortly for the purpose of holding seminars for the benefit of SIPAD's director, technical staff and factory floor staff, in line with contents of this manual, prior to completion of the mission.

A. CARE OF LUMBER

Activities Affected: Yard, Kiln, Rough Mill

Departments Affected: Same

PURPOSE:

The purpose of this manual is to prescribe the proper care of lumber by the "Varda" organization and to emphasize its importance. This section and the attached charts are designed to help all personnel understand the vital role lumber plays in "Varda's" activities.

DISCUSSION:

Lumber purchases typically account for three quarters of total material costs and a third of total factory selling price.

A one percent reduction in cost or a one percent increase in that portion of the lumber which "Varda" expects to convert into furniture amounts to about 190,000 Din in one year. This can be used to raise wages or lower prices, to sell more furniture or purchase equipment, all of which contribute to more and better jobs.

Figure A-1-1 following shows what happens to a typical cubic meter of lumber received on the yard. Some of it is lost at various steps in the manufacturing process. Typically, only 0.55 cubic meters may actually be converted to furniture parts. The rest has been lost due to damage on the yard, shrinkage in the kiln, defecting at the cut-off saw and ripsaw.

Figure A-1-2 shows typical costs of buying that cubic meter of lumber and converting it into furniture parts. Handling on the yard, the operation of the kilns, the handling through dry lumber storage, and the labor of cutting to length and ripping all add to the cost of that cubic meter of lumber.

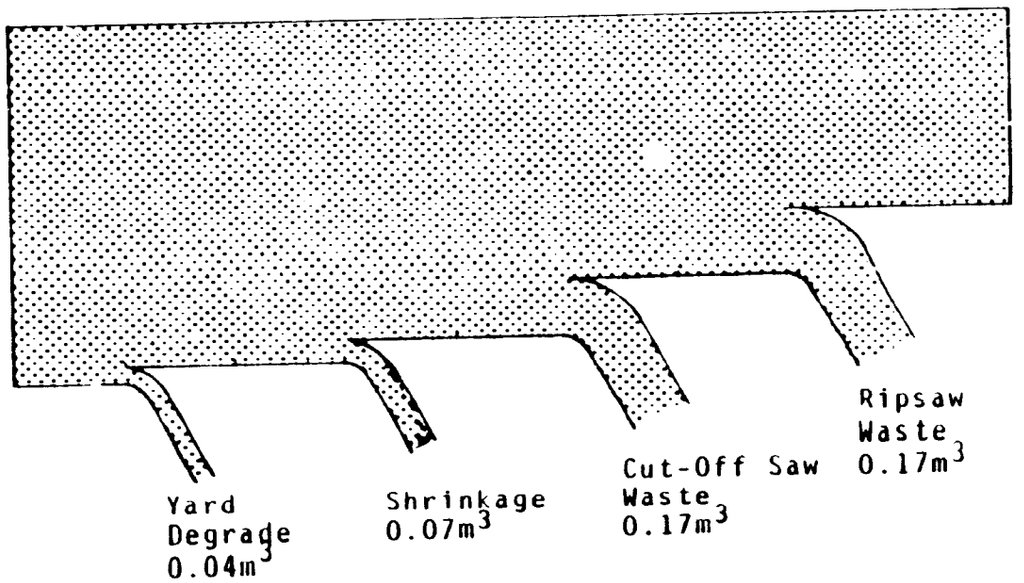
Figure A-1-3 shows how the cost of the remaining lumber in terms of cubic meters of lumber after each stage in the process increases. A smaller and smaller quantity of lumber carries more and more costs.

Figure A-1-4 shows how valuable the remaining lumber is in terms of man-hours of work. This demonstrates two things:

1. It gives an indication of the relationship between the cost of lumber and the cost of labor.
2. It gives an indication of how little lumber salvaged from the scrap box is necessary to justify a man-hour's work.

The charts were based on a lumber price of 2500 Din per Cubic meter of lumber, an average hourly wage of 22.2 Din in the Rough Mill and estimates of "Varda's" labor hours for the yard, cut-off saw and ripsaw labor. Kiln costs were estimated on 11.76 Din per Cubic Meter per day, with an average kiln cycle of 6.75 days.

REMAINING USEFUL LUMBER



Purchased Lumber
Minus
Typical Losses
in Rough Mill

FIGURE A-1-1

COSTS ADDED TO COST OF ORIGINAL CUBIC METER OF LUMBER PURCHASED

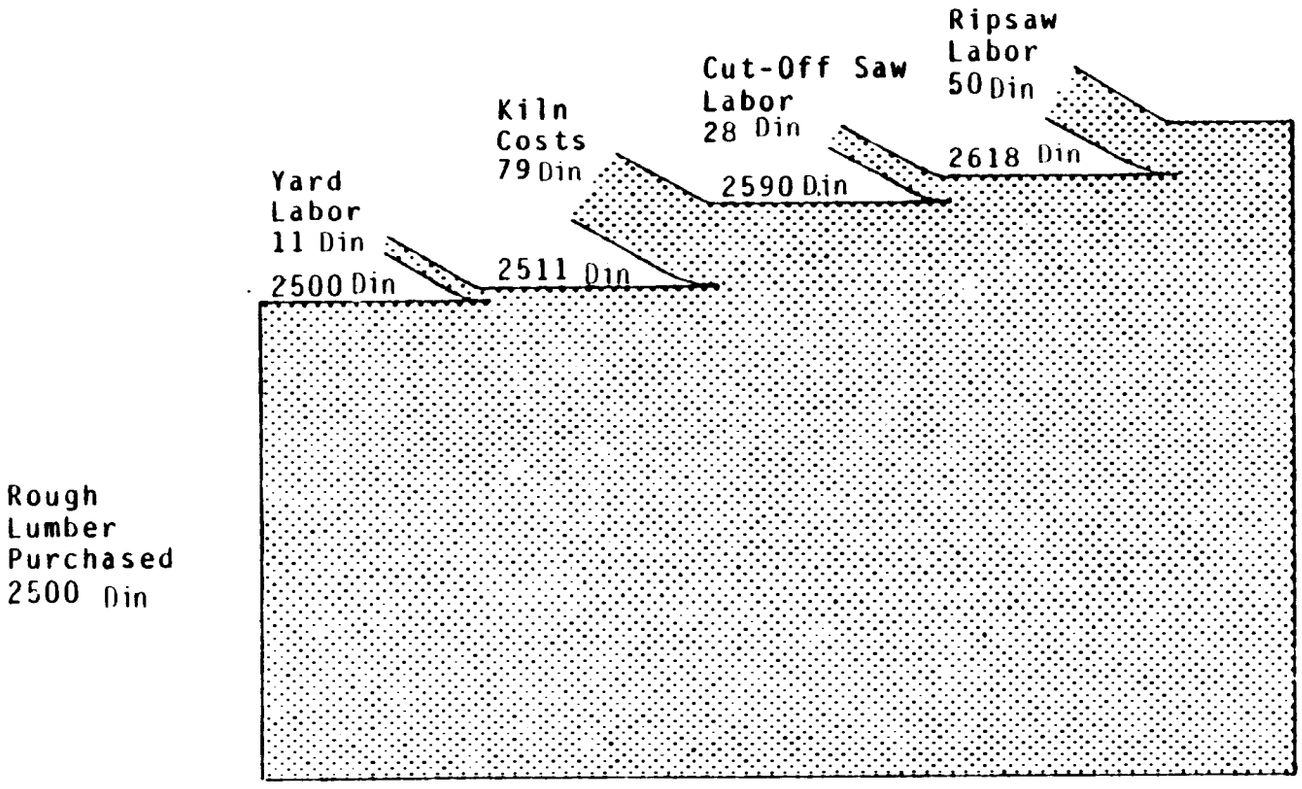
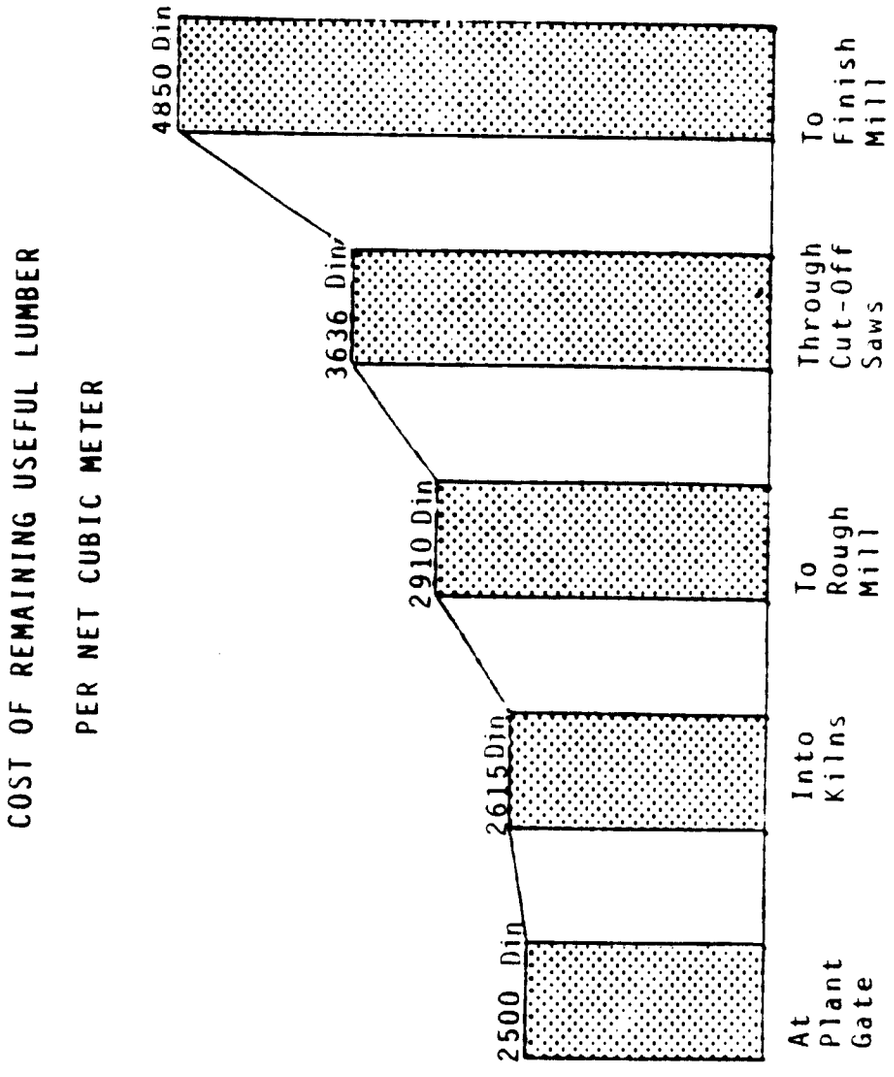
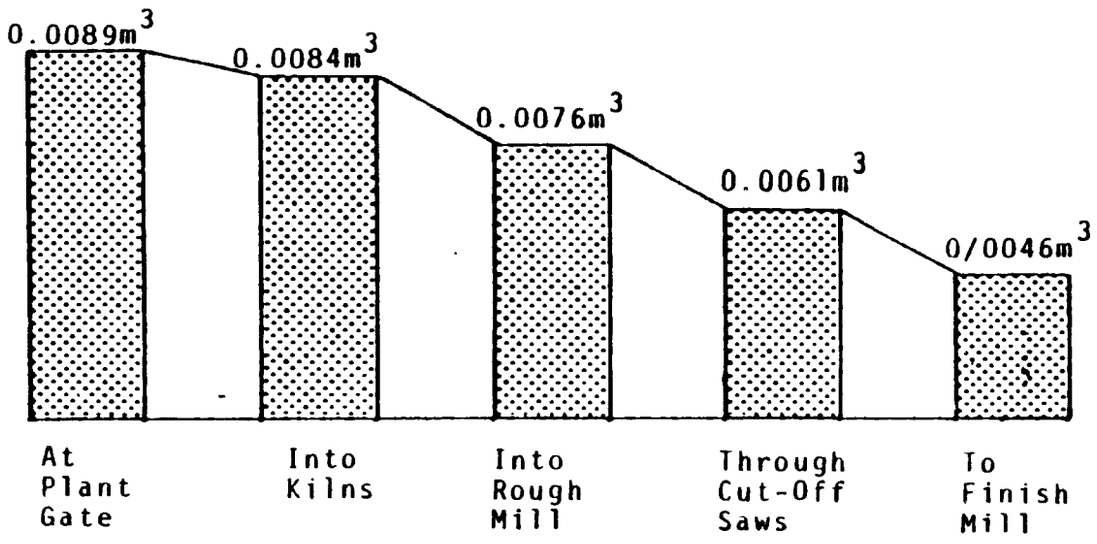


FIGURE A-1-2

FIGURE A-1-3


COST OF REMAINING USEFUL LUMBER
PER NET CUBIC METER
4850 Din
3636 Din
2910 Din
2615 Din
2500 Din
At Plant Gate
Into Kilns
To Rough Mill
Through Cut-Off Saws
To Finish Mill
Lumber Cost at each successive stage
÷
Remaining part of original purchased m³ of lumber

A MAN-HOUR'S WORTH IN CUBIC METERS OF LUMBER



One Man-Hour's Pay

÷

Cost of remaining lumber at each stage

FIGURE A-1-4

B. LUMBER PROCUREMENT

1. Species

Date Issued_____

Date Revised_____

Approved By_____

Activities Affected: Purchasing, Production

Departments Affected: Merchandising, Production
Purchasing, Design Engineering

PURPOSE:

The selection of species for given furniture parts should be based on machining properties, density, color, and finishing characteristics. Price is of prime consideration but should not override the above factors since there is often a choice of several species for a particular item.

METHOD:

In designing and planning a new furniture, full consideration should be given to all possible species combinations, lumber price ranges, etc. Through conference, decisions should be made by top management; purchasing should then proceed to obtain the required lumber by species , grades, and thicknesses desired.

2. Lumber grades

Activities Affected:	Inventory Control, Lumber Grading	Date Issued_____ Date Revised_____
Departments Affected:	Engineering, Cost, Purchasing, Lumber Yard	Approved by_____

PURPOSE:

Lumber grades form the common price control between buyer and seller of lumber products. At present, the published grades of lumber form the only basis for planning requirements to meet cutting schedules. Information should be available to the lumber purchasing department on the yields to be expected from different lumber grades or combinations of grades. Using this information plus current price quotations on lumber by grades, the purchasing agent can purchase the most economical combination of lumber grades to meet cutting requirements.

When lumber is purchased by grade, it must be graded by the company grader to assure value received.

METHOD:

The purchasing agent shall send a copy of the purchase order to the person responsible for receiving, grading, and accepting the lumber. The purchase order shall clearly indicate any agreed-upon departure from the standard grading rules as to dimension, moisture content, or other possible variables.

Lumber shall be graded by the local lumber grading rules and accepted if the total value is within 4 percent of the invoiced value.

If the total value of the shipment is more than 4 percent below the invoiced value, the lumber shall be set aside and the purchasing agent notified.

Local lumber that is purchased green or dry, but not previously graded, will be inspected by the local lumber grading rules. Lumber that falls below grade requirements will be set aside and returned to seller if he picks it up within 10 days. After 10 days, below grade lumber will be disposed of in any feasible manner.

EQUIPMENT:

Grading will be done by hand from piles. Green and dry lumber grading sticks are needed. (See section B.4) Lumber inspectors should wear shoes with steel capped toes when turning boards by hand. Laborers handling lumber should be provided with gloves.

PERMISSIBLE DEVIATIONS:

No deviations from local lumber grading rules should be permitted unless clearly written on the lumber purchase order.

RECORDS:

Complete records of all lumber grading shall be made on standard forms and turned in to Purchasing.

RESPONSIBILITY:

Yard Foreman, Lumber Inspector.

3. Size and Thickness

Activities Affected: Handling, Seasoning, Rough End

Departments Affected: Purchasing, Grading

Date Issued_____

Date Revised_____

Approved by_____

PURPOSE:

Excessive variations in lumber thickness create problems in uniform drying, produce uneven lumber packages resulting in drying degrade, and create problems in the Rough Mill, especially in undue stress on planing equipment or in rejects from being too thin.

Excessive amounts of odd lengths or ragged lumber ends, or an undue amount of narrow lumber causes seasoning degrade and waste.

Adherence to the standard practices outlined below will result in a minimum of these size and thickness problems.

METHOD:

Buying strictly by the local lumber grading rules will eliminate problems of excessive amounts of lumber of odd lengths. This will not prevent an excess amount of narrow widths, a problem that occurs occasionally with local sawmills cutting small timber. In purchasing from such mills, the purchase order should specify that widths must average 180mm or more, or the price will be reduced 5 percent.

The lumber purchase order should state that 95 percent of the lumber should meet local lumber grading specifications for thickness.

When 6 percent or more of lumber in a shipment does not meet thickness specifications (which in reality does not meet grade

requirements). the portion that does not meet specifications will be set aside and returned to the seller if he picks it up within 10 days and pays 2 percent handling charge. After 10 days, such lumber will be disposed of in any feasible manner. If 5 percent or less of the lumber in an order does not meet thickness specifications, the total shipment will be accepted and paid for, but the lumber not meeting specifications will be re-processed to a different but usable thickness. Any miscut boards with thick spots (usually ends) will be planed to nominal thickness by a roughing planer before being stacked.

EQUIPMENT:

Rough planer -- located in yard to plane thick areas of boards to nominal thickness.

Go/no-go thickness gauge -- each lumber inspector should be provided with a go/no-go thickness gauge. It is good policy to provide these gauges free to local sawmill owners.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

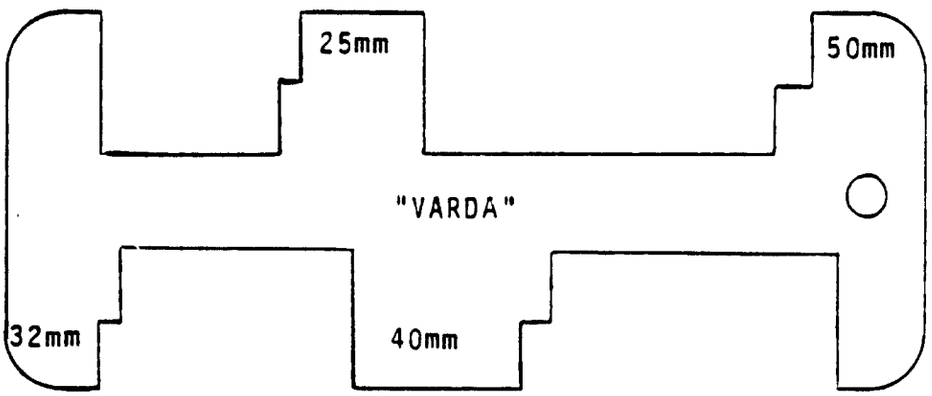
A record shall be made of all suppliers that send in miscut lumber. Purchasing can use these records to weed out continual offenders.

RESPONSIBILITY:

Purchasing Agent, Lumber Grader, Lumber Coordinator.

FIGURE B-3-1

GO/NO-GO GAUGE



Note: Tolerance is net to net + 10 percent

4. Inspection, Measurement, Count

Date Issued_____

Activities Affected: Lumber Grading

Date Revised_____

Approved by_____

Departments Affected: Purchasing, Lumber Grading

PURPOSE:

To outline procedures for handling incoming lumber.

METHOD:

All incoming hardwood lumber will be inspected by local lumber grading rules unless the purchase order calls for an exception to the grade or additional requirements, such as limitations on average width.

As lumber is inspected and measured by hand, each board shall be separately counted on a count sheet similar to the one attached. (See Figure B-4-1.)

The count sheets and tape must show the seller's name, date of inspection, and name of lumber grader.

When discrepancies thought to be greater than 4 percent in value are found between seller's count or grade and the company's inspection, the lumber should be set aside and all records sent to purchasing for further handling.

EQUIPMENT:

Green and dry lumber measuring devices, thickness gauges.

PERMISSIBLE DEVIATIONS:

Green lumber may be purchased on the basis of measurement with a dry lumber rule, but the shrinkage of 4 percent should be considered in establishing the purchase price.

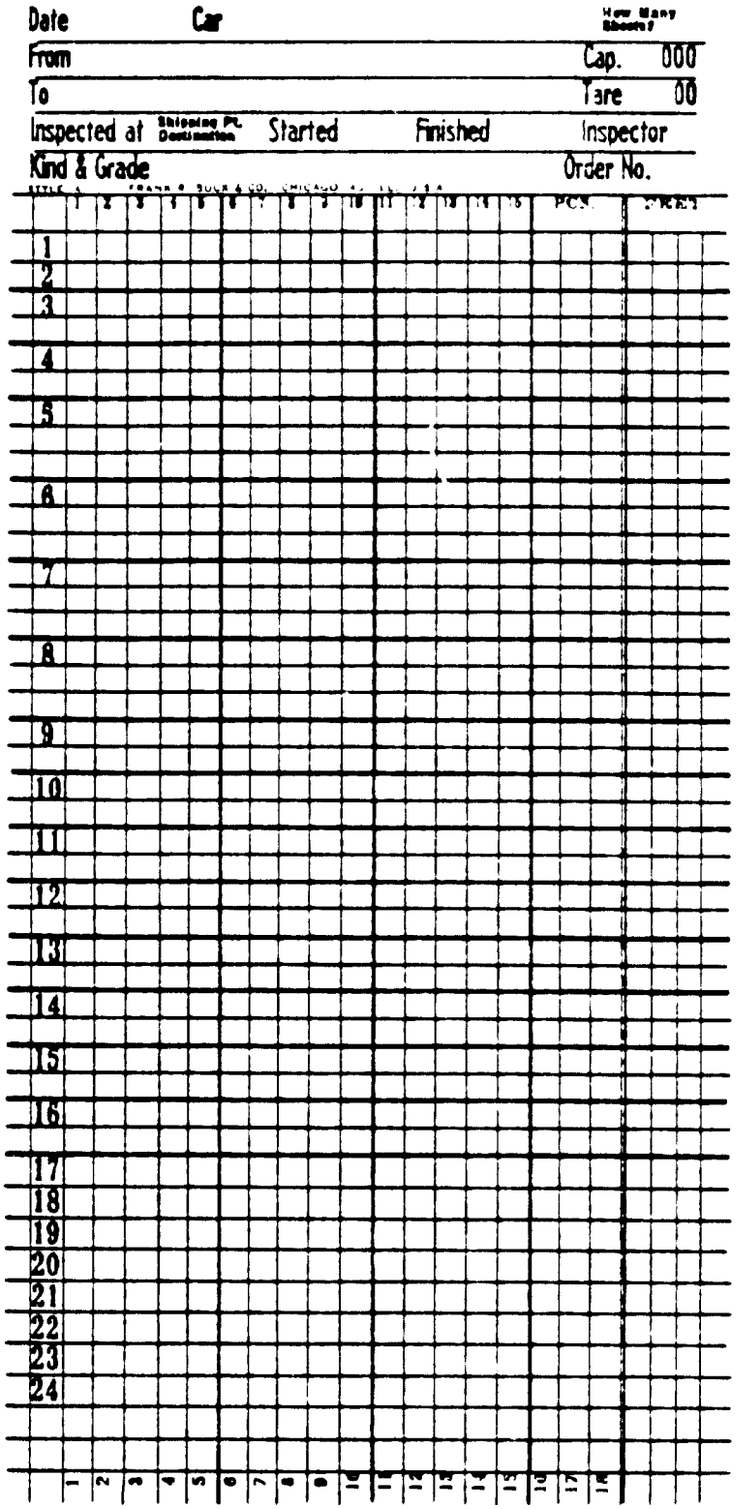
RECORDS:

Complete records must be made of all lumber inspection and measurement and forwarded to Purchasing.

RESPONSIBILITY:

Lumber Grader.

FIGURE B-4-1


Date
Car
How Many Sheets?
From
Cap. 000
To
Tare 00
Inspected at Shipping Pt. Destination
Started
Finished
Inspector
Kind & Grade
Order No.
PCS.
WEIGHT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

C. LUMBER HANDLING

1. Stain Control

Date Issued_____

Activities Affected: Cutting Yields in Rough Mill

Date Revised_____

Departments Affected: Yard

Approved by_____

PURPOSE:

Certain species of lumber are subject to damaging stain during warm, humid weather. Precautions must be taken to avoid the development of such stain.

METHOD:

Sap stain or blue stain is one of the most common stain problems. When green lumber is dead piled at a sawmill or in a receiving yard in warm, humid weather, blue stain is likely to develop in the sapwood of most species within 24 hours.

Incoming green lumber, which is to be used for exposed parts, will be dipped in stain preventative chemicals when it is to be held more than 24 hours before placing on separator sticks, when the outside temperature is above 20°C, and when humid conditions are expected to exist.

Varda's species most prone to stain is the Pinus nigra, and to a lesser degree beech. The sapwood of most hardwoods will blue stain under moist, warm conditions.

Chemical stains or brown stains occur in Pinus nigra also as a result of dead piling in warm, humid weather. The best control for

this stain is immediate placement on separator sticks. If this is impossible, then the lumber should be dipped in sodium azide or sodium fluoride and subsequently put on separator sticks as soon as possible.

Brown stain can also occur in green Pinus nigra when it is put in the dry kiln with a high wet bulb. Special kiln schedules are available for controlling this problem. (See section D.4, Drying Schedules.)

Stains from separator sticks in beech are usually chemical in nature, resulting from an acid hydrolysis action in the non-drying area under the sticker. The problem is minimized by the use of dry separator sticks and avoiding separator sticks over 30mm wide.

EQUIPMENT:

Where a green chain is used for lumber grading, a dip vat can be built into the system.

When the entire package of lumber needs to be dipped immediately upon receipt, the best piece of equipment for doing this job is shown in Figure C-1-1 attached.

This equipment is also useful for controlling insect infestations that may occur in green or dry wood.

PERMISSIBLE DEVIATIONS:

1. Lumber that is not green.
2. Lumber that will be stacked within 24 hours.
3. When temperature is not over 20°C for one hour or more during day.

4. Species not subject to stain. (All heartwood of walnut, locust, oak, chestnut, and a few other species.)
5. Grades or products where stain is not a defect.

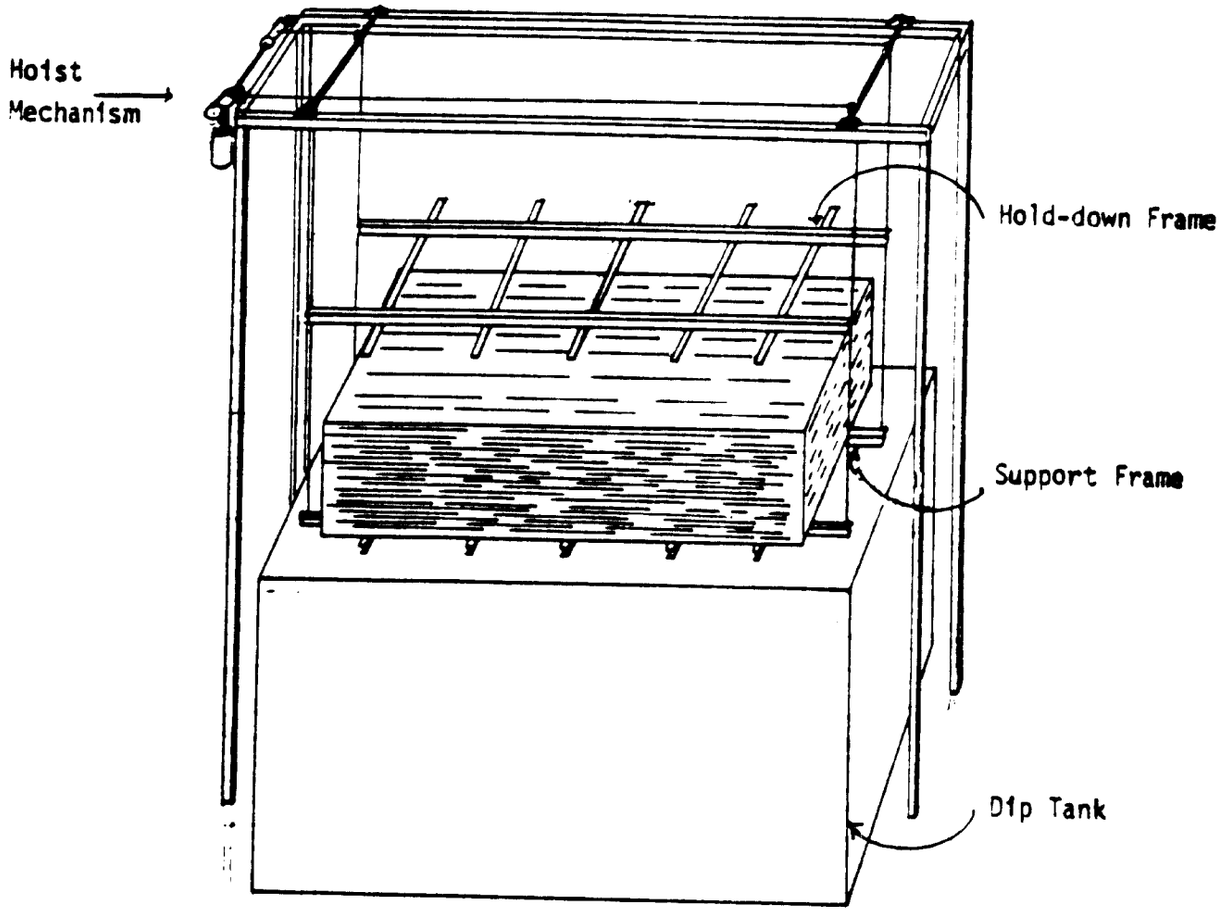
RECORDS:

When a package of lumber has been dipped to prevent stain, a record will be made of the species, quantity, thickness, grade, and date. (See Figure C-1-2 attached.) The package will be marked before it is placed on the yard awaiting grading and stacking.

RESPONSIBILITY:

Yard Foreman.

FIGURE C-1-1



STAIN CONTROL DIP TANK

FIGURE C-1-2

TKT. NO. 247

DATE

NAME

LOAD NO.

TKT. NO. 247

DATE

NAME

LOAD NO.

DATE DIPPED

2. Sorting

Date Issued_____

Date Revised_____

Approved by_____

Activities Affected: Packing and Piling Lumber, Purchasing

Departments Affected: Yard, Purchasing

PURPOSE:

Lumber should be sorted by species, thickness, and original moisture content to permit the use of proper drying schedules; it should be sorted by length to provide optimum piling methods, maximum lumber per pile, and minimum drying degrade.

METHOD:

Sorting lumber by species and thickness is an accepted practice and requires no change in present methods.

Sorting lumber by original moisture content is not always done and may require slight modification of procedures in some yards to accomplish the practice. Essentially, it means that complete packages or complete kiln loads must be built from lumber of uniform moisture content.

If a package or kiln load has been only partially constructed and the source of lumber changes as to moisture content, then a new package or kiln truck must be started with the old one being set aside until additional comparable lumber is available to complete it. This is the same procedure that would be used when there is a change of species or thickness.

Sorting for length is often the most difficult procedure to work out, but one that pays large dividends in increased drying capacity along with improved drying quality and increased yield.

Where an automatic stacker is used, it will be necessary for the lumber to be sorted for length prior to placing the lumber on the chain. Obviously, the best place for sorting to length is at the sawmill, so the purchasing agent should buy lumber sorted by length. If lumber cannot be purchased separated by length, then it should be hand piled if the volume is not too great. Here it can be pulled and sorted by length as it is stacked into separate bins.

Separations for length should be in three groups: 3.0 meters or shorter, 3.0 to 4.0 meters and 4.0 to 5.0 meters. In other words, there will be lumber packages and kiln trucks of three standard lengths, 3.0, 4.0, and 5.0 meters. Packages will vary in width and in height according to kiln design.

EQUIPMENT:

Additional handling by fork lift trucks may be necessary for making all the sorts required.

When hand piling is practiced, three stacking bins need to be located adjacent to the grading station to permit separation by length. Two bins can be back to back with the lumber to be graded at the end, with the third bin on the other end of the lumber to be graded.

PERMISSIBLE DEVIATIONS:

Shorter boards may be included in a package if the total footage of short boards is not more than 10 percent of the footage in the package, and if full length boards are on the outside edges of each layer of lumber in the package.

Moisture content separation may be waived if the lumber is to remain on the yard for one month for poplar and soft maple and two months for other species.

RECORDS:

No special records are involved in sorting operations.

RESPONSIBILITY:

Yard Foreman.

3. Stacking packages

Date Issued_____

Activities Affected: Packaging and Piling Lumber

Date Revised_____

Departments Affected: Yard

Approved by_____

PURPOSE:

Lumber must be correctly piled into packages for fork lift handling, for air seasoning on the yard, and for finish drying in the kilns. In most instances, packages will be placed directly in the kiln by fork truck, but at some plants two or more packages are Placed on kiln trucks to be moved into the kiln. (See section C. 4, Lumber Handling - Stacking Kiln Loads.)

METHOD:

Lumber packages should be built in automatic stacking devices or hand piled in bins with separator stick guides. The principles of building good packages are the same in both cases and will apply in both cases as described herein.

Lumber packages vary in size and depend upon dry kiln sizes. Widths may vary from 1.5 meters to 2.5 meters wide and heights from 1.0 to 2.0 meters. However, the width and height should be standardized to make optimum use of the dry kiln sizes.

Lumber shall be stacked tight (edge to edge) in each layer with full length boards always on the outside edges. When lengths shorter than the package length must be used, they should be used in the same

position in each layer. This results in continuous vertical voids but provides separator stick support that results in a minimum of warped lumber. (See Figure C-3-1 attached.)

Lengths shall not be changed within a package--i.e., starting with a 4-meter long package and changing to 3 meters long because of a shortage of 4-meter lumber. A partial package shall be set aside until additional comparable lumber is available to complete it.

The distance between separator sticks may vary by the lumber thickness, length of package, tendency of lumber to warp, and the uniformity of lumber thickness (presence of miscuts, etc.). The following table shows the maximum allowable distance between separator sticks.

Lumber Thickness	Distance Between Separator Sticks in Millimeters			Number of Separator Sticks Per Layer		
	5m Package	4m Package	3m Package	5m	4m	3m
25mm	625	570	500	9	8	7
32mm	625	570	600	9	8	6
40mm	710	660	600	8	7	6
48mm or up	830	800	750	7	6	5

The end separator sticks must be within 50mm of the board ends to prevent end splits.

One end of the package should be perfectly square edged as the result of the even-ender on the automatic stackers, or a solid wall in one end of the bin where hand built packages are made. The other end may have a variation of as much as 150mm, but anything more than 150mm should be trimmed.

On the ragged end of the package, the separator sticks must be placed at the end of the normal length lumber; thus, some boards will project more than 50mm from the separator sticks.

Packages should be built to the same height regardless of lumber thickness. Thus, thicker lumber packages will have fewer layers of lumber. The height of the package is determined by the kiln dimensions and the need to have the lumber piles in the dry kilns high enough to be above the overhead baffles and thus prevent overhead air by-pass.

When it is necessary to stack odd lengths of lumber in a package, such as 2.5-meter lumber in a 3-meter package, 3.7-meter lumber in a 4-meter package, etc., extra separator sticks will be used to support the ends of the shorter boards.

Separator stick guides and side supports must be used on all stackers, automatic or hand piled bins. Absolute separator stick alignment is necessary on both sides of a package or a kiln load, and the edges of a package must be even, with no boards jutting out or recessed in the package. This is essential to develop proper and uniform air flow in the dry kilns.

Lumber packages must be clean from dirt and rocks. A brush or an air gun should be used to clean lumber packages when necessary.

EQUIPMENT:

Automatic stackers may be in use at some locations. At other locations, bins have been constructed to assure proper stacking of lumber by hand. The attached drawing (Figure C-3-2) indicates a suitable bin for hand stacking.

PERMISSIBLE DEVIATIONS:

Sticks may be placed closer together than recommended for extra high value lumber, lumber that is prone to warp, or lumber that contains considerable odd lengths.

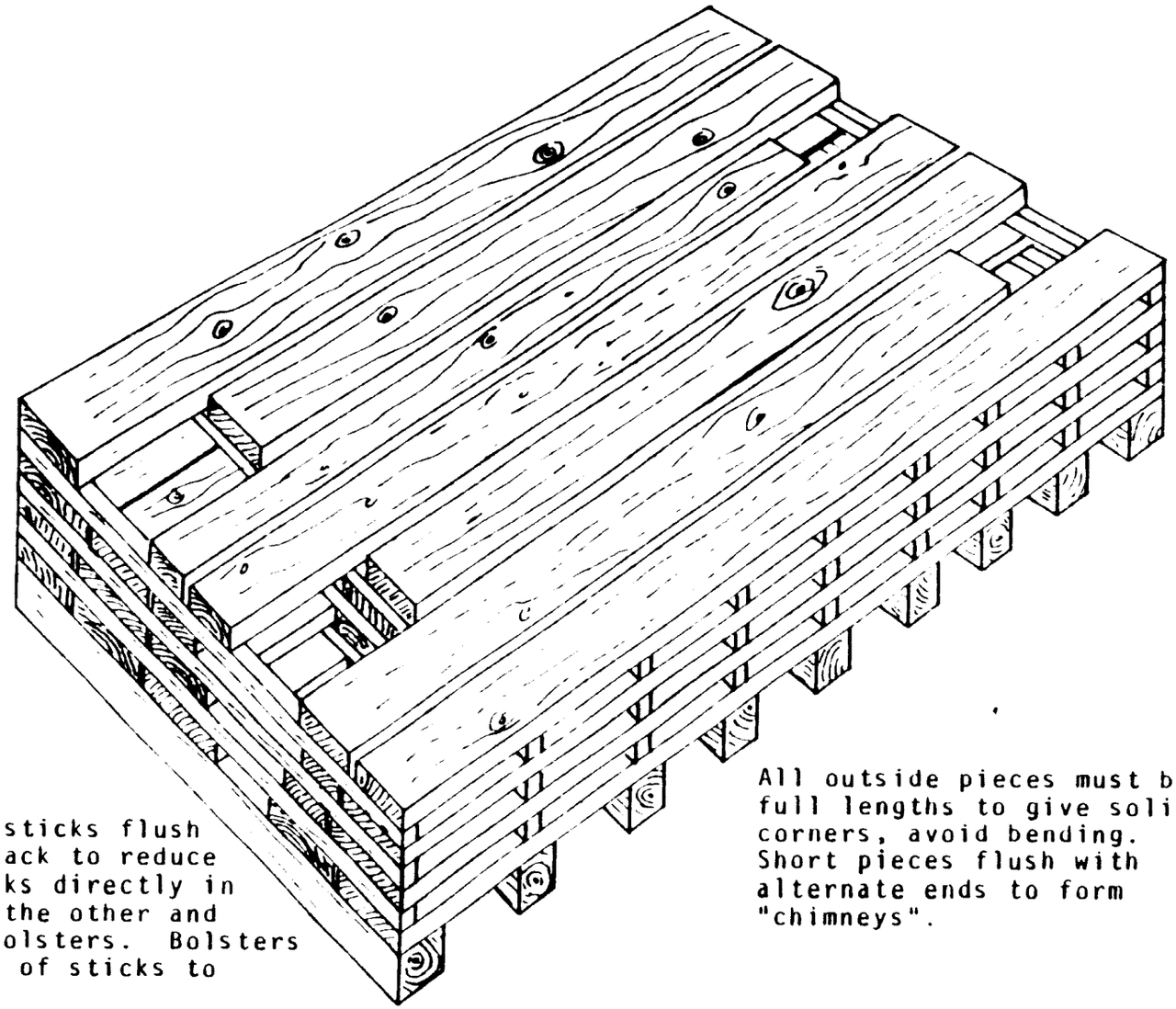
On some occasions, it is permissible to stack 3.0 to 5.0 meter lumber in 5-meter packages. This should be done only if (1) there is a small amount of lumber to stack and not enough to separate by lengths, or (2) longer package lengths are essential to full utilization of kiln space.

RECORDS:

After each package is completed, it must be tagged with pertinent information including date, species, thickness, grade, quantity, and moisture content. A copy of the tag should go to Inventory Control with an indication of yard location. (See section C.9, Inventory Control.)

RESPONSIBILITY:

Yard Foreman.

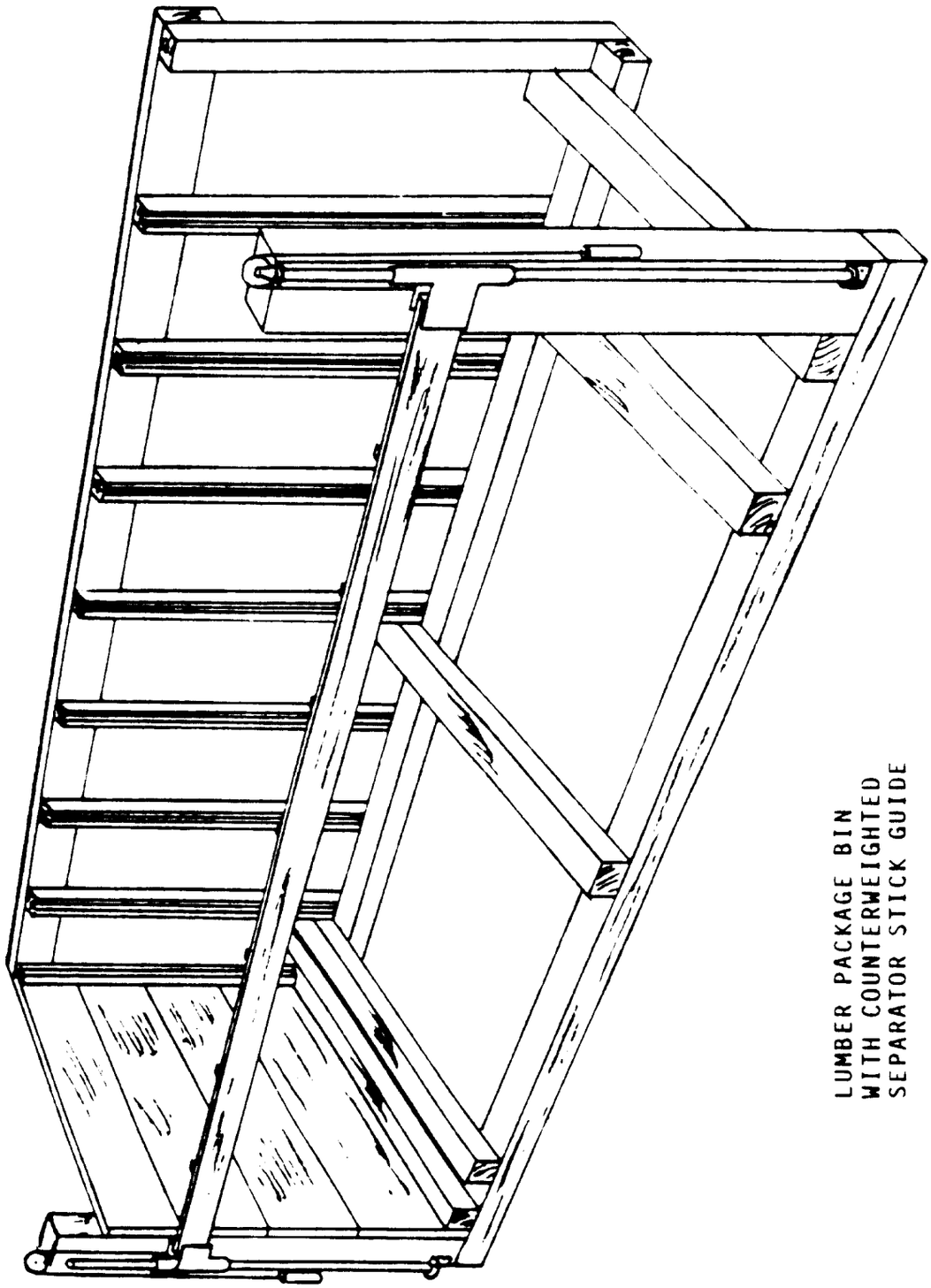


Note separator sticks flush with ends of stack to reduce checking. Sticks directly in line one above the other and directly over bolsters. Bolsters under every row of sticks to avoid bending.

All outside pieces must be full lengths to give solid corners, avoid bending. Short pieces flush with alternate ends to form "chimneys".

FIGURE C-3-1

FIGURE C-3-2



LUMBER PACKAGE BIN
WITH COUNTERWEIGHTED
SEPARATOR STICK GUIDE

4. Stacking Kiln Loads

Date Issued_____

Activities Affected: Piling Lumber, Kiln Drying

Date Revised_____

Approved by_____

Departments Affected: Yard, Dry Kilns

PURPOSE:

Kiln loads can be built at automatic stackers, in stacking bins for handling piling, or by assembling packages on kiln trucks. This directive is concerned with placing completed packages of lumber on kiln trucks. Other considerations of piling are fully covered under Lumber Handling - Stacking Packages, Section C.3.

METHOD:

The first package can be put on kiln trucks by the fork lift truck without difficulty. The important consideration is to be certain that timber supports under the package are under each vertical row of sticks and are in perfect alignment with the sticks.

The upper package on a kiln truck should be placed carefully to maintain separator stick and edge alignment with the lower package and to remove bolsters

The simplest and most practical method to remove bolsters is by the use of wedges which are inserted to permit fork removal. The wedges away from the fork lift truck will eject themselves as they are lightly tapped sidewise with a hammer. Another method of removing wedges is to have a chain or eye attached to the large end. This can then be pulled by the fork lift.

The wedges in the lumber on the fork lift truck side of the package are easily removed as the fork lift backs out and then lifts the edge of the package with the thin end of the forks. The wedges are removed and the package is let down.

The important factor in using wedges is to be absolutely sure that separator sticks and package edges are aligned before pulling wedges.

EQUIPMENT:

Wooden or metal wedges for building kiln truck loads from packages of lumber.

PERMISSIBLE DEVIATIONS:

If kiln capacity is not critical, bolsters can be left in and the spaces between can be baffled except for sample board location. (See section D. 4. Figure D-3-1.)

RECORDS:

None.

RESPONSIBILITY:

Kiln Operator.

5. Separator Sticks

Activities Affected: Stacking Lumber, Air Drying, Kiln Drying

Departments Affected: Yard, Kiln, Rough Mill

Date Issued _____

Date Revised _____

Approved _____

PURPOSE:

Lumber separator sticks normally cost from 1.8 to 3.6 Din each. It takes about 45 sticks to handle one cubic meter of lumber. Converted to dinars, it takes about 81 to 162,000 Din for separator sticks to nandle 1,000 cubic meters of lumber. They can and should be used over and over to keep the cost per cubic meter for lumber drying as low as possible. This directive describes how to handle and protect sticks to maintain the lowest costs.

METHOD:

Lumber sticks must be uniform in thickness and length and reasonably uniform in width. For normal purposes, the sticks will be as long as the lumber package is wide, 30mm wide ± 5mm, and 20mm thick.

Sticks must be dried to 20 percent moisture content or below before being used.

Sticks must be dressed on top and bottom with a uniform thickness of 20mm. Sticks should be trimmed to length with a tolerance of ± 15mm for automatic stacking or ± 25mm for hand piling.

Sticks must be relatively straight with crook not to exceed 20mm/meter of length. (Crook is the deviation from a straight line as the stick is laid on a flat surface with the wide face down. Bow is not considered a problem because the weight of the lumber will flatten it.)

Broken sticks, sticks with wane on one edge, or sticks containing decay should be discarded.

Representative species for sticks are: hickory, ash, oak, and cypress. When these are not available or when prices are out of line, Pinus negra, beech, and maple may be substituted. No other species are to be used.

Sticks that are not being used should be stacked in palletized form and must be placed in a dry storage area until needed.

Recovery of sticks at breakdown hoist or other locations must be in orderly, parallel fashion rather than in a jackstraw pile. Sticks should be collected in palletized bins that can be transported by a fork lift truck.

EQUIPMENT:

Sufficient bins for storage of one-third of all sticks being used should be available. This will take care of the usual lumber inventory variations and production schedules. If lumber inventory is depleted more than expected, sticks should be steel strapped and stored in a dry place until again needed.

Lumber package breakdown hoists should be equipped with stick conveyors that automatically transport the dropped out sticks to a waiting bin.

PERMISSIBLE DEVIATIONS:

None, except as indicated above.

RECORDS:

Separator sticks should be inventoried at least twice a year to prevent running out at a critical time, and to determine sticker costs on a periodic basis. A knowledge of sticker costs will insure their better care.

RESPONSIBILITY:

Yard Foreman, Kiln Operator.

6. Bolsters

Date Issued_____

Date Revised_____

Approved by_____

Activities Affected: Lumber Yard, Dry Kilns

Departments Affected: Lumber Yard

PURPOSE:

Bolsters are used to separate packages of lumber, permitting fork lift trucks to insert or remove forks as necessary.

METHOD:

Bolsters are to be square and 50mm longer than the package width. They should be made from pine and dressed to 90mm square. They should be dry, free from decay, and straight (not more than 20mm crook per meter of length. Bolster ends must be square cut to permit proper insertion of bolster clamps.

Bolsters should be placed on top of the lumber packages immediately after they have been built and should be fastened directly in line with lumber sticks with a bolster clamp. (See Figure C-6).

The bolster should remain clamped to the package until the package is converted to a kiln truck load, or in case of package kilns, until the lumber goes to the breakdown hoist at the Rough Mill.

Bolsters are to be placed on packages in line with every row of sticks except the center row on every third package. This center bolster is omitted to allow the insertion of the sample cradle. (See section D.1)

A supply of bolsters should be on hand for a 20 percent excess of lumber handling capacity, including yard, kilns, and dry storage.

Bolsters not in use are to be stacked in cradles that can be moved by the fork lift truck.

An excess of bolsters should be steel strapped in 1 meter bundles and placed in dry storage until needed.

EQUIPMENT:

Two bolster clamps are needed for each bolster in use. Bins for bolster clamps are needed for storage and transport of bolster clamps at point where bolsters are removed from the package.

PERMISSIBLE DEVIATIONS:

None.

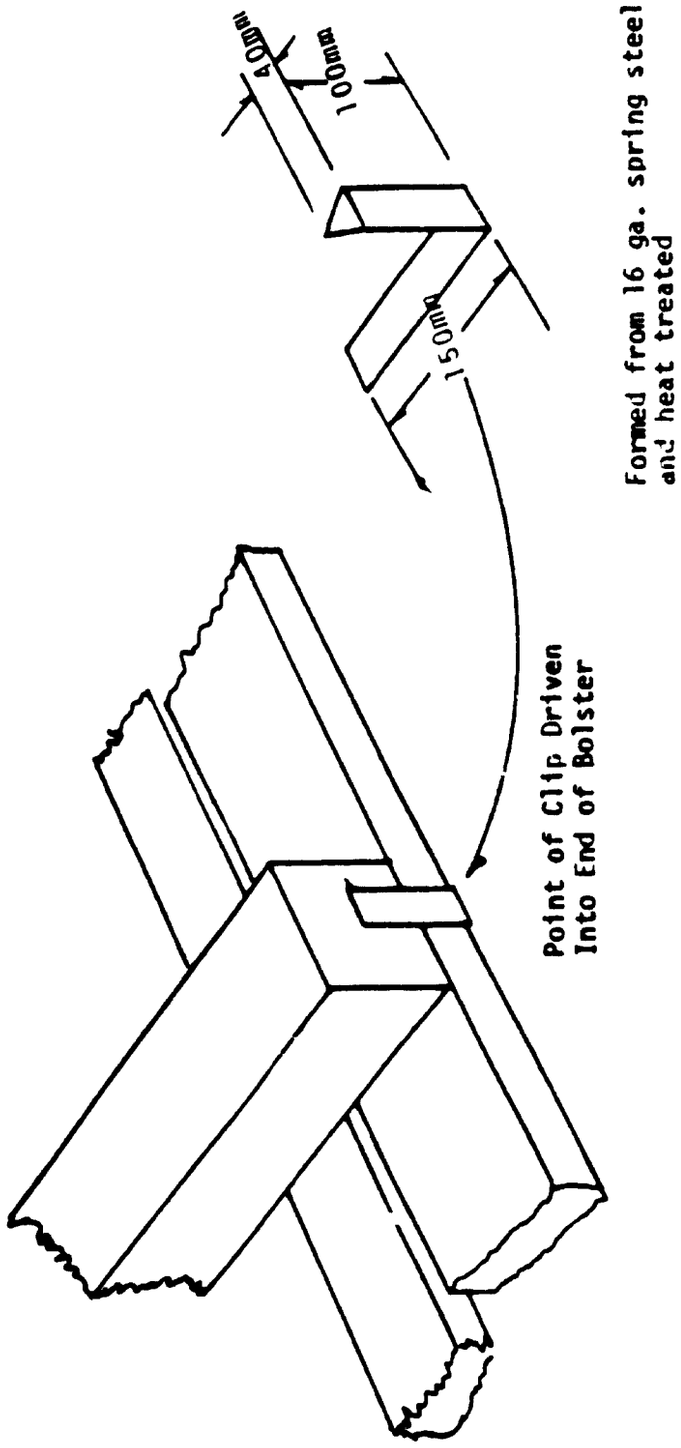
RECORDS:

None.

RESPONSIBILITY"

Yard Foreman, Stacking Crew.

FIGURE C-6


40mm
100mm
150mm
Formed from 16 ga. spring steel and heat treated
Point of Clip Driven Into End of Bolster

7. Pile Foundations

Date Issued_____

Activities Affected: Air Drying or Yard Storage of Lumber

Date Revised_____

Departments Affected: Lumber Yard

Approved by_____

PURPOSE:

To provide a solid foundation for lumber piles that will support the weight without settling and that will permit circulation of air under the lumber piles.

METHOD:

There are two acceptable methods for building lumber pile foundations. Method No. 1 is preferred and should be used when the yard layout is fixed and no changes are anticipated. Method No. 2 is to be used on yards that may be subject to change, or paved yards where flexibility of pile location is desired.

Method No. 1. This method requires pouring concrete in forms to provide piers which are then placed in position with a concrete base poured around 3 in line. Steel rails are fastened to the top of the piers. (See Figure C-7-1.) This system is designed for a line yard with two adjacent lines of rails so that two piles of lumber can be built back to back. Bolsters are located on top of the rails and perpendicular to the rails and should be placed directly under every line of sticks.

The line yard will have 9 to 10-meter alleys between each 2 lines of lumber piles. Packages can be placed 4 or 5 high on this

type of foundation, depending on the lift height of the fork lift truck. With sufficient lift capacity, the last 2 packages can be put up together.

Method No. 2. This method consists of using timbers that are of durable woods or timbers pressure treated with creosote or pentachlorophenol.

Timbers should be 15cm x 20cm or larger, straight and of uniform thickness.

Mud sills should be 30cm longer than the package width and laid down on firm ground, crushed rock, or pavement perpendicular to the pile length and 1.2m apart. Longitudinal sills should be placed on top of the mud sills and parallel to the lumber pile length. For piles 1.8 meters wide or less, 2 longitudinal sills are sufficient. (See Figure C-7-2.) For wider packages, 3 longitudinal sills are needed.

Bolsters are then placed on top of the longitudinal sills and perpendicular to pile length. The bolsters should be put down when the lumber package is ready to be installed so that bolsters will be in alignment with lumber sticks.

Foundation timbers must be sound and free from decay. Foundations must be level. If any settling occurs from the weight of lumber piles, the foundations should be re-leveled before again piling lumber on them.

If foundations are built on ground, a piece of black polyethylene film should be placed under the foundation to serve as a moisture barrier and to prevent weed growth under lumber piles.

In addition to the polyethylene film on the ground, a 5 percent pentachlorophenal solution should be sprayed on the ground under the polyethylene film to prevent decay and to kill weed growth. The penta solution should also be used when foundations are constructed on top of crushed rock.

Weeds and trash must not be allowed under lumber pile foundations at any time. Chemical sprays (245-T) should be used to control weeds. Mixing the weed killer with light oil rather than water gives a more effective kill and lasts longer.

EQUIPMENT:

None.

PERMISSIBLE DEVIATIONS:

Temporary storage of lumber on pavement or in dry storage areas can be done on bolsters without foundations.

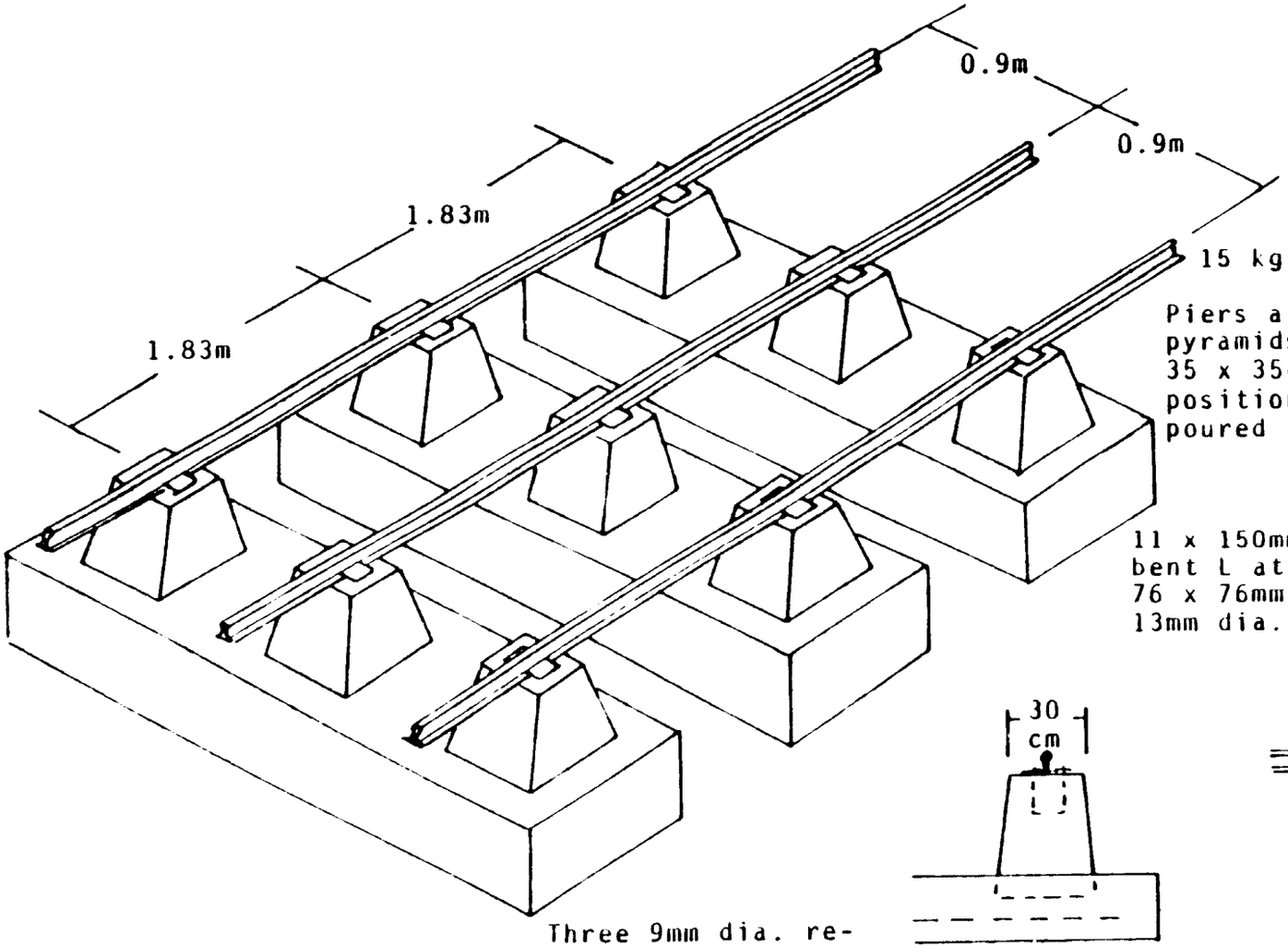
RECORDS:

None.

RESPONSIBILITY:

Yard Foreman.

PILE FOUNDATIONS FOR LUMBER DRYING YARD



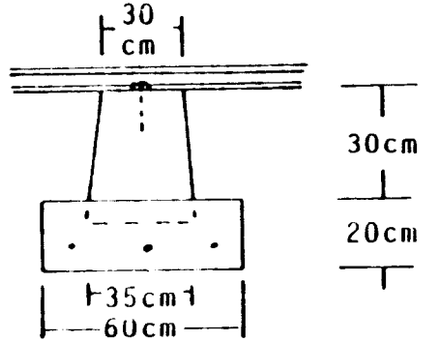
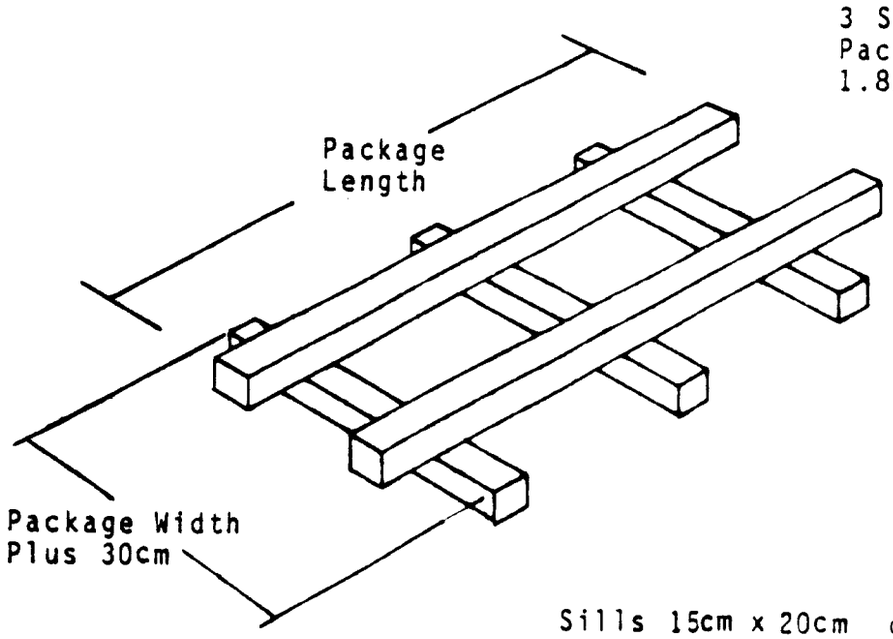


FIGURE C-7-1

FIGURE C-7-2


3 Sills for
Packages Over
1.8m Wide.
Package
Length
Package Width
Plus 30cm
Sills 15cm x 20cm or larger
Straight, uniform thickness
Pressure treated with
preservative (Penta or
Coal Tar Creosote).

8. Roof Covers

Date Issued_____

Activities Affected: Air Drying of Lumber

Date Revised_____

Approved by_____

Departments Affected: Lumber Yard

PURPOSE:

Excessive degrade occurs on lumber that is exposed to rain, wind, and sun. Roof covers on lumber piles greatly reduce such damage and generally pay for themselves in two or three uses.

METHOD:

All lumber, except No. III or lower grade, that is being air dried or stored in an open yard will be covered to prevent degrade.

The cover will be fastened on a package before it is lifted to the top of the lumber pile. Usually this operation will be performed by the lift truck operator.

The package will have the usual number of bolsters clamped to its top.

Corrugated roofing (0.4 to 0.5mm) in 2.5- and 3-meter lengths by 0.7 meters wide will be used to make the cover. (See Figure C-8-1.)

The roofing will be lapped on sides and ends (10.0cm laps on ends), and the package will be completely covered with the roofing projecting 15.0 to 20.0 centimeters beyond the ends and sides of the pile.

Lumber sticks will be placed on top of the corrugated roofing at 120mm intervals and fastened to the lumber pile with wireform No. 2 spring "C" clamps.

EQUIPMENT:

No. 0.4 to 0.5mm standard galvanized corrugated roofing in lengths of 2.5 to 3.0 meters long and 0.75 meters wide. A supply should be on hand to cover all piles in the open. To determine the amount of roofing needed, determine the area of the top of all lumber piles and increase this by 30 percent. In most yards, about half of the roofing sheets should be 2.5 meters long, the other half 3mm long.

It will take 10 "C" clamps for a 5-meter package, 8 for a 4-meter package, and 6 for a 3-meter package.

Pallets should be used to store and transport roofing sheets. Bins for fork lift transport are needed for "C" clamps.

Regular size lumber sticks and bolsters are satisfactory.

PERMISSIBLE DEVIATIONS:

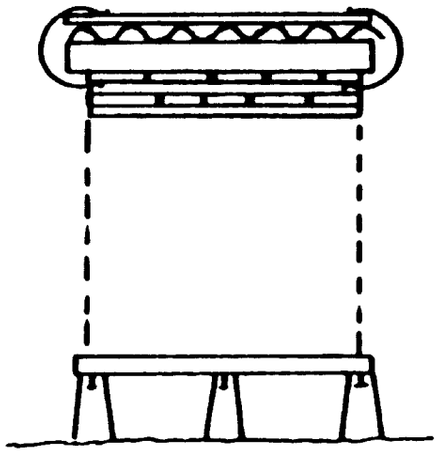
Lumber stored under open sheds requires no covers. Lumber of No. III or lower grade can be left uncovered. No other deviations are permitted.

RECORDS:

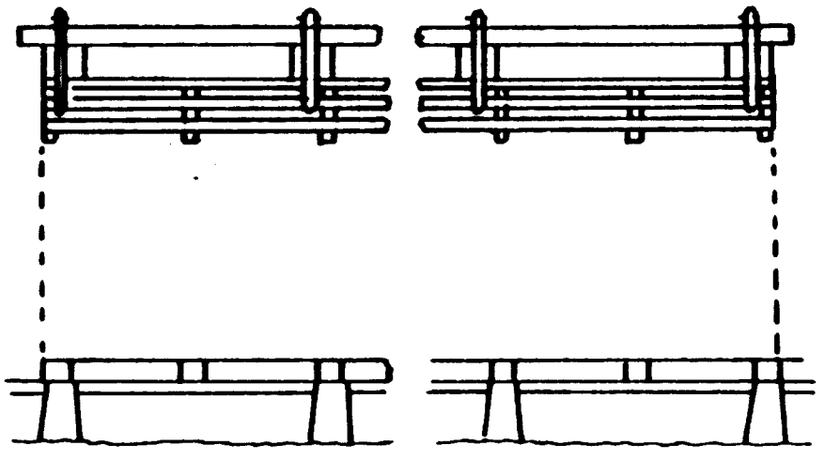
None.

RESPONSIBILITY:

Yard Foreman, Fork Lift Truck Driver.



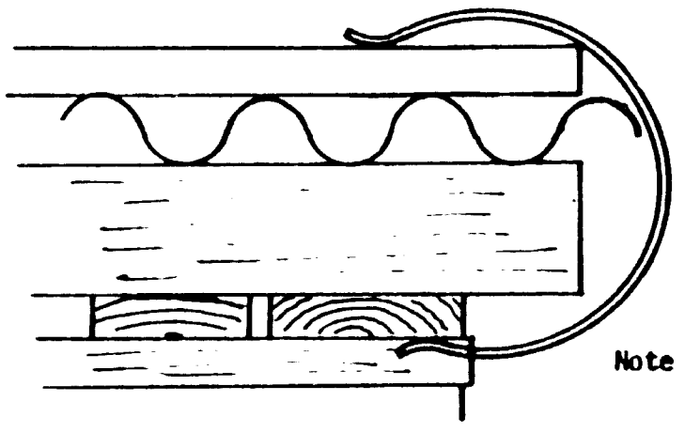
End View



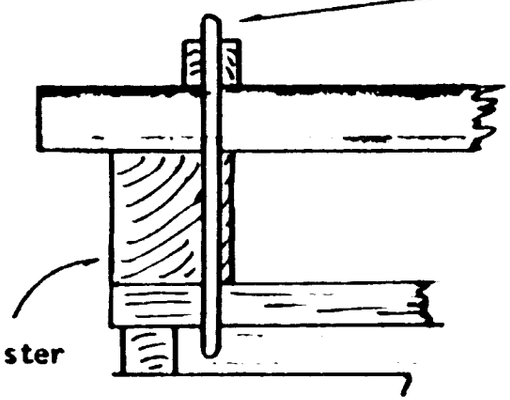
Side View

FIGURE C-8-1

Cover should extend 20cm beyond pile in all directions.



End View



Note Bolster

Side View

"Wireform" #2 Spring "C" Clamp from V. Yost Superior Co. Springfield, Ohio

0.4 to 0.5mm standard galvanized corrugated roofing 2.5 and 3.0m lengths. Corrugated roofing must be separated from top layer of lumber by bolsters.

9. Inventory Control

Activities Affected:	Lumber Grading, Yard Handling, Kiln Drying, Scheduling	Date Issued_____
Departments Affected:	Lumber Yard, Kiln Drying Scheduling, Purchasing	Date Revised_____ Approved by_____

PURPOSE:

Current inventory records are absolutely necessary to permit the proper planning of furniture production which must begin with the proper movement of lumber by species, thickness, and grade through the dry kilns and to the Rough Mill.

METHOD:

The current inventory and location of lumber by species, grade, and thickness should be known at all times by the yard foreman and the purchasing agent; such records should be readily available to other departments concerned with the scheduling of furniture production.

As incoming lumber is measured, graded, and piled, a triplicate record should be made for each package. (See Figure C-9-1 attached.) One copy should be stapled to the package, one copy should be retained by the Yard Foreman, and one copy should go to the Purchasing Department

When the lumber package goes to the dry kiln, the Dry Kiln Operator should receive the Yard Foreman's copy or the Yard Foreman should note on his copy that the package has gone to the dry kiln. When the lumber has been dried and is moved into dry storage, the

copy of the inventory should go to the Rough Mill Foreman. When the lumber is in process in the Rough Mill, the Rough Mill Foreman should so note and forward the copy to the Purchasing Department where it is filed with the Purchasing Agent's copy as lumber processed but no longer in inventory.

EQUIPMENT:

None.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

As described above, Figure C-9-1.

RESPONSIBILITY:

Yard Foreman, Kiln Operator, Rough Mill Foreman, Purchasing Agent.

FIGURE C-9-1

Lumber Package No._____ Inspected by_____ Date Stacked_____

Source_____ Species_____ Thickness_____Plant No._____

Length of Package_____ Width of Package_____Total Footage_____

Location in Yard_____

Dried in Kiln No._____Date in Kiln_____Date out of Kiln_____

Average Moisture Content_____Stress Condition_____MC Variation_____

Date in Dry Storage_____Date of Rough Mill_____

Remarks on Degrade or Other Factors_____

_____

_____

_____

D. KILN DRYING

1. Use of Samples

Date Issued_____

Activities Affected: Lumber Drying

Date Revised_____

Departments Affected: Lumber Yard, Dry Kilns

Approved by_____

PURPOSE:

The use of kiln samples is the best known method for accurately following kiln schedules and keeping degrade to a minimum while maintaining the fastest possible drying rate.

METHOD:

At least one kiln sample will be used for every 12 cubic meters of lumber in a kiln charge. Half of the kiln samples used in each charge will be selected from fast drying boards and half will be selected from the heaviest slow drying boards.

Where large quantities of similar lumber (species, thickness, and moisture content) are being stacked, a full board selected for fast drying or slow drying can be cut into a number of samples. Where small lots of dissimilar lumber are being stacked, it may be necessary to cut only one or two samples from a selected board.

The selection of samples should be made at the point where lumber is being stacked. The selection should be made by the stacking crew and the boards laid aside for the kiln operator to

examine for final kiln sample preparation. A few more boards than necessary should be pulled by the stacking crew and the unused boards put back in process after the kiln operator has made his selection.

Where kiln trucks are being stacked, the stacking crew should leave a pocket for the kiln sample in the side of every third package. This can be done by using two short boards (the total length of both boards being 1 meter less than package length) and using 2 extra short separator sticks to support the inside ends of the short boards.

Where fork lift packages are being used, the kiln samples will be placed in bolster spaces with a tray (Figure D-1-1), and no pocket is necessary in the pile.

Kiln samples are to be prepared as shown in Figure D-1-2, where a full board is used. The same procedure is used when only one or two samples are cut from a board.

The boards must be cut for kiln samples at a point where scales and end coating material are available. It is imperative that moisture sections are brushed clean of splinters and weighed immediately after cutting. If there is a delay of even two or three minutes between cutting sections and weighing, the sections should be wrapped in a polyethylene bag to prevent moisture loss. It is also imperative that kiln samples are end coated immediately or they will not truly represent the moisture content of the load being dried. Again, if there is any necessary delay, the kiln samples should be wrapped in polyethylene film.

The kiln samples are numbered and identified with the package or kiln truck of lumber that they represent. They are then weighed and the green weight written on the sample and in the record form.

The end sections are marked with the kiln sample number and placed in an oven at 102° Celsius and dried to constant weight. The original moisture content of the sections is then determined by the formula:

Formula No. 1

$$\text{Original MC} = \frac{\text{Original Weight of Section}}{\text{Oven Dry Weight of Section}} \times 100$$
$$\text{Oven Dry Weight of Section}$$

When the moisture contents of the sections have been determined, the moisture content of the sections from each end of a sample are averaged to determine the original moisture content of the sample. This original moisture content of the sample is then written on the sample and in the record form.

The calculated oven dry weight of the sample is then determined by using the following formula:

Formula No. 2

$$\text{Calculated Oven Dry Weight of Sample} = \frac{\text{Original Weight of Kiln Sample}}{\text{100 + MC of Sample in Percent}} \times 100$$

After the calculated oven dried weight of the sample is determined, its moisture content can be determined at any time by weighing it and using Formula 1.

The kiln sample is then placed in the pocket of the kiln truck load or the bolster space between packages and remains with this lumber through the yard and through the kilns.

The moisture content of the kiln samples will be used to adjust the kiln schedules. The wettest samples will determine schedule changes until the final drying step is reached; then, the driest samples will determine the point where equalization schedules should be used.

If some kiln samples do not seem to be drying fast enough and are slowing down kiln schedule changes, these samples should be re-checked by cutting new moisture sections, end coating the remaining portion, and determining new moisture content and new calculated oven dry weights. In other words, repeat the process used in the original preparation of samples.

For use of kiln samples in equalization and conditioning, see Standard Practice numbers D-5 and D-6.

For more detail on preparation and use of kiln samples, see the annex.

EQUIPMENT:

Portable electric saw, band saw, drying oven, triple beam balance for sections, pound scales for samples, and end coating material.

Saws must be sharp at all times to prevent overheating and subsequent loss of moisture from ends of sections and samples. Polyethylene bags should be used in which to wrap sections between sawing and weighing.

EQUIPMENT:

Sufficient trays should be constructed to handle samples in bolster spaces between packages (Figure D-4-1). One tray will be needed for each 3 packages in the yard and in the kilns.

PERMISSIBLE DEVIATIONS:

Self-calculating scales for sections and samples may be used when available. Manufacturer's directions should be followed carefully in using these instruments.

Twice as many samples may be used when drying high value, hard-to-dry species in small kilns.

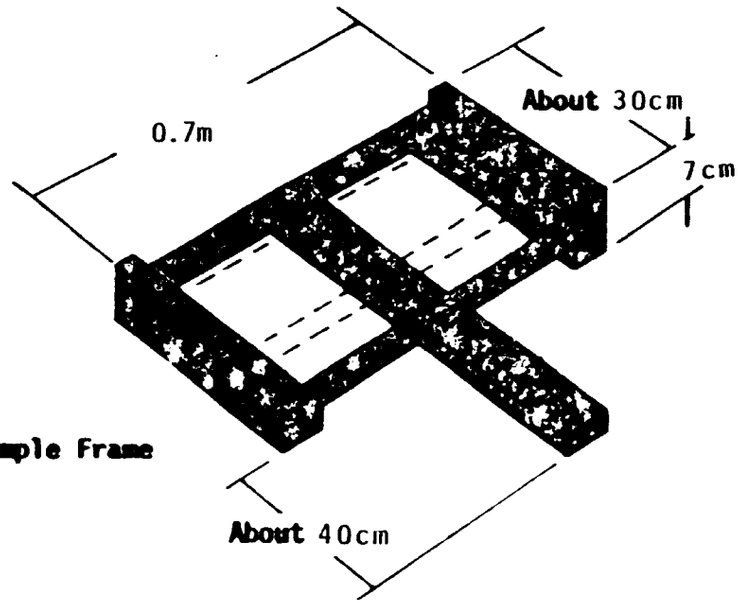
RECORDS:

Accurate records must be kept of all weighings and determinations of kiln samples and sections for determining moisture content. (Figure D-1-3).

RESPONSIBILITY:

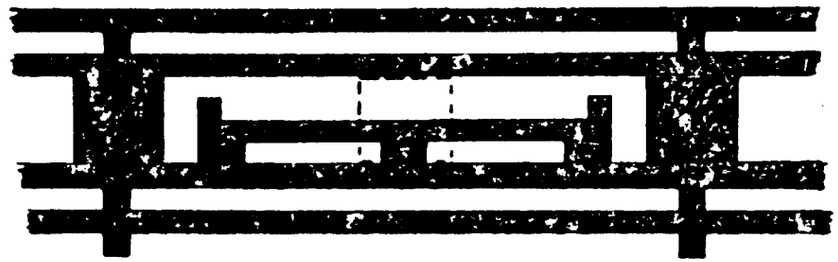
Kiln Operator.

KILN SAMPLE FRAME



Kiln Sample Frame

Omit Middle Bolster



Position of Frame
Between Bolsters &
Packages in Stack

Note: These samples are used both in Air Drying and in Kiln Drying

Figure D-1-1

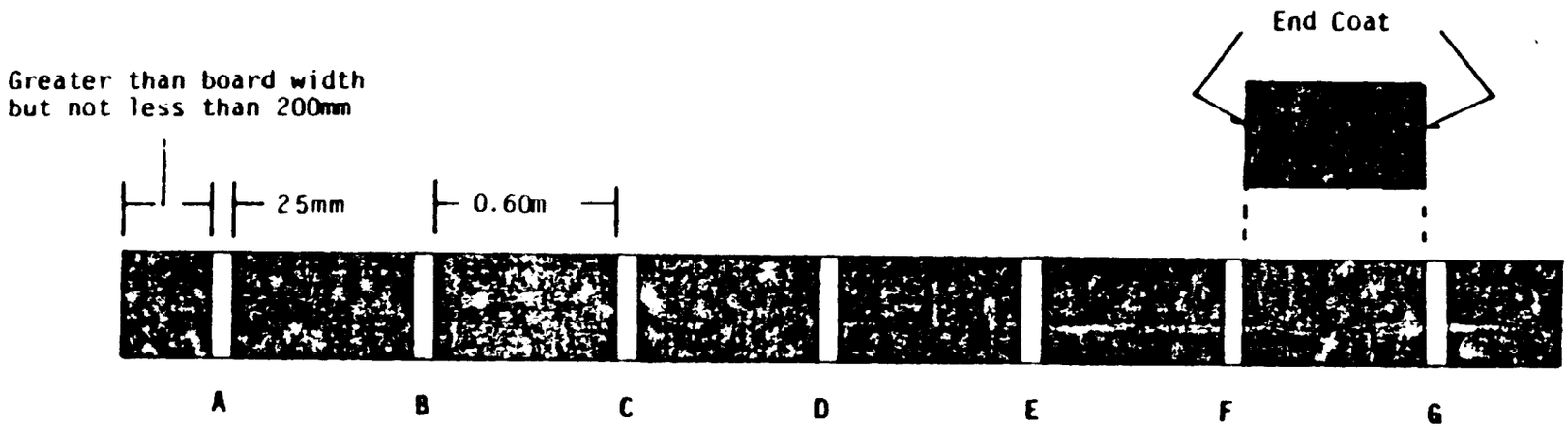


Figure D-1-2

Each kiln charge should contain several kiln samples from each of several boards. These boards should represent the hardest-to-dry and the easiest-to-dry lumber. The boards are cut into short and long pieces, beginning at least 200mm from the end. All pieces are individually identified; long pieces are kiln samples and are end coated immediately upon cutting and are then placed in various places in the kiln. The short 25mm sections are immediately weighed oven-dried, and weighed again. These 25mm sections are used to obtain the initial moisture content of the kiln samples. For example, the average of moisture content of sections A and B is the moisture content of sample #1.

Note: These samples are used both in Air Drying and in Kiln Drying

Figure D-1-3

Yard Location _____ Date In Yard _____ Date In Kiln _____

Kiln No. _____ Species _____ Thickness _____ Amount _____

FPL Kiln Schedule No. _____

														Remarks
Section Number														
Green Weight														
Dry Weight														
Moisture Content														
Kiln Sample No.														
Average MC														
Kiln Sample Wt.														
Calculated O. D. Wt.														

DATE	Wet Bulb	Dry Bulb	Weight	% MC	Weight	% MC	Weight	% MC	Weight	% MC	Weight	% MC	Weight	% MC	

EQUALIZATION

Date	Hour	Wet Bulb	Dry Bulb													

CONDITIONING

Date	Hour	Wet Bulb	Dry Bulb													

2. Loading Track Kilns

Activities Affected: Kiln Operation

Departments Affected: Lumber Yard, Dry Kiln

Date Issued_____

Date Revised_____

Approved by_____

PURPOSE:

To load track kilns to obtain maximum production, good baffling, and maximum air velocity through the lumber.

METHOD:

Kiln trucks in track kilns should be of 3-, 4- or 5-meter lengths with each truck containing the same length of lumber from bottom to top.

If kiln trucks are loaded using fork lift packages and bolsters, a baffle shall be used in the openings created by the bolsters. (See Section D. 3, , Figure D-3-1.)

It is preferable to build kiln trucks without bolsters to increase kiln capacity and to obtain maximum air velocity. This can be done by using wedges that are removed when the lift truck forks are withdrawn.

In multiple track kilns, spacing of kiln trucks should be uneven on different tracks to avoid straight through openings that permit air by-pass.

Kiln trucks should fill the tracks as completely as possible. If a space is open, it should be staggered on different tracks, and

preferably toward the center of the dry kiln rather than at the ends, since most dry kilns have some longitudinal drift of air toward the ends.

Kiln trucks should be built high enough to project 15cm above fixed overhead baffles to allow for lumber shrinkage without creating overhead air by-pass.

End baffles of the hinged or swinging type should be used in the ends of the kilns to prevent air by-pass at those locations.

EQUIPMENT:

Kiln trucks of 3-, 4- or 5-meter lengths. Often it is necessary to build special kiln trucks for 3-meter lengths by using spacer bars bolted to the kiln truck wheel frames.

A supply of wedges, wood or metal, for converting fork lift packages to kiln truck loads.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

None.

RESPONSIBILITY:

Dry Kiln Operator, Yard Foreman.

3. Loading Package Kilns

Date Issued_____

Activities Affected: Kiln Operation

Date Revised_____

Departments Affected: Lumber Yard, Dry Kiln

Approved by_____

PURPOSE:

To load trackless kilns with fork lift packages of lumber to obtain maximum production, good baffling, pile stability, and maximum air velocity through the lumber.

METHOD:

Lumber packages will always be stacked perpendicular to the air flow in a package loaded kiln.

Packages must be well built with lumber of uniform thickness and sticks in good alignment, or shrinkage during drying can be uneven and cause packages to fall against the wall or against other packages.

If this happens, excessive costs and dangerous conditions exist when the lumber is to be removed from the kiln.

Floor baffles 100mm high will be installed on the floor between posts that separate the stacking area from the back plenum chamber. These will prevent air from by-passing under the packages.

Regular bolsters will be placed on the concrete floor of the kiln to support the bottom package and permit fork withdrawal. These will be placed at intervals of not more than 1.2 meters apart and will be in alignment with separator sticks in the bottom package.

Upper packages should be the same length as the bottom package and should be separated by bolsters in alignment with bolsters on the floor and with separator sticks in the package.

Packages will be piled high enough to raise the overhead hinged baffle at least 150mm for 3 packages, 225mm for 4 packages, or 300mm for 5 packages. This will permit the baffle to function after the lumber shrinks and the pile is reduced in height.

Packages should be placed on the back row so that the end packages extend to the baffles in the end of the kiln. If any opening between packages is necessary, it should be toward the center of the kiln rather than at the ends. The second row of packages should be staggered so that the openings between packages do not coincide with openings between packages of the first row. The third row of packages next to the door should also be staggered so that the openings will not coincide with either the first or second row, or, if this is not possible, the front row of packages should coincide with the back row. (See Figure D-3-2 attached.)

A plenum chamber of at least 2.0 meters must be left on the back and the front (door side) of the kiln.

Any large openings between packages that cannot be avoided must be baffled with plywood that has been perforated with 25mm holes every 150mm.

Bolster openings must be baffled (Figure D-3-1) unless odd height packages can be used to break the continuous bolster openings between rows of packages. Bolster openings need to be baffled only on front or back row.

EQUIPMENT:

Fork lift truck, bolster baffles, and perforated plywood sheets.

PERMISSIBLE DEVIATIONS:

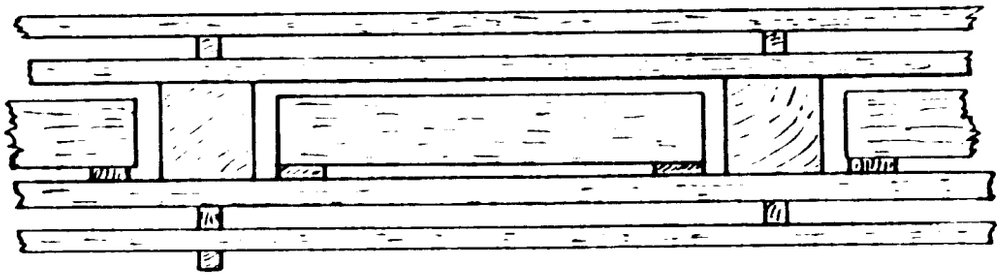
None.

RECORDS:

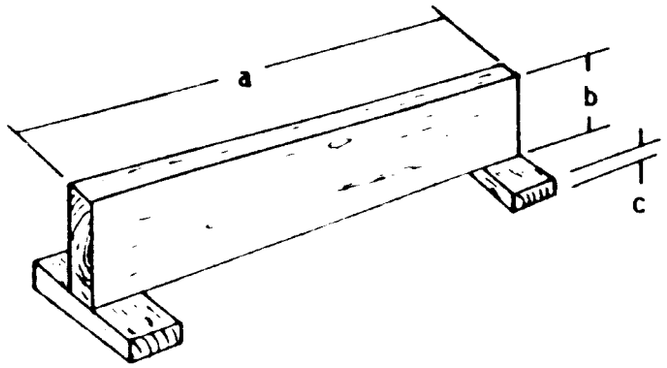
None.

RESPONSIBILITY:

Dry Kiln Operator, Fork Lift Operator.



These blocks should be placed in all bolster spaces to restrict air flow through them and force the air to move through the packages in the openings between separator sticks.



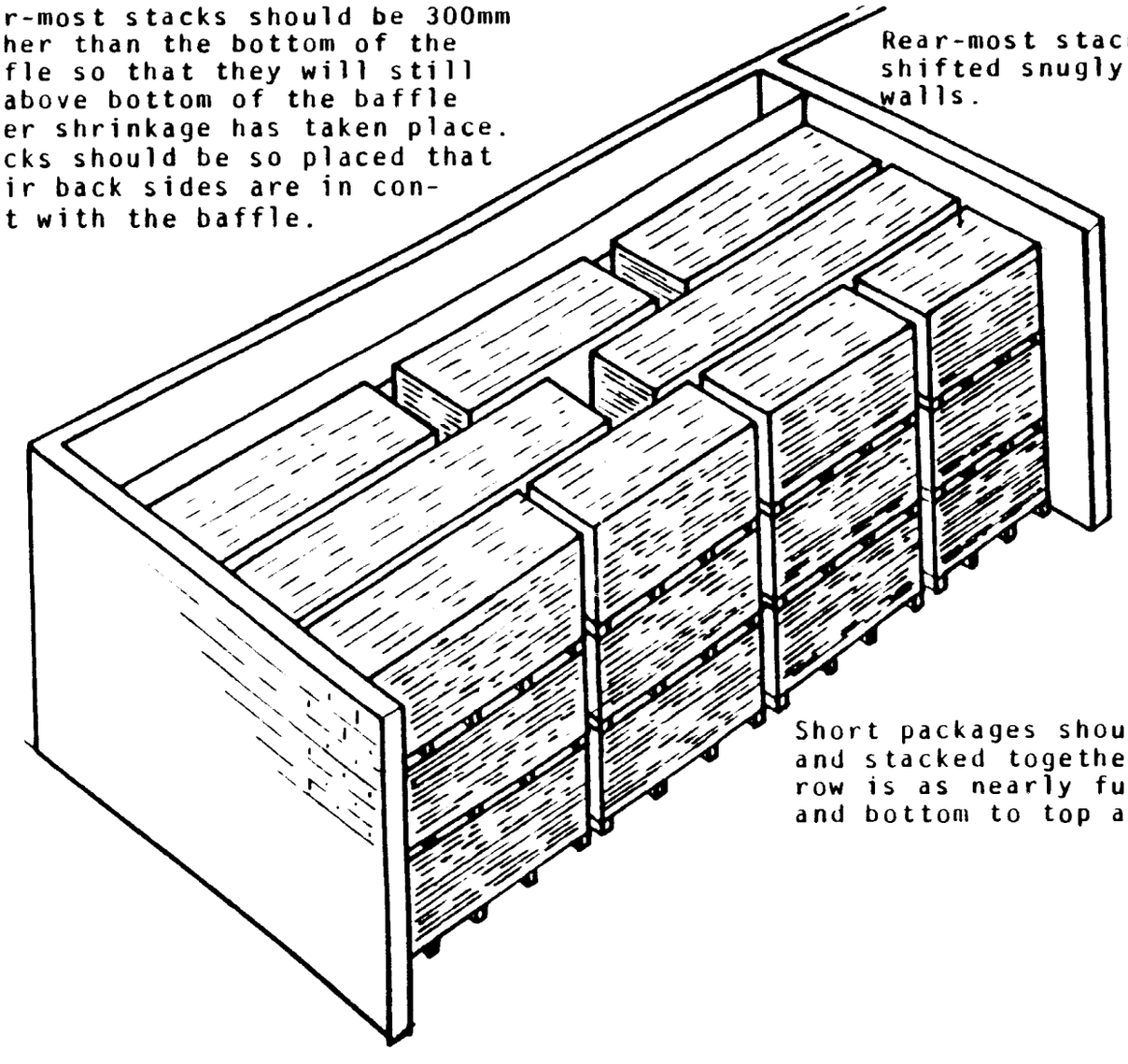
a - 50mm less than distance between bolsters
b - bolster thickness less 180mm
c - 10mm

FIGURE D-3-1

Each succeeding row of stacks should be placed to cover up the openings between the ends of the stacks in the previous row.

Rear-most stacks should be 300mm higher than the bottom of the baffle so that they will still be above bottom of the baffle after shrinkage has taken place. Stacks should be so placed that their back sides are in contact with the baffle.

Rear-most stacks should be side shifted snugly against the side walls.



Short packages should be grouped and stacked together so that each row is as nearly full side to side and bottom to top as possible.

FIGURE D-3-2

4. Schedules

Date Issued_____

Activities Affected: Lumber Drying

Date Revised_____

Departments Affected: Dry Kiln

Approved by_____

PURPOSE:

To develop drying schedules for each dry kiln that will permit the fastest drying possible within allowable degrade limits.

METHOD:

Dry kilns are of different shapes, capacity, arrangement, and are constructed of different materials. The Dry Kiln Operator must "learn" his kilns and develop schedules accordingly.

Lumber is also variable in density, moisture content, moisture distribution, and drying rates, and two different kiln loads of the same species and thickness may require adjustment of the drying schedule. This is the reason why kiln samples must always be used.

"Varda's" current best schedule for each species and thickness should be carefully recorded, showing the moisture contents of the lumber, dry bulb temperature, the wet bulb depression and the wet bulb temperature at each level of moisture content. The normally expected elapsed time should also be recorded. This schedule might look like this:

Moisture Content of Sample at Start of Step %	Dry Bulb Temperature °C	Wet Bulb Depression °C	Wet Bulb Temperature °C
Above 40	54	2	52
40	54	3	51
30	54	4	50
30	60	8	52
25	66	17	49
120	71	28	43
15	82	28	54

Normal elapsed time from green to 6% - 150 hours.

These present best schedules, one for each species and grade, will serve as the basis for modification to reduce the drying time and the kiln degrade. As each modification is tried, the results should be recorded, that is the condition of the lumber and the elapsed time, and explanation of any delays.

Changes in the kiln are to be made by using the average moisture content of the wettest samples. These are the controlling samples and will be used until the lumber charge approaches the equalization step. (See Standard No. D-5 on Equalization).

After a schedule has been used satisfactorily with little or no degrade, the Kiln Operator should attempt to increase the severity of the schedule to speed up drying. This has to be done for each kiln. A fast schedule may not work the same in all kilns.

To speed up a schedule, the first action is to increase the wet bulb depression in increments of one step. Do not increase the dry bulb temperature until all that is possible by increasing wet bulb depressions has been done.

When a change like this is made, the increase in wet bulb depression may cause surface or end checks, so the kiln samples and lumber must be watched carefully. If serious checking develops, the speed-up has been carried too far and should be backed up.

After it has been determined how far the speed-up can go with increasing wet bulb depression, increasing dry bulb temperature may be tried.

Increase in dry bulb temperature, especially at the beginning of a kiln run, may cause honeycombing. This must be watched very carefully by having enough wet samples so that some can be cut up every day to see if any honeycombing may be developing.

Honeycomb is especially serious in oak and in thick stock. It is not usually safe to increase dry bulb temperatures on such stock until the average moisture content of the wettest samples is 30 percent moisture content or lower.

A good kiln operator who watches the samples and lumber in a kiln closely can increase the drying rate without excessive degrade. An occasional check or even an occasional honeycomb indicates that the dry kiln operator is drying the lumber as fast as possible, but he must be careful not to go too far.

A resistance-type moisture meter with long insulated needles on the electrode can be a great help to the Dry Kiln Operator when kiln drying air dried lumber, but it does not replace the need for samples.

The Dry Kiln Operator should check a number of boards with the moisture meter when the kiln is loaded. This is to assure himself that his kiln samples represent some of the wettest lumber in the charge.

During the kiln run, the Dry Kiln Operator can use his moisture meter as a check on lumber in the kiln or on the kiln samples, but he must make temperature corrections for hot lumber. (Ref.: Instructions which accompany a particular meter.)

The moisture meter is especially useful to determine the highest moisture content in the center of the board. When the kiln operator knows that the center of the lumber in a charge is 30 percent moisture content or lower, he can raise the dry bulb temperature drastically without fear of honeycomb or other damage.

EQUIPMENT:

Ovens, scales, band saw, resistance-type moisture meter with long insulated needles in the electrode.

PERMISSIBLE DEVIATIONS:

None except as described above for modifying schedules.

RECORDS:

Complete records must be kept of the schedule used on each kiln run. The kiln charts must be marked with species, thickness, dates, and the kiln schedule used. Charts must be changed weekly. Overlap or second cycle of charts is not permitted.

RESPONSIBILITY:

Dry Kiln Operator.

5. Equalization

Date Issued_____

Activities Affected: Lumber Drying

Date Revised_____

Approved by_____

Departments Affected: Dry Kiln

PURPOSE:

Lumber must be brought to a uniform moisture content in order to properly condition it to relieve stress. It must also be at a uniform moisture content to eliminate problems of warping as it is manufactured into furniture parts.

METHOD:

Equalization of moisture content of lumber in a dry kiln is done near the end of the drying operation.

The average moisture content of lumber for manufacturing furniture by your company should be 6 percent. The final variation should be ± 1 percent or between 5 and 7 percent moisture content.

Equalization in the dry kiln is started when the driest kiln sample is 1 percent below target, or 5 percent.

At this point, the wet bulb is raised to give an EMC of 5 percent so that the driest lumber will not go below 5 percent.

If, for instance, the kiln is operating at a dry bulb temperature of 82°C and a wet bulb temperature of 54°C, when the driest sample reaches 5 percent moisture content, the wet bulb should be raised to 63°C to produce an EMC of 5 percent in the dry kiln.

These conditions in the kiln should continue until the wettest sample reaches an average moisture content of 6 percent.

The charge will then be ready for the conditioning treatment. (See section D. 6, Kiln Drying - Conditioning.)

It should be emphasized that the equalization treatment is based on the average moisture content of the kiln samples, and not the outside surface or the interior as would be measured with a moisture meter. There will still be a moisture gradient of a few percent in each board, but this will even out in the conditioning treatment and in dry storage.

EQUIPMENT:

None.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

A complete record will be kept on the chart and the kiln charge forms of the equalization treatment.

RESPONSIBILITY:

Dry Kiln Operator.

6. Conditioning

Date Issued_____

Activities Affected: Lumber Drying, Machining Operations

Date Revised_____

Approved by_____

Departments Affected: Dry Kilns, Rough Mill

PURPOSE:

All lumber dries with a gradient of moisture content from low on the outside to high on the inside. This drying gradient causes a stress to form that is known as casehardening, in which the outside of the lumber is in compression and the inside is under tension. When such lumber is re-sawn or machined unevenly, the stresses react and cause cupping or warp of some sort. The only known way to relieve such stress is to condition the lumber in a dry kiln. The conditioning can best be done with the lumber as hot as possible to soften the lignin in the wood, and the introduction of moisture on the outside of the board with a high humidity in the dry kiln.

METHOD:

The conditioning treatment is performed as soon as equalization is completed.

The wet bulb should be raised to an EMC value of 10 percent for hardwoods when a final target moisture content of 6 percent is desired.

For a kiln operating at 83°C, this means raising the wet bulb to 76°C.

This conditioning treatment should be maintained until samples are free of stress. This may take from 8 to 36 hours or even more on very thick stock.

To test for stress relief, cut the kiln sample boards for a stress sample as shown in Figure D-6-1. The prongs of the test sample from properly stress-relieved lumber may turn out immediately after being cut but should be straight and free when cooled. Sometimes it may take 24 hours for them to straighten out.

If the prongs turn in or are tight on each other when the stress sample is cut, the conditioning treatment needs to be continued.

If the samples are straight when cut but turn in and become tight in a few hours, then conditioning is not complete and needs to be continued.

With experience, the Kiln Operator will learn how long it takes to condition different species and thicknesses.

Reverse casehardening cannot occur if this schedule is used and the conditioning treatment does not have to be stopped at a particular time. In other words, there is no need for a Kiln Operator to check for stress relief during the night. He can wait until the next day.

Reverse casehardening, indicated by stress sample prongs that remain turned out, is caused by using line steam uncontrolled in the kiln. This should never be done because the only cure for reverse casehardening is to completely re-wet the lumber and start over on the drying process.

Some kilns are not tight enough to hold 83°C dry bulb and 77°C wet bulb. In this case, the dry bulb should be dropped on hardwood to 77°C or even 71°C until a 10 percent EMC can be obtained. At 77°C, the wet bulb should be 69°C; at 71°C, the wet bulb should be 64°C. If it is necessary to condition at these lower temperatures, it will require a longer time. For softwoods, the EMC should be 9 percent and the temperatures as follows: 83°C Dry Bulb - 74°C Wet Bulb, 77°C Dry Bulb - 63°C Wet Bulb, 71°C Dry Bulb - 63°C Wet Bulb.

In some kilns, high pressure steam is used in the humidity line and the increased heat from a high wet bulb drives the dry bulb above the desired temperature and will not permit the 10 percent EMC. In such cases, a steam-reducing valve or other mechanisms provided by the dry kiln companies must be installed to hold the steam pressure in the humidity spray pipes to not more than 73 kg/m^2.

Care must be taken to cut the stress sections properly. The stress section must be cut across the board and then turned on its side to cut the prongs. If the lumber is casehardened, the prongs may bind the saw so that the stress section cannot be withdrawn without pulling the saw off the track. If this occurs, it is best to stop the saw before pulling the stress section out.

In cutting the stress section, the prongs and voids should be approximately 6mm thick; thus, a 25mm board would have only 2 or 3 prongs, whereas a 60mm board might have 5 prongs.

When the lumber is properly conditioned the kiln can be shut off and the lumber removed to dry storage.

Shell and core moisture samples should then be made from all the kiln samples to serve as a record of the final moisture content and variation. (See Figure D-6-2.)

EQUIPMENT:

Band saw, oven, and scales.

PERMISSIBLE DEVIATIONS:

None.

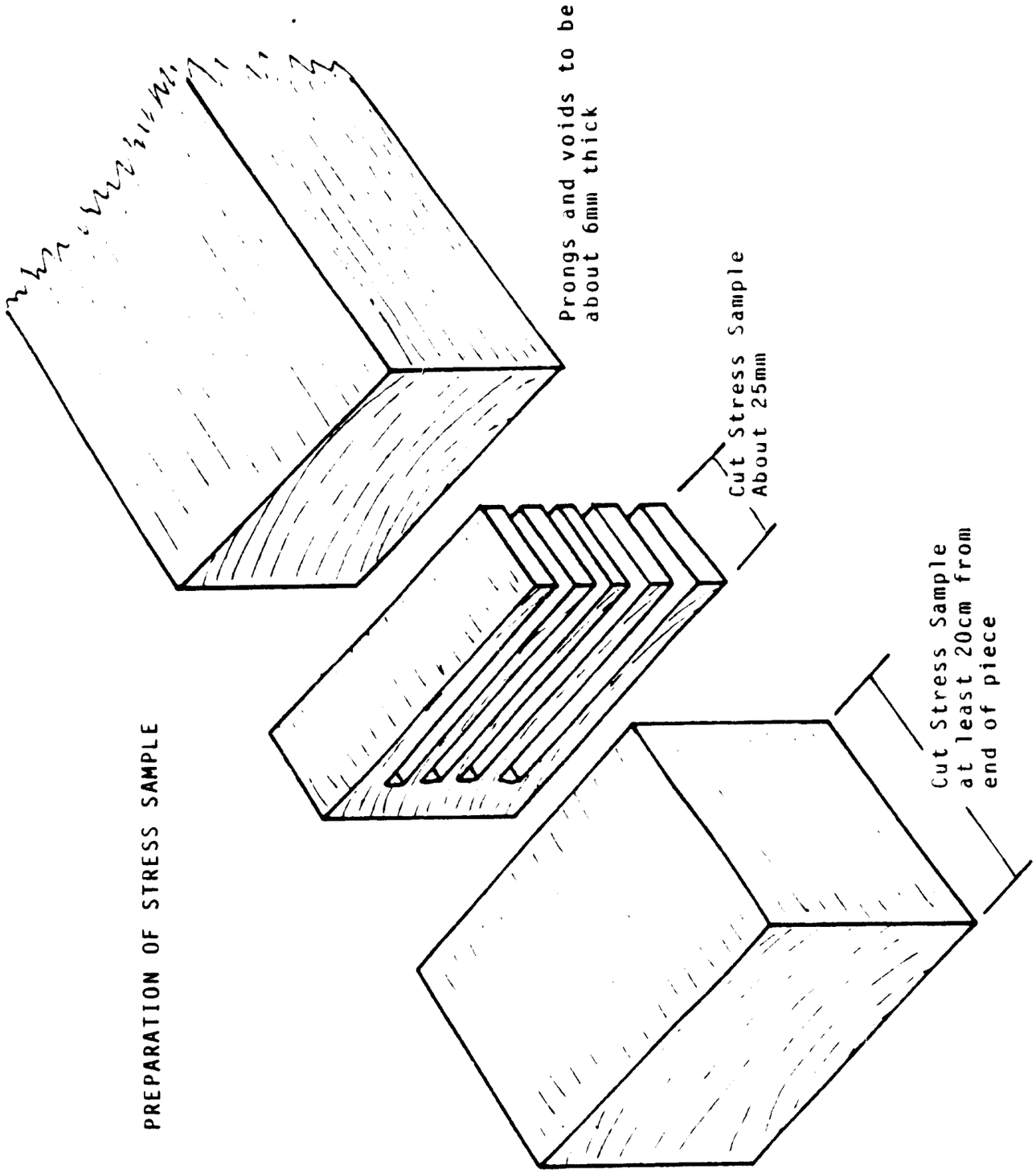
RECORDS:

A record of stress condition should be written into the kiln record form. It is also a good idea to draw the outline of the stress sample on the back of the kiln chart.

RESPONSIBILITY:

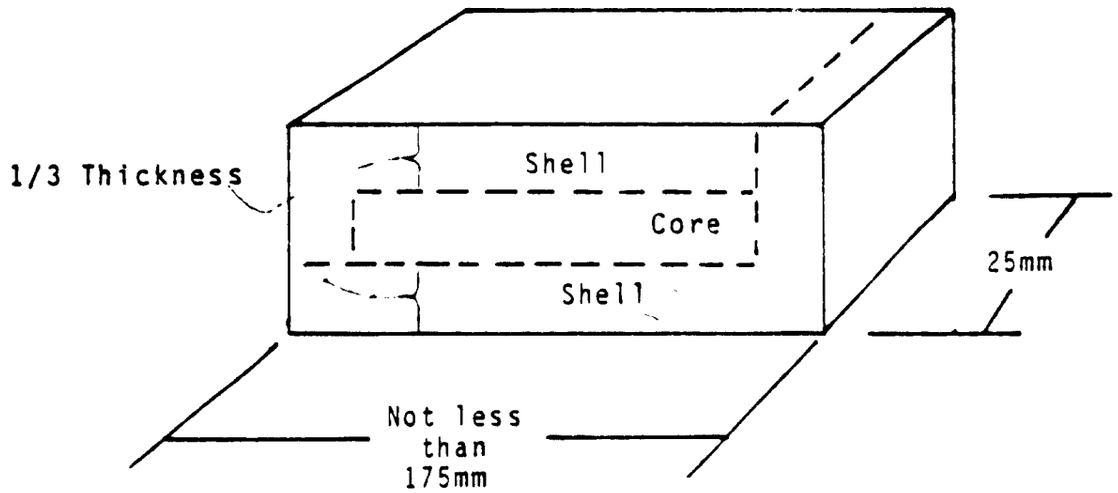
Kiln Operator.

FIGURE D-6-1



PREPARATION OF STRESS SAMPLE

FIGURE D-6-2



7. Daily Maintenance

Date Issued_____

Activities Affected: Kiln Operation

Date Revised_____

Departments Affected: Dry Kiln

Approved by_____

PURPOSE:

To maintain operation of dry kiln at highest possible efficiency.

METHOD:

Certain maintenance items must be checked daily. The kiln operator must set aside a few minutes each day to consistently check the following items to see that everything is functioning properly:

1. Check control instruments to see that recording pens are recording conditions as set on the control dials.
2. Check ink supply in pens. Do not allow part of the kiln chart to be blank.
3. Check operation of wet bulb. If erratic or reading wrong, check water supply and wick.
4. Check air pressure on compressor.
5. Check temperature in oven for drying samples. It should be 102°C ± 2°C.
6. Check records to see that all are up to date.
7. Look for any water or steam leaks that may need immediate attention.

EQUIPMENT:

None.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

Make a record of any maintenance required and action taken.

RESPONSIBILITY:

Kiln Operator.

8. Weekly Maintenance

Date Issued_____

Activities Affected: Kiln Operation

Date Revised_____

Departments Affected: Dry Kiln

Approved by_____

PURPOSE:

Weekly preventive maintenance can prevent little problems from becoming big ones.

METHOD:

Kiln operators will make the following maintenance check every Monday morning. Things can go wrong over a weekend, so a careful check needs to be made to start the week off right.

1. Check all instruments to see that they are recording properly with set controls. Change kiln charts for charges running more than 7 days.
2. Check all wet bulb wicks and water supply. Replace wicks that are dirty or crusty.
3. Check operation of fans and motors to be sure all are operating properly.
4. Check all load baffles to be sure they are operating properly and are in place to prevent air by-pass.
5. Check hand valves and steam lines, both heating coils and humidity lines.

6. Check all traps to be sure condensed water is being carried off but steam is not escaping.
7. Check all vents to see that they are properly opening and closing.
8. Check kiln doors to be sure they are tight fitting and not allowing heat to escape.
9. Air filter is operating properly.
10. All bearings are oiled and greased according to manufacturer's directions.
11. Kiln trucks are greased and rolling properly.
12. Moisture meter battery is strong and meter is working properly. Check against sample of known moisture content. Replace broken needles or needles with insulation worn off.
13. Check previous week's records for completeness.
14. Take corrective action where called for.

EQUIPMENT:

None.

PERMISSIBLE DEVIATIONS:

Some of the above items cannot be checked while a kiln is at high temperature or high humidity. Schedule a checking of such items during the week when the kiln is shut off.

RECORDS:

Make a record of any maintenance required and the action taken.

RESPONSIBILITY:

Kiln Operator.

9. Monthly Maintenance

Activities Affected: Kiln Operation

Departments Affected: Dry Kiln

Date Issued_____

Date Revised_____

Approved by_____

PURPOSE:

A thorough check of kiln maintenance is required monthly to avoid costly breakdown and repairs.

METHOD:

On the first Monday in each month, the Dry Kiln Operator will make a thorough check of all dry kilns, will make a record of all action needed and action taken, and supply a copy to the Plant Superintendent. The inspection will cover the following items:

1. Buildings

   a. Check for any structural failures that could cause a loss of heat.

   b. Check kiln wall coatings and recommend re-coating where necessary.

   c. Check roof condition for leaks or weak spots that need repairs.

   d. Check stairs and ladders for safety.

   e. Check all kiln doors for tightness. Check door latches inside and out. Grease door carriers.

f. Check draining inside and outside buildings. Take corrective action to eliminate standing water.

g. Clean all debris such as broken sticks, trash, and other items from inside kilns and on outside of buildings.

2. Air Circulation System

a. Check, grease, and oil all fans and motors. Check fan housings for clearance of at least 25mm. Tighten bolts, check fan blades, check drive shaft housings. Check all "V" belts and replace as necessary.

b. Check fan baffles for tightness and proper placement.

c. Check fan reversal system.

d. Check all kiln baffles, permanent and temporary. Oil when necessary. Replace or repair bent or improperly working baffles.

e. Measure air velocities through lumber throughout length of kiln and at different elevations. Make a record of locations where velocity is below 60 mpm and attempt to establish cause.

3. Heating and Humidifying System

a. Check all feed lines and headers for leaks. Check valves and re-pack or replace when necessary.

b. Check all heating coils for leaks or water logging. Be certain that steam is flowing freely through open lines.

c. Check all traps to be sure they are eliminating condensed water but not losing steam. Repair as necessary.

d. Check automatic control valves to see that diaphragms are operating properly.

e. Check spray lines to see that openings are not clogged and that leaks are not present. Be sure that no condensate is dripping on lumber.

f. Check all vents for proper opening and closing. Any damaged or rusted vents or vents with holes must be repaired or replaced.

g. Check temperature next to dry bulb and next to wet bulb with wet and dry bulb hygrometers. Compare with chart readings. If difference exists of more than $3^{o}C$ dry bulb or $2^{o}C$ wet bulb, check dry bulbs in hot water bath with accurate thermometer. If differences still exist, have Dry Kiln Company serviceman readjust instruments.

h. Check all capillary tubes to see that they are protected and undamaged.

i. Check air compressor, air filter, and air supply lines to instruments.

EQUIPMENT:

Air meter, wet and dry bulb hygrometers, thermometer, flashlight.

PERMISSIBLE DEVIATIONS:

Obviously, the monthly job of checking kilns will have to be done as kilns are unloaded and the total job may take a week or 10 days as occasions permit.

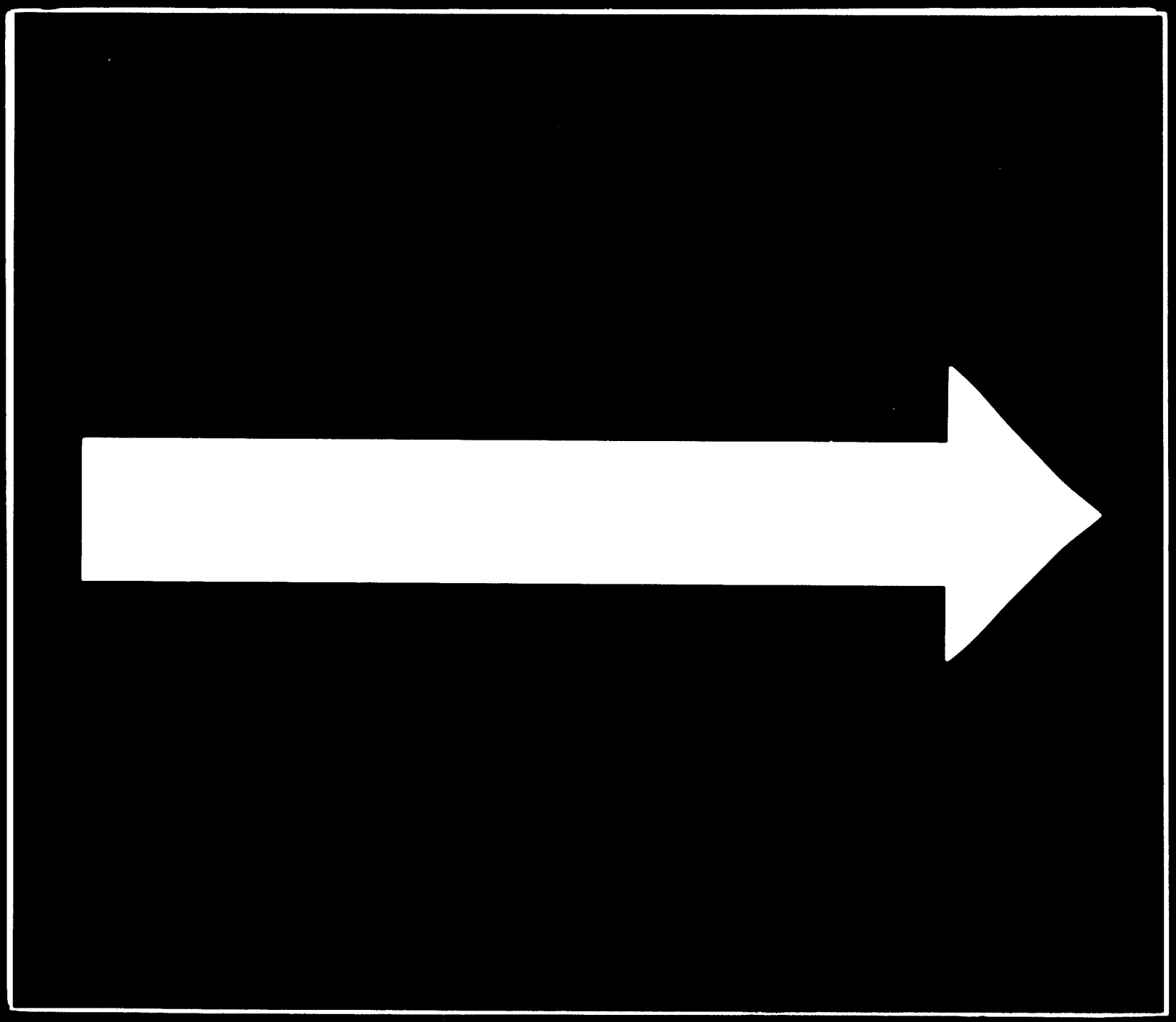
RECORDS:

A check list of the above items should be prepared. As each item is checked, the Kiln Operator will date and initial the item and indicate action needed or action taken. The completed check list should be sent to the Plant Superintendent for information or for further action when necessary.

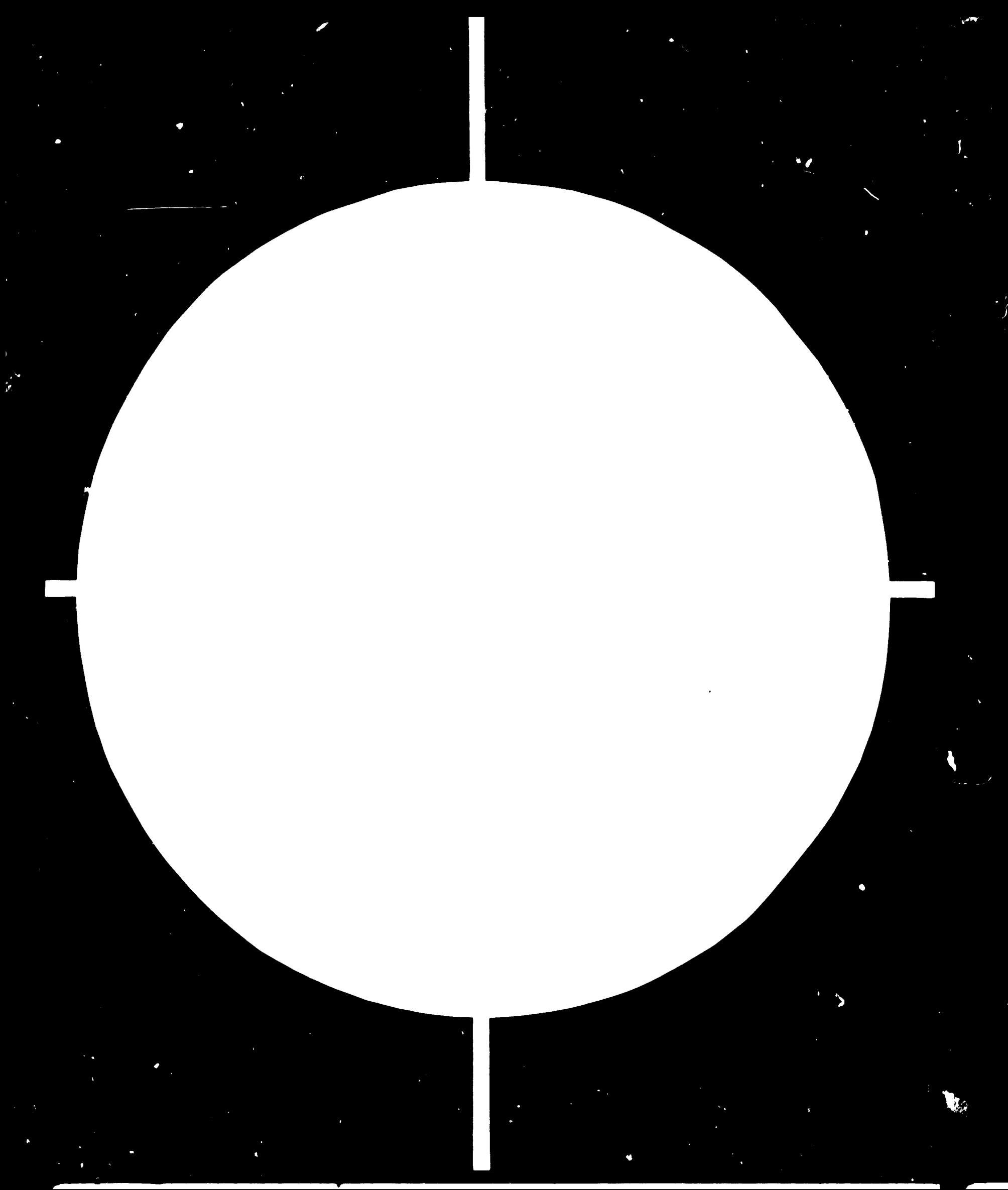
RESPONSIBILITY:

Dry Kiln Operator.

B-363



80.12.01



10. Instrument Charts

Date Issued_____

Activities Affected: Lumber Drying

Date Revised_____

Departments Affected: Kiln Drying, Quality Control

Approved by_____

PURPOSE:

To describe the use and function of control instrument charts used in dry kiln operation.

METHOD:

When a chart is placed on a dry kiln control instrument, it should be marked with the date, kiln number, charge number, species, thickness, kiln schedule number being used, and original moisture content of the lumber being dried. Any unusual conditions, such as mixed species, mixed thickness, mixed moisture contents, etc., should also be entered on the kiln chart.

"Start" should be written at the point where the pens start marking on the chart, and "End" should be written at the end of the run. Intermediate markings should be made on the outside circumference of the chart for equalization and conditioning, showing the hour started. Anything unusual should also be marked on the circumference of the chart, such as steam off or other interruptions of the kiln run.

One chart should be used only for a 7-day period. It should be replaced with a clean chart which is also fully marked as for the first chart, and both charts should be marked "continued" and

referenced to the other. A kiln charge may run for several weeks and thus require several charts. They should be marked 1 of 4, 2 of 4, 3 of 4, and 4 of 4, etc.

After the kiln run is completed, all the charts will be fastened together, an outline of an average stress section drawn on the back of the final chart, and the charts filed as reference for one year.

When a successful but unusual kiln run is made of different species, thicknesses, or other factors, it should be placed in a permanent file so that the schedule can be repeated at any future date when a similar charge may be dried.

Care must be taken to see that the pens have an ink supply all of the time so that no gaps exist in the chart record.

EQUIPMENT:

Kiln control instruments, charts, and ink supply.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

As described above.

RESPONSIBILITY:

Kiln Operator.

E. DRY STORAGE

1. Open Sheds

Date Issued_____

Activities Affected: Lumber Storage

Date Revised_____

Departments Affected: Dry Kiln, Rough Mill

Approved by_____

PURPOSE:

Kiln-dried lumber can be stored temporarily in an open shed in certain kinds of weather, but precautions are necessary to prevent excessive moisture regain.

METHOD:

Your plant may have roofed sheds, open on one or more sides, that are used for dry lumber storage. The use of these sheds for short periods of kiln-dried lumber storage (one to two weeks) is satisfactory in the spring and fall when outside weather conditions produce an EMC of below 10 percent. This means a relative humidity of about 56 percent. Such conditions occur when temperatures are as follows:

Dry Bulb	Wet Bulb	EMC	R. H.
32°C	25°C	9.7	55
27	21	10.1	57
21	16	10.1	55
16	11	9.9	53
10	6	10.3	56
4	1	9.9	52
-1	-4	9.0	46

In the summer and winter, humidity conditions are usually unsatisfactory for storage of kiln-dried lumber in open sheds, and lumber may pick up 1 to 2 percent moisture content in a few days of humid weather. Tests have shown that stickered dry lumber at

8 percent will increase to 10 percent in 2 to 3 weeks and on up to 14 to 15 percent moisture content in 2 to 4 months. Obviously, such lumber would have to be re-dried before manufacture into furniture.

Open sheds that are needed for dry lumber storage should be converted to closed, heated sheds as soon as possible; in the meantime, they should be used only as described above.

EQUIPMENT:

Sling psychrometer to determine outside weather conditions.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

Lumber inventory records should show date of lumber in and out of dry storage and nature of lumber storage building. When there is question about moisture content, at least 20 boards should be checked for moisture content with a moisture meter before transferring to the Rough Mill. Such meter readings should be recorded and furnished to the Plant Superintendent.

RESPONSIBILITY:

Dry Kiln Operator, Yard Foreman.

2. Closed Sheds

Activities Affected: Lumber Storage

Departments Affected: Dry Kiln, Rough Mill

Date Issued_____

Date Revised_____

Approved by_____

PURPOSE:

Properly constructed and operated dry lumber storage sheds permit storage of kiln-dried lumber for an indefinite period. Such buildings must be maintained properly and conditions checked Periodically.

METHOD:

A closed dry storage shed with sufficient heat to maintain 8°C to 11°C above outside temperature throughout the year will keep lumber moisture content at about 6 to 7 percent except under very unusual conditions. Heat can be applied from steam pipes on the floor of the building underneath the lumber or from unit heaters spaced overhead.

The heating system should be automatically regulated and controlled by an outside dry bulb protected from the sun and weather.

Three or four samples of basswood or poplar lumber, 15cm wide by .3m long by 15mm thick should be calibrated by determining the weight at 7 percent moisture content. The weight should be written on the sample.

The samples are then hung in different locations of the dry storage area. The samples should be free of any finish or coating. Once a week, these samples should be weighed and the weight recorded to check on any moisture content changes or variations in the dry storage area.

A table should be made up that shows the moisture content of each sample at different weights from 6 percent to 10 percent moisture content.

The samples are to be taken from lumber stick that is known to be at 7 percent moisture content. Sections are to be cut from each end to determine exact moisture content and calculated oven dry weight, the same procedure as is used for kiln samples. With this information, the weight at different moisture contents can be determined.

The dry lumber storage shed must have reasonably tight doors, and these should be kept closed except when lumber is being put in or taken out.

The dry lumber storage shed should not be adjacent to dry kiln doors where escaping steam can cause humid conditions in the dry storage area or condensation that may drip from the roof onto the lumber.

The dry lumber shed must be kept free of debris and trash. Special care must be observed in looking for insect infestations, especially powder-post beetles in the sapwood of dry lumber. This is especially important in the dry storage of hickory, pecan, and ash. Kiln drying will kill such insects, so any infestation must develop

from other lumber in the dry storage area. Cleanliness is the best preventive measure.

If an infestation occurs, the infected lumber should be placed in a dry kiln and sterilized with a dry bulb temperature of 54°C and a wet bulb of 46°C. After the kiln reaches set conditions, maintain these temperatures for 10 hours for 25mm thick lumber, 12 hours for 50mm thick lumber, and 14 hours for 75mm thick lumber. The area of infection in the dry storage area should be sprayed with a chemical insecticide to prevent further infection.

EQUIPMENT:

Moisture samples for maintaining records in dry storage. Automatic control equipment for maintaining 8°C increase on inside temperature.

PERMISSIBLE DEVIATIONS:

Hand controls for heat can be used if conditions are checked daily. Heat may be turned off when outside relative humidity is below 40 percent. Usually, this condition occurs only during the day, and heat must be turned on again during the night.

RECORDS:

Weekly records will be kept of moisture content of samples. Copies should be forwarded to Plant Superintendent.

RESPONSIBILITY:

Kiln Operator, Yard Foreman.

3. Water Resistant Wrappings

Date Issued_____

Activities Affected: Lumber Storage, Lumber Transport

Date Revised_____

Departments Affected: Kiln Drying, Rough Mill, Interplant Exchange

Approved by_____

PURPOSE:

Dry lumber can be protected from wetting for short periods of storage and for transport with water resistant wrappings.

METHOD:

Wrappings are excellent protection for lumber transport from one plant to another to prevent rain wetting or moisture pick-up from high humidity.

Research has shown that plastics such as polyethylene film and coated papers are only temporary barriers of moisture. Stickered and dead-piled dry lumber packages wrapped carefully in such coverings will keep out moisture for only a short time. Condensation often occurs inside such packages stored outdoors, and free water then wets the lumber.

Black polyethylene film is cheap and satisfactory for this purpose. It should completely encase the lumber on the sides, ends, and top, but need not be closed on the bottom.

When lumber is transported with such a wrapping, it should be placed in dry storage within three days after it reaches its destination. The covering should be removed when the lumber goes into

dry storage, so the covering will not act as a barrier to maintaining equilibrium of moisture with dry storage conditions.

Under no circumstances should dry lumber be stored outdoors for more than a week with any type of wrapping.

EQUIPMENT:

A supply of black polyethylene film and an adhesive tape to fasten it.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

When dry lumber is packaged in a protective coating, the package should be marked as to date of packaging and moisture content at time of packaging.

RESPONSIBILITY:

Yard Foreman, Truck Drivers.

F. MOISTURE CONTENT

1. Quality Control

Date Issued_____

Activities Affected: Lumber Drying, Lumber Processing, Furniture Manufacture

Date Revised_____

Departments Affected: Quality Control, Dry Kiln, Rough Mill, Assembly

Approved by_____

PURPOSE:

To establish a system for continuous check of moisture content and lumber conditions from kiln drying through furniture assembly.

METHOD:

A system will be set up to collect random samples of lumber at different points in the plant to determine average moisture content, moisture gradients within boards, and lumber stress conditions. Samples will be collected by Quality Control personnel at odd times according to the following schedule:

Location	Frequency	No. of Samples	Size of Samples
Dry Storage	Weekly	4	150mm x 300mm
Cut-off Saws	Twice Daily	5	$150m^2$
Panel Sizing	Daily	2	Defective Panels
Machining	Weekly	5	Defective Parts
Assembly	Weekly	5	Defective Parts

Samples from dry storage will be obtained from accessible boards or projecting ends from 4 locations in dry storage. Samples will be from boards at least 15.0cm wide and 0.3m long. The 4 samples should include two or more thicknesses, preferably 25mm and 50mm stock.

Moisture content sections 25mm wide and stress sections 25mm wide will be cut from the sawn end of the 0.30m sample. The other 250mm toward the end of the board will be discarded. The moisture content section will be cut for shell and core moisture content, and the stress section will be cut for stress determination. (See section D. 6, Figures D-6-1 and D-6-2.)

Samples from cut-off saws will be obtained from defect trim or 0.15m cuttings at least 0.30m from the board ends. Samples will be taken from 5 boards from a total of 25 boards--i.e., every fifth board. This will be done twice daily. This can be done by the cut-off saw operator at any time that he is instructed to do so by the Quality Control Foreman.

After panels are glued and cured and being sized, two defective panels will be collected daily and two moisture content sections cut from each panel for a shell and core test. These will be cut perpendicular to the grain and across glue lines. No stress sections will be taken.

Once a week, 5 defective parts from machining operations will be collected and moisture content sections obtained from them. Shell and core moisture contents will be obtained.

Once a week, 5 defective parts from the assembly line will be collected and moisture content sections obtained from them. Shell and core moisture contents will be obtained.

As samples are collected, they will be marked as to plant number, location in plant, and date. Samples should be placed in plastic bags

until they are ready for cutting, weighing, and determining moisture content and stress relief.

Samples will be collected, processed, and recorded by the plant Quality Control Foreman, with results being sent weekly to the Plant Manager and a copy to the Division Manager.

Simple control charts (Figure F-1-1) will be kept for each location in each plant. It should be emphasized that this is a method of simple quality control and not statistical quality control.

When more than one determination at any location is out of control limits (6 percent moisture content ± 1 percent), a second sample of the same size should be taken immediately at that point. If the second sample continues to show lumber moisture content out of control, a statistical sample should be taken at that point with a moisture meter for several days to determine the extent of moisture variation. Other lumber from the same kiln charge will be thoroughly checked with a moisture meter before it is brought to the Rough Mill.

The practice described herein is designed to determine if moisture content is within control limits. It calls attention to trouble spots that need corrective action. It does not prescribe the necessary action.

Procedures for determining moisture content and preparing stress sections are given in section D. 1 and D. 6.

EQUIPMENT:

Portable electric saw, band saw, oven, scales, moisture meter, plastic bags.

PERMISSIBLE DEVIATIONS:

When moisture content is consistently out of control at a plant, statistical quality control with a moisture meter shall be conducted at the cut-off saw until the cause is found and corrected.

RECORDS:

A record of moisture content determination of samples will be filed and retained for one month. Stress determinations will be recorded as stress free, slightly stressed, and casehardened. These records will also be retained for one month.

A control chart (Figure F-1-1) will be maintained for the plant and kept on file for one year.

When moisture content goes out of control, a written record will be sent immediately to the Plant Superintendent.

Records of additional sampling will be sent to the Plant Superintendent as soon as completed.

RESPONSIBILITY:

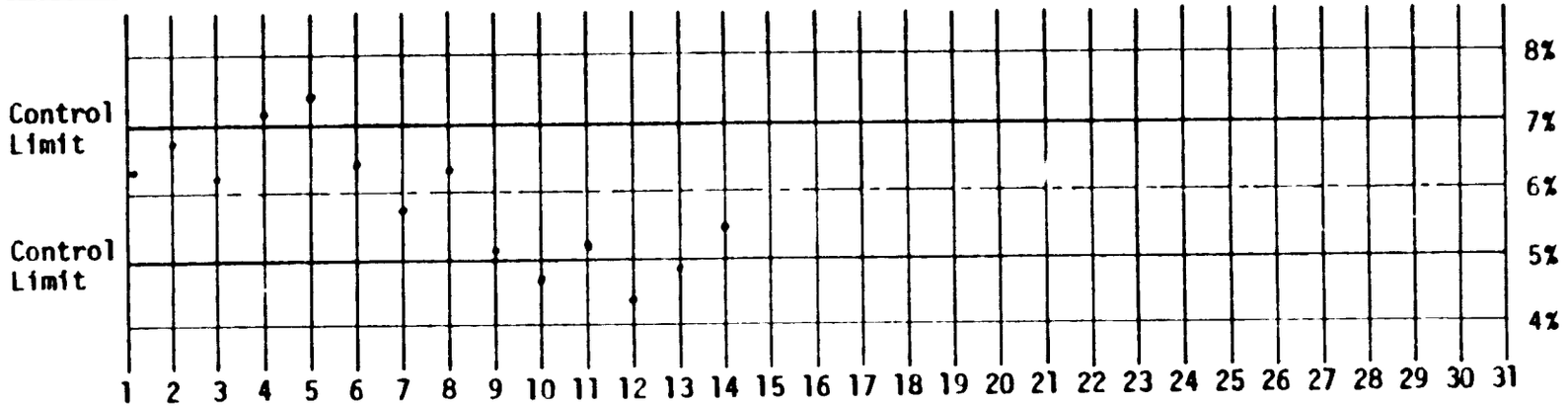
Quality Control Foreman.

MOISTURE CONTENT CONTROL CHART

Plant No. _____

Month _____

Dry Storage



Cut-off Saws

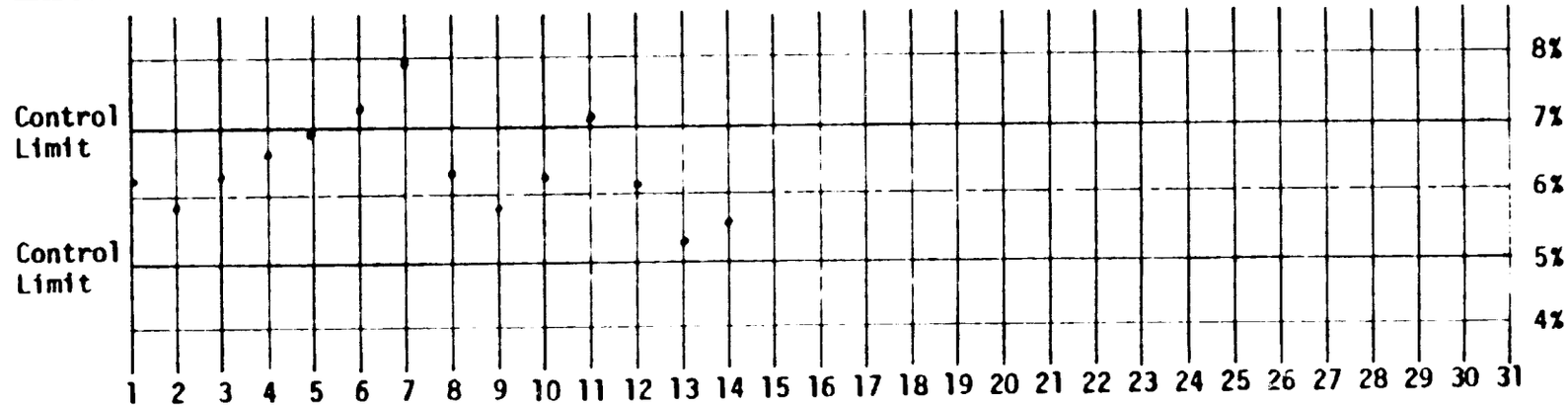


FIGURE F-1-1

2. Use of Moisture Meters

Date Issued_____

Activities Affected: All Drying Operations and Quality Control in Plant

Date Revised_____

Departments Affected: Lumber Drying Yard, Dry Kilns, Rough Mill, Quality Control

Approved by_____

PURPOSE:

To describe the use and limitations of resistance and power loss type moisture meters for determining wood moisture content.

METHOD:

Moisture meters are fairly accurate for measuring wood moisture content from 7 to 25 percent. They are not accurate below 7 percent or above 30 percent moisture content. Their only accurate use for high moisture content is for the separation of boards above and below 30 percent.

The Resistance Type Meter. This is most commonly used on hardwoods. This meter is equipped with an electrode that has needles that are driven into the wood for a measurement. Long, insulated needles are most desirable to avoid false readings when lumber surface is wet and to permit moisture content determinations at any depth up to 25mm.

To determine the average moisture content of a board, the needles should penetrate to 1/5 the thickness of the lumber. To determine the center moisture content, the needles should penetrate to 1/2 thickness. For determining the wettest part of the board, refer to Figure F-2-1.

Resistance moisture meters must be checked for calibration frequently in accordance with manufacturer's instructions. If they will not adjust or if a reading will not hold but the indicating needle drops, fresh batteries should be inserted.

The resistance moisture meter is affected very little by wood density but is affected by temperature. Below 10 percent moisture content, species differences because of density and other factors are less than 1 percent except for a very few species. (See manufacturer's correction data.)

Temperature corrections for moisture content as given by a leading manufacturer are as follows:

Temperature Dry Bulb °C	Meter Readings - % MC				
	6	7	10	15	20
	Corrections in Percent MC				
16°	0	0	+1	+1	+1
27°	0	0	0	0	-1
38°	-1	-1	-2	-2	-3
49°	-2	-2	-3	-4	-5
60°	-2	-2	-4	-5	-6
71°	-3	-3	-4	-6	-8
82°	-3	-3	-5	-8	-9

At least several moisture content readings should be made on each board until the operator is confident that he can select the wettest spot. When readings fall below 7 percent, oven dry tests must be made to determine the true moisture. Lumber that is too dry can create as many problems as lumber that is too wet.

The Power Loss Type Meter (Or Capacity Type). This has a ring of surface contact electrodes that do not penetrate or mar the surface. This meter is especially useful in measuring the moisture content of machined pieces, veneer, etc. It does not give a direct reading but a reference number. The operator must use the manufacturer's chart of species tables for converting the reference reading to moisture content.

This type of meter is affected very little by temperature but is affected strongly by specific gravity or density. The reference tables use the average specific gravity of a species for converting the reference number to moisture content.

Some species, such as beech, vary greatly in specific gravity, and a light piece and heavy piece at the same moisture content can give different readings. Hence, great care must be taken when using this type meter, or wrong moisture content readings will result. If doubt exists about a reading, it must be checked with a resistance type meter and/or an oven dry test.

Care and Operation. Moisture meters are delicate instruments and shall be stored in a clean, dry place. Weak batteries must be replaced, and worn electrode wires or electrode fixtures must be repaired. The meter must be allowed time to come to the temperature of the room it is being used in before it is adjusted. The meter should not be used in a hot dry kiln; the samples should be taken out of the kiln and measured in a room of normal temperature.

EQUIPMENT:

Resistance type and power loss type moisture meters, electrodes, and accessories including needles. A band saw, scales, and drying oven are needed to check on questionable meter readings.

PERMISSIBLE DEVIATIONS:

Sometimes it is absolutely necessary to use a meter in a hot kiln. This should be restricted to a few minutes at a time.

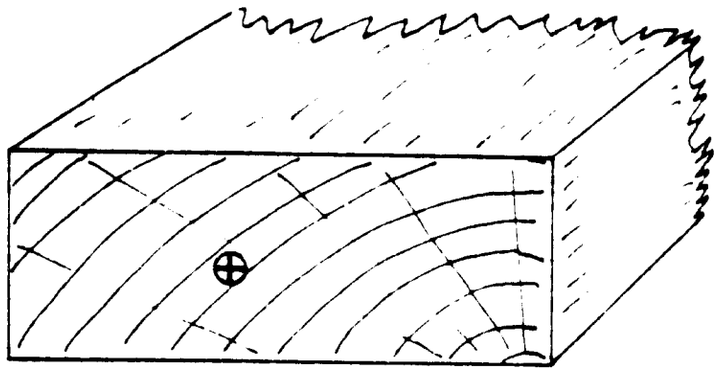
RECORDS:

Records are necessary when meter readings vary with oven dry tests and when statistical quality control is being practiced. Generally, however, a meter is used for spot checking, and records are not required.

RESPONSIBILITY:

Kiln Operator, Lumber Yard Foreman, Rough Mill Foreman, Quality Control Foreman.

FIGURE F-2-1



To determine the wettest spot in a board, drive the needles to a point where the longest distance occurs from the medullary rays to the surface. The medullary rays extend from the center of the tree to the outside, at right angles to the annual growth rings. The medullary rays serve as a path for moisture movement in drying, hence control the drying rate to some extent.

G. ROUGH MILL

1. Cut-off Saw Operation

Date Issued_____

Activities Affected: Cutting of Lumber to Length

Date Revised_____

Departments Affected: Rough Mill, Planing

Approved by_____

PURPOSE:

This standard covers the cutting of full length boards into rough lengths, the first converting operation in the Rough Mill. It sets forth the procedure for obtaining maximum lumber yield consistent with production.

METHOD:

Specifications. The cut-off saw operator must be provided with shop grade specifications for his product. He must know the requirements for which he is cutting (Clear One Face, Clear Two Faces, etc.). These will be provided on the Route Cards.

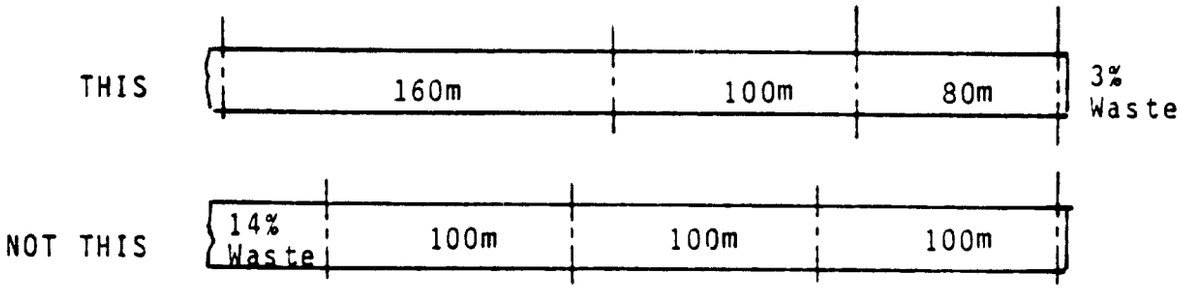
Inspection of the Board. As the board is lifted into position on the saw table, the cut-off saw operator must inspect both sides of the board. Clear One Face specifications require cutting from the best face. Clear Two Faces should be cut from the worst face. These boards will be set aside for use in special runs, for face glued parts, etc. The use of a "go/no-go" gauge will facilitate decisions. (See section B. 3)

Choice of Lengths. Boards normally contain various defects, and lengths are seldom specific multiples of those of the parts to be cut.

In order to produce the maximum usable lumber from any given board, the operator must have a number of lengths from which to choose in cutting the board.

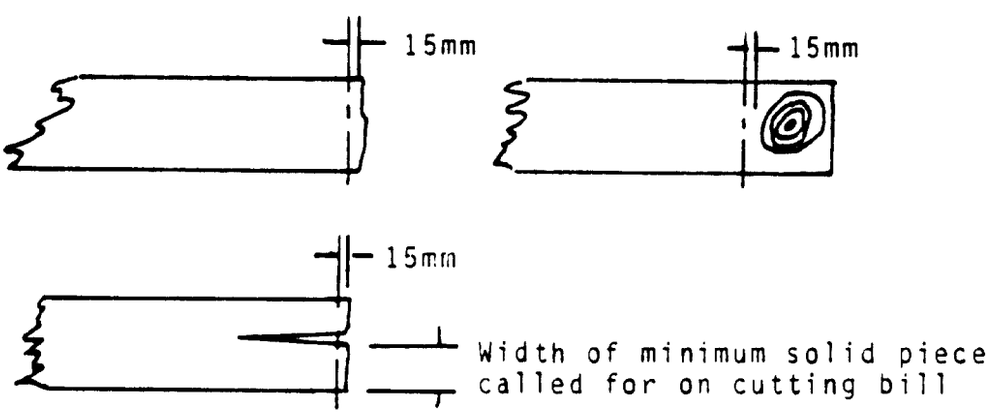
A minimum of 4 and an average of at least 5 different lengths will be set up on the gauge bar at all times. When the quantity of one length called for by the cutting bill has been cut, that length should be replaced by another.

FIGURE G-1-1



First Cut. The initial cut at the end of a board must not take more than 15mm back of the deepest point of the rough cut or of a major significant defect in the board.

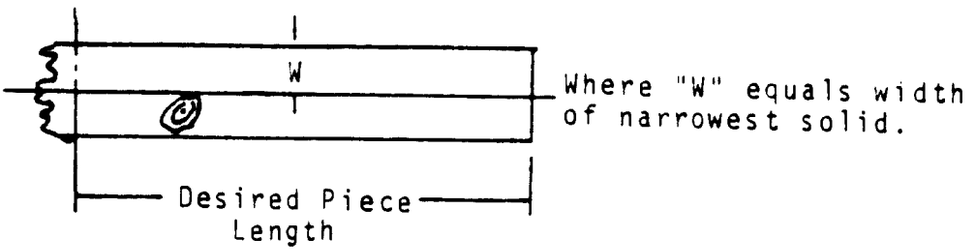
FIGURE G-1-2



Splits which will leave a sound minimum solid width are not considered to be a significant defect at this stage when followed by "solid and random" ripping. Splits will be defected at the ripsaw. If not, or if other significant defects remain after the initial cut, additional cuts at not more than 15mm intervals are to be made until the defect is removed.

Defecting. Defects leaving a strip of clear lumber between them and the opposite side of a board at least equal in width to the width of the narrowest "solid" on the cutting order will not be removed at the cut-off saw. These are to be left to be removed later by the ripsaw and salvage saw.

FIGURE G-1-3



As the board is cut to various lengths, care must be taken to reduce any crook or severe bow which may be present, to the extent that the lumber will clean up properly in the planing operation. This sometimes necessitates the cutting of a series of short lengths from a board which, had the defect not existed, could have generated long cuttings. Short cuttings are normally not desired; however, the

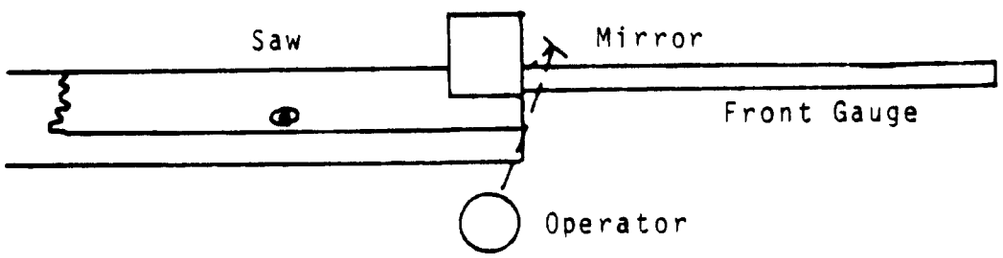
short lengths are preferable to a bowed part of longer length, which will cause serious quality problems in the subsequent operations.

Occasionally, there will be a cutting length in the group which will be specified as "clear white", "straight grain only", or some other special need. Care must be taken by the sawyer to see that any part cut for such special needs conforms to the specification, as once the part is cut to length, converting it for use in another product generally causes waste.

EQUIPMENT:

Mirrors. To assist the operator in making a quick decision on the clean-up of a cut, all cut-off saws will be equipped with a mirror positioned to enable the operator to see the end of the board as soon as the saw is retracted. Mirror must be mounted so as to be free of vibration. Lighting must be provided to illuminate the end of the board in the cut-off position.

FIGURE G-1-4



Go/No-Go Gauge. A gauge to enable the operator to quickly and accurately determine if a board is of proper thickness will be provided. (See section B. 3, Figure B-3-1.)

Back Gauge Bars. To assist the operator in making decisions as to best combinations of lengths to cut, back tables will be equipped with pin-gauge bars. (See Figure G-1-5.) Stop gauges will be color coded. Pins colored to match the stop gauges will be set in the gauge bar to show appropriate combinations of lengths. (See Figures G-1-6 and G-1-7.)

Cut-Off Saw Gauge Set-Up Chart. To facilitate the setting up of the stops and pins, a chart is used. (See Figure G-1-8.)

A dispersion of lengths (5 to 7) from the cutting bill is selected and listed in the top horizontal row of boxes and the left vertical row of boxes. (See "a" in figure.) At the intersection of the vertical and horizontal lines from these boxes, the sums of these pairs of lengths are placed. (See "b" in figure.) Coded pins are set in the back gauge bar for all of the single lengths (43-56-81-102-163 in Figure G-1-6). The combination lengths are then inspected, and the longest of similar groups of lengths are also placed on the gauge bar. (See "c" in figure.) When one or the other length of any combination of lengths is cut out, it is replaced by a shorter length from the cutting bill. (See "d" in figure.) And, a new set of length combinations is figured. (See "e" in figure.)

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

Appropriate Production Control records.

RESPONSIBILITY:

It will be the Plant Manager's responsibility to see that the equipment is provided.

It will be the Rough Mill Foreman's responsibility to see that the equipment is installed and that the operators are trained in and observe these standards of operation and are informed of the specifications on each cutting.

It will be the Operator's responsibility to use these methods, including the making of the pin chart and setting up of the back gauges.

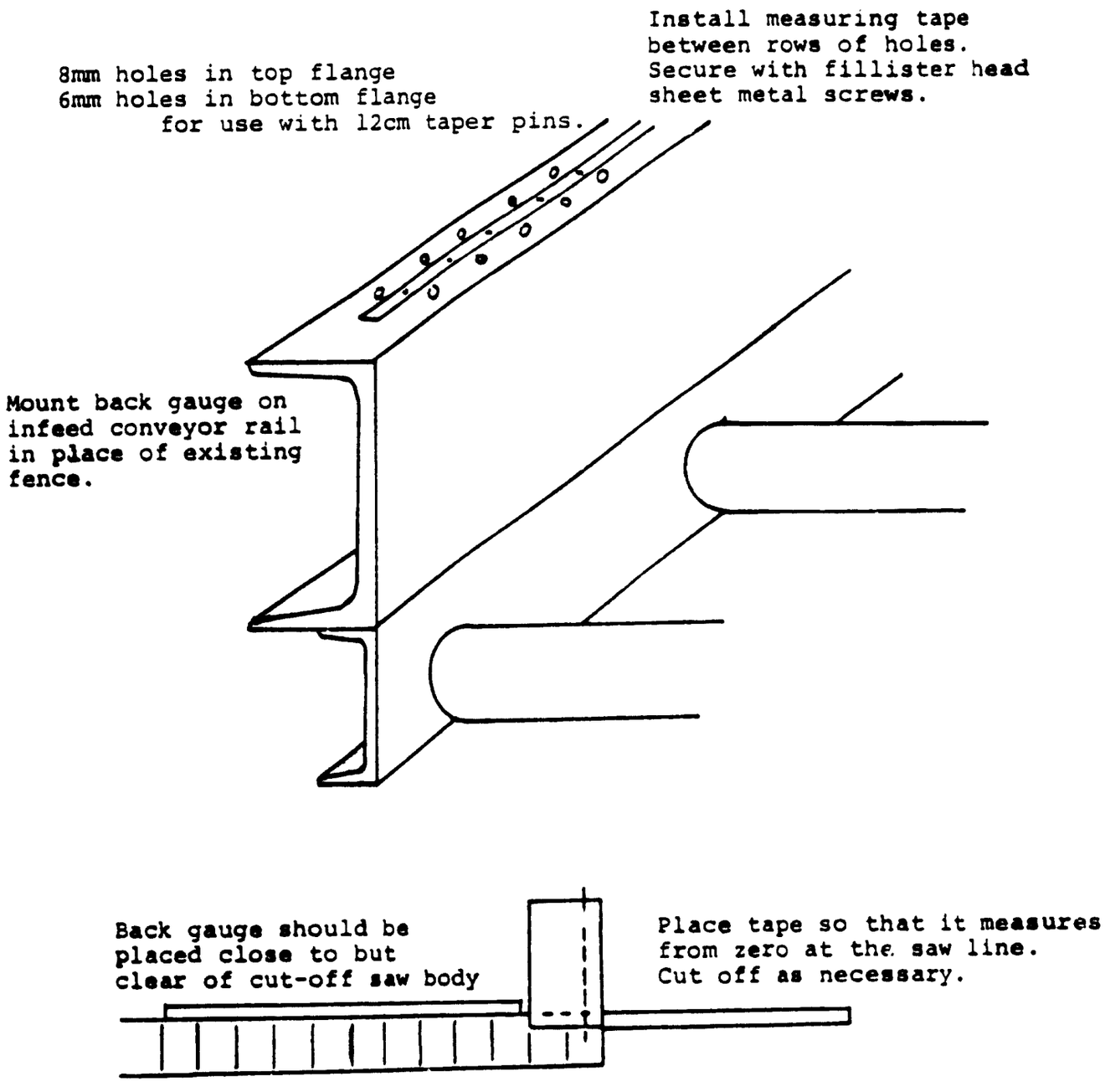


Figure G.1-5 Installation of Ross Associates' Back Gauge.

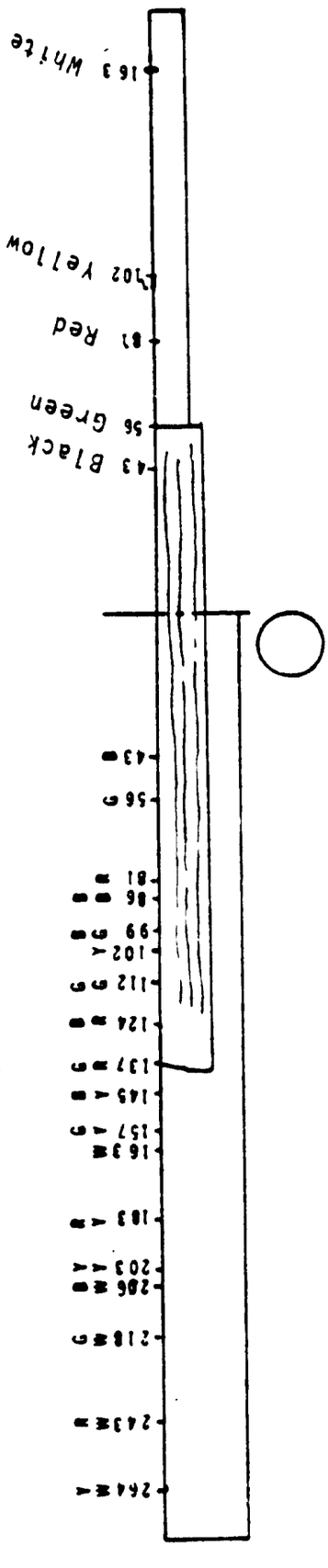


FIGURE G-1-6. Use of back gauge to reduce end trim. Here an operator can readily tell that his last two cuts on this board must be 56cm and 81cm or red stop and green stop, with minimum waste.

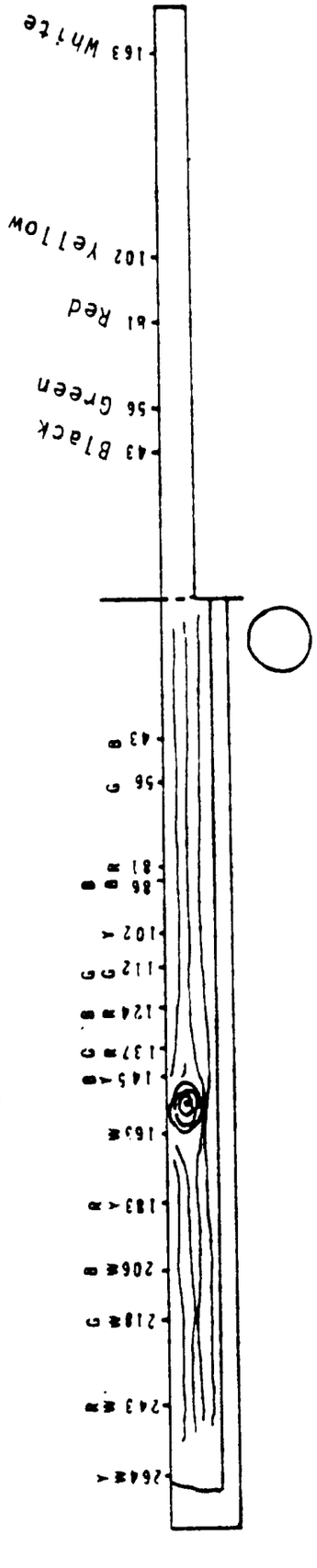


FIGURE G-1-7. Use of back gauge in defecting. Here an operator can readily see that the best combination of lengths will be 43cm and 102cm (black stop and yellow stop), with minimum possible waste.

BACK GAUGE SET-UP CHART

	BLACK	GREEN	RED	YELLOW	WHITE	PINK	SILVER
	43 [a]	56 [a]	81 [a]	102 [a]	163 [a] / 157 [d]		
BLACK 43 [a]	BLACK-BLACK 86 [b] [c]	BLACK-GREEN 99 [b]	BLACK-RED 124 [c] [b]	BLACK-YELLOW 145 [b] [c]	BLACK-WHITE 206 [c] [b] / 200 [e]	BLACK-PINK	BLACK-SILVER
GREEN 56 [a]		GREEN-GREEN 112 [b] [c]	GREEN-RED 137 [b] [c]	GREEN-YELLOW 157 [b]	GREEN-WHITE 218 [c] [b] / 213 [e]	GREEN-PINK	GREEN-SILVER
RED 81 [a]			RED-RED 163 [b]	RED-YELLOW 183 [b] [c]	RED-WHITE 243 [b] [c] / 239 [e]	RED-PINK	RED-SILVER
YELLOW 102 [a]				YELLOW-YELLOW 203 [b]	YELLOW-WHITE 264 [b] [c] / 259 [e]	YELLOW-PINK	YELLOW-SILVER
WHITE 163 [a]					WHITE-WHITE 325 [b] [c] / 315 [e]	WHITE-PINK	WHITE-SILVER
PINK						PINK-PINK	PINK-SILVER
SILVER							SILVER-SILVER

FIGURE G-1-8

2. Grading Saw Operation

Date Issued_____

Activities Affected: Grading

Date Revised_____

Approved by_____

Departments Affected: Rough Mill

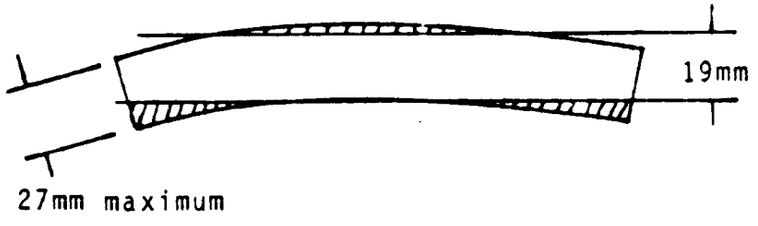
PURPOSE:

This standard covers the preparation of lumber for facing (jointing). It sets forth the limitations on cupping and the procedure for handling it.

METHOD:

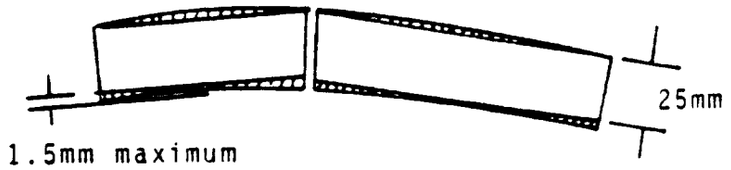
Boards that are excessively cupped cannot be properly faced (jointed), planed, and subsequently be accurately ripsawn. These must be removed from the regular flow and ripsawn prior to facing (jointing) and planing to reduce the cup.

FIGURE G-2-1



By ripping the board, the amount of cup and the loss of board thickness when planing are reduced.

FIGURE G-2-2



Ripping to reduce cupping must be done so that the two resulting pieces are both usable to the maximum extent. The saw kerf must pass through pith line or the edge of a defect is possible. The width of the two pieces must be such that they both are usable as a "solid" and/or a good "random". (See section G.4, Ripping Operation.) Solids should be ripped whenever possible.

The Grading Saw Operator may lay off to a truck those solids, or certain lengths of them, that he has ripped. These solids cannot be glued up as they will not have a glue joint surface.

LIMITATIONS:

A cup of 1.5mm is considered the maximum allowable without grading.

Boards with an acceptable cup are to be placed cup side down on the conveyor leading to the infeed of the facer (jointing planer).

EQUIPMENT:

A standard straight-line, chain-feed ripsaw is required. This should face incoming lumber on conveyor so operator can have a second chance at a board.

PERMISSIBLE DEVIATIONS:

Certain plant arrangements at present do not permit the installation of a grading saw. Until such time as changes to permit this are made, grading will be omitted.

RECORDS:

When the Grading Saw Operator rips solids, production of these will be recorded on the appropriate production control form.

RESPONSIBILITY:

It will be the Rough Mill Foreman's responsibility to see that the operators are trained and that they observe these standards.

It will be the Plant Manager's responsibility to provide means for removing the cupped boards from the regular flow and for grading them.

3. Facing and Planning Operation

Date Issued_____

Activities Affected: Facing (Jointing), Planing

Date Revised_____

Approved by_____

Departments Affected: Rough Mill

PURPOSE:

This standard covers the operations of facing (jointing) and planing of rough lumber before ripping and sets forward the speeds and cuts permitted.

METHOD:

All boards which have been cut-to-length and have an acceptable cup are to be face-planed first and surface-planed secondly. These operations may be done as automatically or manually fed successive operations or as one combined operation. Double planers are not acceptable in the latter. Only Strait-O-Planes or their equivalent with "soft" hold-downs and at least one meter between heads are to be used.

The facer (jointing planer) will be set to take a 1.2mm cut. The planer-surfacer will be set to give a thickness according to the following schedule:

25mm Stock	22.6mm Net Thickness
32mm Stock	29.6mm Net Thickness
40mm Stock	37.6mm Net Thickness
50mm Stock	47.6mm Net Thickness
60mm Stock	57.6mm Net Thickness
70mm Stock	67.6mm Net Thickness

This operation should clean up to 70 to 75 percent of both surfaces of a board, primarily to produce two true and parallel faces as basis for subsequent operations including the following:

1. Expose color characteristics.
2. Expose defects.
3. Provide flat surface for holding part stable while rip jointing.
4. Allow separation of "thick" and "thin" in matching.

Pieces which do not properly clean up because they were from thin lumber, or which will be thin after the re-surfacing required because of nips, biting, and tear-outs, are to be separated and given special treatment. (See section G.7, Surfacing of Panels).

FEED SPEEDS:

Facer and planer will be operated at such cutter head and feed speeds as will result in not less than 4 knife marks per centimeter of work. (Cutter head r.p.m. x number of knives in head ÷ speed in centimeters).

Heads must be balanced and knives jointed in the head. See section G.11 for knife angles, relief angles, and chip breaker setting.

EQUIPMENT:

A facing planer (jointing planer) and a planer-surfacer may be used in tandem, or a Strait-O-Plane or its equivalent with"soft" hold-down mechanism and at least one meter between heads are to be used. Double planers will not be used in this operation.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

None.

RESPONSIBILITY:

The Set-up Man or other qualified person designated by the Foreman has the responsibility for the proper set-up of this equipment. The Busting Saw Operator or other persons designated by the Foreman is to observe the infeed, prevent or correct any jam-ups which may occur as a result of stock which is too thick, or which may be over-lapping on the infeed, and is to see that acceptable cup is face down on entry to the facer.

4. Ripping Operation

Date Issued_____

Activities Affected: Ripping

Date Revised____

Departments Affected: Rough Mill

Approved by_____

PURPOSE:

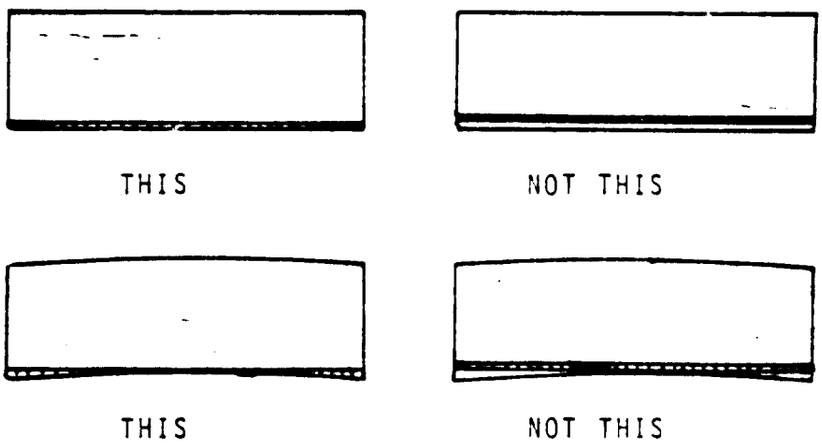
This standard covers the operation of ripping of boards which have been cut to rough length and hit-or-miss faced (jointed) and planed. These are ripped to produce parts of proper width and/or to prepare pieces for panel glue-up, eliminating defects in the process.

METHOD:

1. Specifications must be clear and concise; both operators and tailmen must be fully aware of the grade they are seeking.
2. Lumber must be properly prepared, as previously described.
3. Outside edges, when jointing is required, should be jointed before rips are taken from the piece.
4. Solids for moulding should not be jointed unless the edge is crooked to the extent that the part will not clean up in the moulder.
5. Edging waste should not exceed the thickness of the saw blade except in the case of a crook in the board to be

edged. It is not necessary to "bury the saw" to obtain a clean joint for the full length of the part.

FIGURE G-4-1



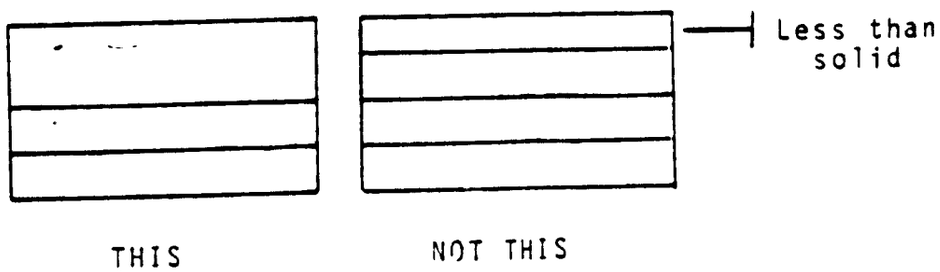
6. Wherever final product will permit, boards will be ripped to produce widths according to product specifications and random widths which will later be glued into panels for re-ripping to specified widths or used as panels. Ripping for solids alone is not to be permitted except under special conditions. (See "Permissible Deviations").

FIGURE G-4-2

5.7cm Random
5.0cm Solid
5.0cm Solid

7. Outside edges must be jointed (edged) before ripping any strip less than 3.8cm wide.
8. Random strips less than the width of narrowest solids are not to be produced. If the ripping operation to produce a minimum width solid would leave a random width strip narrower than one inch, the rip is to be made so as to produce a random width wider than the solid would have been.

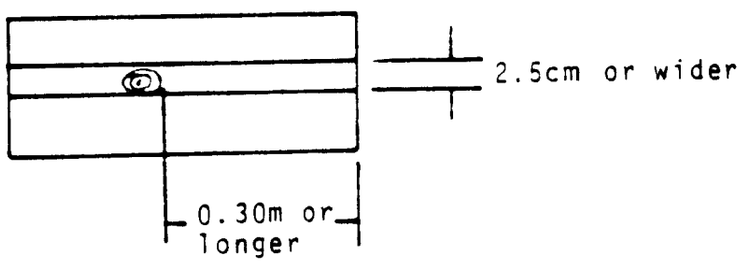
FIGURE G-4-3



9. Solids ripped should not exceed 11.0cm in width unless a further reduction in width will occur in later processing. If a panel is being matched to glue multiples, and that panel will eventually be ripped to 11.0cm or less, it is, of course, acceptable to use the widest strip which can be developed. Pieces being ripped for core stock should not be more than 9.0cm wide.

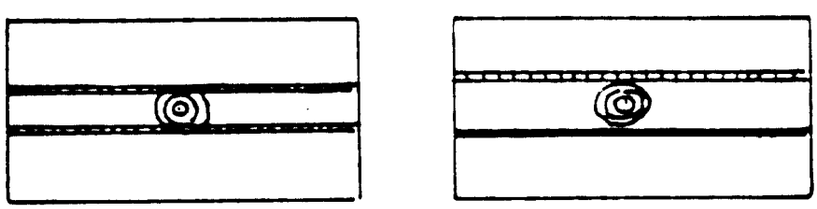
10. Any piece resulting from defecting which contains sound material at least 2.5cm wide and 0.30m long will be sent to a salvage operation.

FIGURE G-4-4



11. Rips made to remove defects should be made to pass through the edge of the defect. No sound wood should be left on the defect side of the cut if possible.

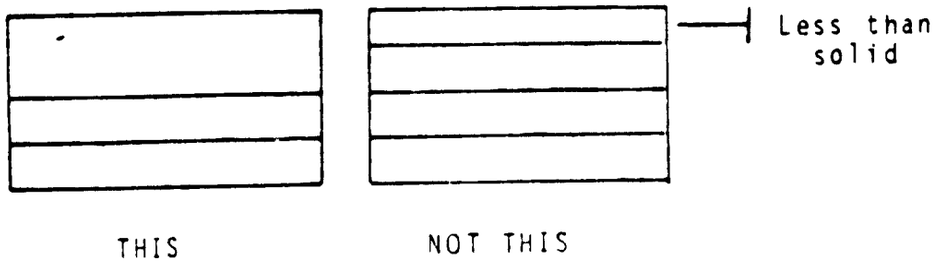
FIGURE G-4-5



7. Outside edges must be jointed (edged) before ripping any strip less than 3.8cm wide.

8. Random strips less than the width of narrowest solids are not to be produced. If the ripping operation to produce a minimum width solid would leave a random width strip narrower than one inch, the rip is to be made so as to produce a random width wider than the solid would have been.

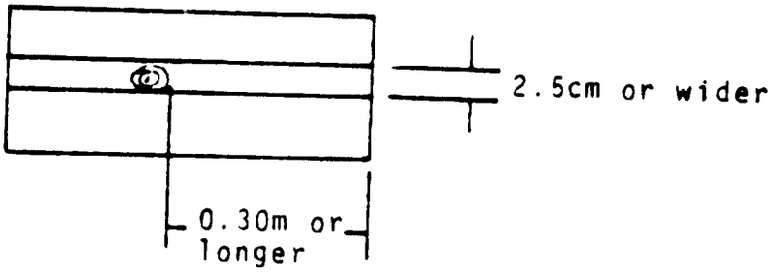
FIGURE G-4-3



9. Solids ripped should not exceed 11.0cm in width unless a further reduction in width will occur in later processing. If a panel is being matched to glue multiples, and that panel will eventually be ripped to 11.0cm or less, it is, of course, acceptable to use the widest strip which can be developed. Pieces being ripped for core stock should not be more than 9.0cm wide.

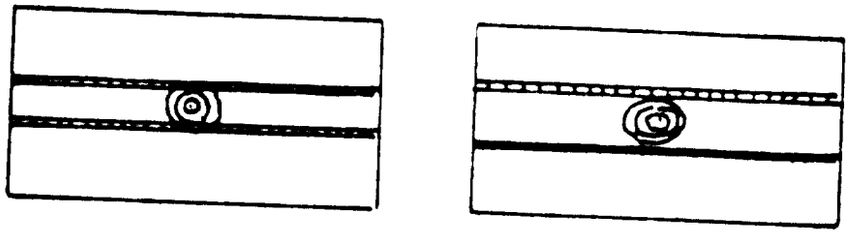
10. Any piece resulting from defecting which contains sound material at least 2.5cm wide and 0.30m long will be sent to a salvage operation.

FIGURE G-4-4



11. Rips made to remove defects should be made to pass through the edge of the defect. No sound wood should be left on the defect side of the cut if possible.

FIGURE G-4-5



12. Color separations must be performed at the rip operation, and full thickness material kept separated from thin stock. Tailboys must be provided with "go/no-go" gauges.
13. Clear Two Faces specifications should be ripped with the worst side of the board up, Clear One Face with the best side up. This encourages good yield by allowing the operator to see the appropriate side during the defecting operation.
14. Glue joints must be at 90 degrees to the face which is down on the rip chain. Surfacing properly will eliminate most of the problem, and pieces which have a high percentage of skip in dressing on one face only may be ripped with the smooth surface down.
15. The rip pointer must be aligned with the flat side precisely in line with the outer edge of the saw. This allows an edging strip the thickness of the saw blade, which is the maximum thickness desired. The pointer should be used as an index in defecting as well as edging.
16. The rip fence must be set to remove the minimum amount of material as previously described. The rip fence should be used in edging material up to one meter in length. The use of the rip fence is also helpful in eliminating tapered strips which is essential to good gluing practice. Edges of ripped pieces destined for gluing must be absolutely free of burn or glaze.

FEED SPEEDS:

Ripsaws are to be run at the maximum speed at which the saw can be kept loaded. This is generally as follows:

For Cutting Lengths up to 56cm 20 Meters Per Minute

For Cutting Lengths 56 to 84cm 29 Meters Per Minute

For Cutting Lengths 84 to 213cm 35 Meters Per Minute

EQUIPMENT:

Standard straight-line, chain-feed ripsaws will always be used for this operation.

Ripsaw blades producing a kerf width of not greater than 3mm are to be used on all 25 and 32mm softwoods and soft hardwoods such as beech. These saw blades are to be supported by special collars of a maximum diameter that will still clear the work. (These collars are not usually supplied by the saw manufacturer and must be specially made).

Ripsaws should leave a surface smooth to the touch, but possibly with visible revolution marks. No depressions over 0.08mm are permitted.

Edges of ripped pieces destined for gluing must be absolutely free of burn or glaze.

To assist the operator in edging a piece without producing an edging strip, all ripsaws ripping up to one meter should be equipped with pop-up gauges.[1/] (See Figure G-4-6 attached).

1/ These gauges doe not fit on Mattison Saws.

For edging long stock (over one meter), extended guide boards should be used. (See Figure G-4-7 attached).

To assist the operator in defecting accurately, overhead guide-line lights are to be installed where adequate ceiling heights and vibration-free conditions permit. One guideline is aligned with the saw blade. Additional lines may be set to indicate standard widths for solid pieces. Shadow wires must be kept clean to produce sharp lines.

Saw blades are to be kept clean at all times. They must be inspected, and cleaned if necessary, at the middle of each shift. For exceptionally resinous species, inspections are to be made every two hours of operation.

Saw chains and beds must be kept free of oil, as any oil or like substance present on the glue joint will cause open joints in the gluing process.

Rip chains and saws must be kept in proper alignment. They must be checked at least twice each shift and preferably more often.

Joints must be straight. When resting side by side on the rip table, any two or more rippings of properly conditioned and stress-relieved lumber should show no gap between them that cannot be closed by hand without noticeable effort. A slight concavity (gap in the middle) can be tolerated if the gap does not exceed 0.13mm in a one meter length. Convexity (gap at the ends), even though less than 0.13mm is not acceptable.

Ripped edges must be square. No light should be visible between a square and the bottom (chain side) and the ripped edge of a piece.

Any deviation from these acceptable conditions will produce a joint of questionable strength, one that will experience early failure even though the pieces may be forced together in a heavy clamp.

Adjustments to achieve these conditions shall be made in accordance with the saw manufacturer's instructions.

The lighting must be of a sufficient level to allow the operator and tailman to distinguish color variations and the presence of defects. A minimum of 500 lumens per square meter.

PERMISSIBLE DEVIATIONS:

Solid rips wider than 110mm may be made when specifically called for in the engineering drawings and required by the particular design or style of the furniture.

RECORDS:

Each load of accepted parts which leaves the ripsaw is to be counted according to the units specified on the Route Card (pieces or cubic meters). The count is to be recorded on the proper production control forms.

RESPONSIBILITY:

It is the responsibility of the Plant Superintendent to determine that the necessary equipment is in place or, if not, that it is requested through appropriate channels and when received is installed and used.

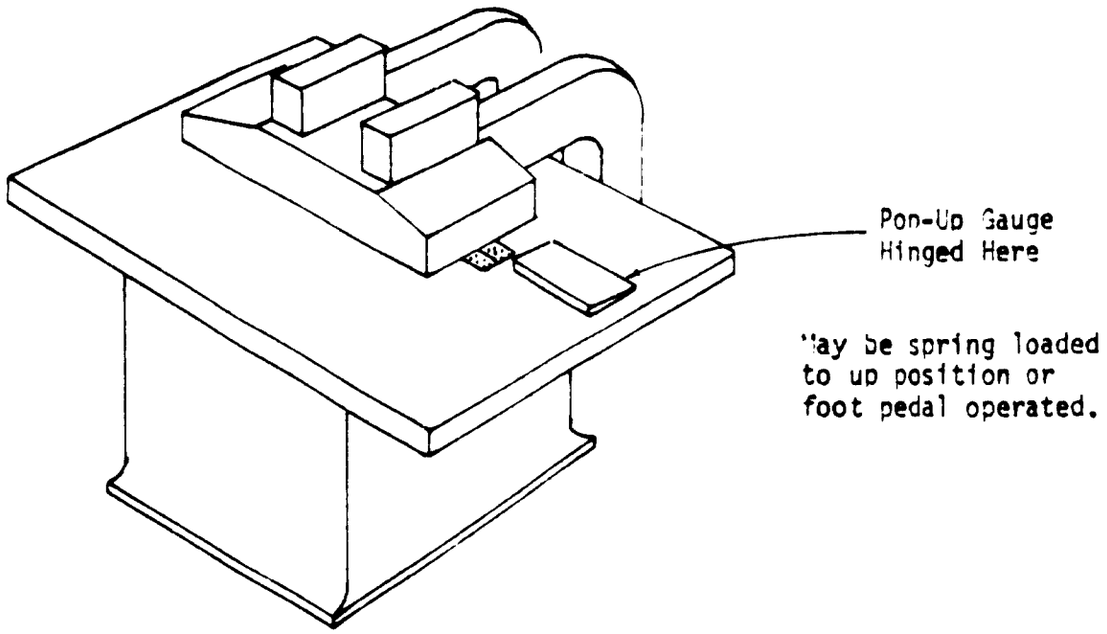
It is the Rough Mill Foreman's responsibility to carry out the Superintendent's instructions, to train the operators, and to see that the equipment is properly maintained and used.

It is the Operator's responsibility to understand the equipment and procedures and use them properly, to report any deficiencies in the equipment, and to instruct and direct the Off-Bearer.

It is the Operator's and the Off-Bearer's duty to set aside thin stock.

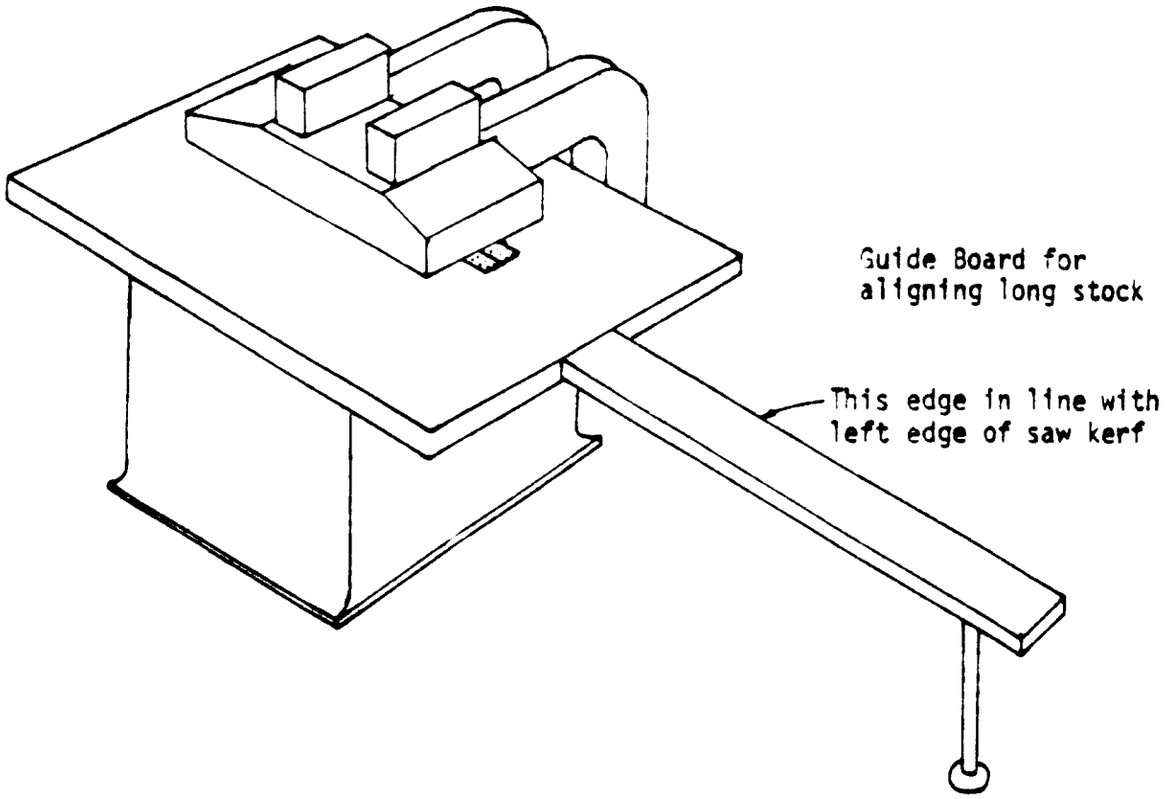
It is the Off-Bearer's duty to determine the usable defect pieces and stack them separately or direct them to the salvage conveyor. It is his duty to acount and record the production.

FIGURE G-4-6



POP-UP GAUGE

FIGURE G-4-7



GUIDE BOARD

5. Panel Build-Up Operation

Date Issued_____

Activities Affected: Matching

Date Revised____

Departments Affected: Rough Mill

Approved by_____

PURPOSE:

This standard covers the proper grouping and ripping of the pieces which are to be edge glued to form planers. The primary objective of this operation is the production of quality panels which, in turn, results in a minimum of re-work and scrap.

METHOD:

Random-width pieces are laid up on a matching saw table to exceed the specification width of the panel, and the group is then ripped to that width.

First consideration in this operation is the elimination of defective pieces (warped, bowed, split, etc.).

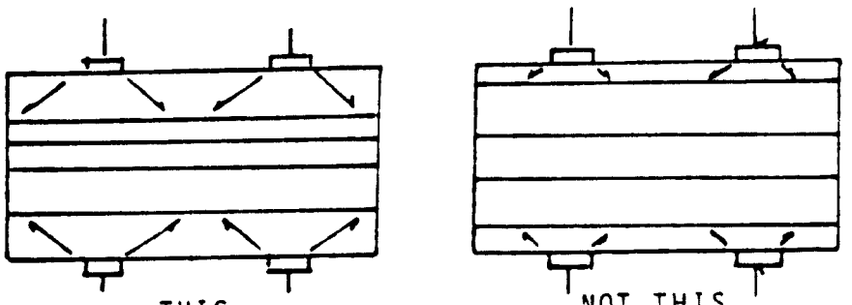
Pieces must be selected for uniformity of thickness. Pieces too thick or too thin must be set aside for special treatment.

Pieces must be selected for color match (when specified) to produce panels of uniform color.

No random-width piece used in a panel shall exceed 9.0cm in width.

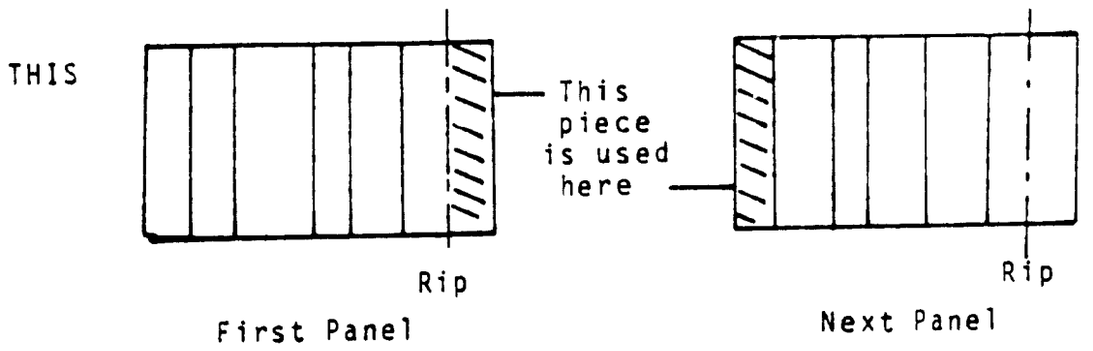
Both edge pieces must not be less than 30mm to provide for adequate distrubition of pressure from the clamps in the gluing operation

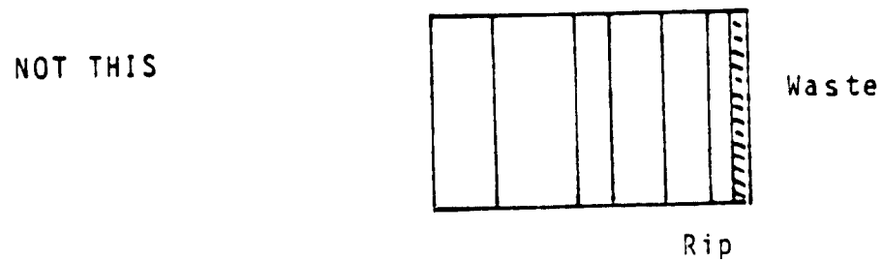
FIGURE G-5-1



The width of the last piece laid up must exceed the edge piece width requirement by at least 3.0cm so that when this piece is ripped, a usable strip is produced. It may be used as the edge piece in the next panel if this strip exceeds the minimum width requirement for an edge strip (3.0cm).

FIGURE G-5-2





Assembled panels are to be faced marked as matched.

Assembled panels may not deviate from the rough size as ordered by more than ± 3mm in either dimension.

Panel pieces are to be stacked on the take-away pallet or truck in a manner to preserve the grouping and piece sequence.

EQUIPMENT:

Either a matching saw or a straight-line, chain-feed ripsaw which is equipped with a panel gauge will be used for preparing panels.

Saw blades which do not produce a kerf of more than 3mm shall be used. Collars shall be used to support the thin blade.

PERMISSIBLE DEVIATIONS:

Heavier gauge saws are permitted in high-density species and on 50mm and thicker stock.

RECORDS:

Appropriate production control forms.

RESPONSIBILITY:

It is the responsibility of the Rough Mill Foreman to instruct and supervise the operators in these standards.

It is the Matching Saw Operator's responsibility to assemble the pieces as prescribed. It is the Off-bearer's duty to mark the "best face" when specified, to stack the group in such a way as to keep their grouping, and to record the count.

6. Panel Edge-Gluing Operation

Date Issued_____

Activities Affected: Clamp Carrier, Panel Flo

Date Reivsed_____

Approved by_ ___

Departments Affected: Panel Department

PURPOSE:

This standard sets forth the best procedures for Panel Edge Gluing on the Clamp Carrier and Panel Flo equipment.

METHOD:

General. All panel operations assume that the lumber has been properly dried, conditioned, and stress relieved before being cut, and that the pieces have been properly faced, planed, and squarely ripped in accordance with standard procedures.

Stock which has been prepared for panel gluing must be stored under conditions of humidity which will maintain as nearly as practical a stable MC in the stock.

Stock ready for gluing should not be stored over one week, even in the best of conditions, between the jointing and gluing operations. Stock which must be stored longer than this must be re-edged before gluing. Ideally, gluing should take place the day stock is edged.

Stock ready for gluing must be clean so that no foreign material will be introduced into the glue, or which will cling to the edges and prevent proper contact between the edged strips.

Glued panels must be "cured" for at least 24 hours before being machined. Table tops will be cured 48 hours.

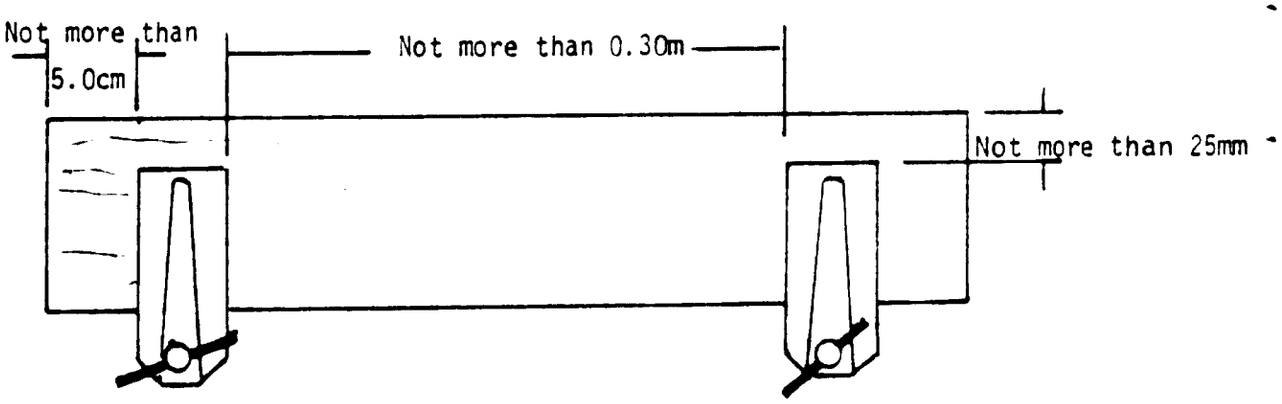
Clamp Carrier Operation. Panel parts must be marked for proper sequence and best face at the matching operation and maintained in that sequence until placed in the clamp.

Polyvinyl glue will be used. Time from application of the glue to the joint surfaces until application of the pressure must be within adhesive manufacturer's recommendations.

The doctor roll on the glue spreader should be set to approximately 0.5mm from the glue applicator roll. Care must be taken to follow manufacturer's instructions as to mixture and consistency. The film must penetrate satisfactorily, but not be thin enough to penetrate the wood excessively leaving insufficient adhesive on the surface and thereby producing a starved joint. Likewise, too much glue can be unsatisfactory and wasteful. A SMALL SQUEEZE-OUT BEAD SHOULD APPEAR THE ENTIRE LENGTH OF ALL JOINTS.

Clamps shall be set up so that the stock projects no more than 5.0cm beyond the outer edge of the outer clamp, and there is no more than 0.30m clear between inner edges of clamps.

FIGURE G-6-1



When torque wrenches are used to tighten clamps they shall be operated on a "run-to-stall" basis. That is, the wrench should stop rotating under load.

Air pressure must never exceed 325kgs per square meter on the wrench, and the following settings shall normally be used:

4/4	2 Clamps to 0.45m Length	100kgs/m^2
4/4	Over 2 Clamps, or all Lengths over 0.45m	170kgs/m^2
5/4	2 Clamps, to 0.45m Length	150kgs/m^2
5/4	Over 2 Clamps, or all Lengths over 0.45m	200kgs/m^2
6/4	2 Clamps, to 0.45m Length	170kgs/m^2
6/4	Over 2 Clamps, or all Lengths over 0.45m	240kgs.m^2

Similar relationships must be determined when other methods of applying clamp pressure are used.

Stock must be kept under pressure in the clamps for a minimum of 40 minutes at 20°C. Higher temperatures will shorten setting time, or increase joint strength for a given time.

Jaws and arms must be kept free of accumulations of adhesive.

Care must be taken to seat all sections of the panels against the clamp arms.

Panel Flo Operation

Adhesive. Urea-Formaldahyde with E-6 catalyst will be used. The doctor roll on the glue spreader will be set approximately 0.50mm from the glue applicator roll. Care must be taken to follow manufacturer's instructions as to mixture and consistency. The film must penetrate satisfactorily but not be thin enough to penetrate

the wood excessively, leaving insufficient adhesive on the surface and thereby producing a starved joint. Likewise, too much glue can be unsatisfactory and wasteful. A SMALL SQUEEZE-OUT BEAD SHOULD APPEAR THE ENTIRE LENGTH OF ALL JOINTS.

Preparation for Operation. Before admitting steam to the platens, all water must be drained from them and from the steam lines. No steam must enter with water in the steam line or water in the platen.

When starting from a cold machine with steam supplied by a package steam generator, the platens should come up to pressure with the generator. If warming up from a high pressure main, steam must be admitted slowly to avoid heavy stresses in the platens.

Platens must be heated for two hours at a minimum of 600kgs per square meter for two hours before operating.

All dried glue must be scraped from the glue applicator conveyor bars, applicator roll gear teeth, glue pan, and the feed section of the Panel Flo before start-up. Do not use steam or a hammer to clean any part of the Panel Flo. Steam endangers proper lubrication of the equipment.

Loading, Start-Up. Dummy panels of the thickness of stock to be glued are fed initially. Glued stock may not be fed in until these dummies start to emerge from the rear of the machine. These dummies must be the same length or longer than the panels to be glued.

Adjustment.

1. Drive Pressure. Gauge pressure on the outside drive rolls should be in the range of 90 to 240kgs per square meter.

Pressure on the center drive roll should be in the range of 70 to 200kgs per square meter. The proper amount is determined by the quality of the joints emerging from the machine and by the marks on the bottom surface of the panels. The marks must be uniform across the top surface of the panel. (Refer to Figures G-6-2 and G-6-7 attached).

Figure 2 - Drive roll pressure evenly distrubuted.

Figure 3 - Insufficient center roll pressure.

Figure 4 - Insufficient right end roll pressure.

Figure 5 - Too much center roll pressure.

Figure 6 - Too much right end roll pressure.

Figure 7 - Too much left end roll pressure.

2. Retard Pressure. This is determined by severity of marks on bottom surface of panels. Too much pressure causes deep imprints and occasionally fractured joints.

Change of Thickness. Any change of thickness requires the feeding of at least 1.3m of dummies between thickness. A maximum of 6mm can be made at one step. A change of more than 6mm must be made stepwise with the dummies of each step driving at least halfway through the machine.

Change of Length. If a second job is longer or substantially shorter than the prior job, or if two ribbons are changed to one or vice versa, dummies at least equal to the greater length of the work must be used between them.

Temporary Shut-Down. A stop of over 10 minutes requires that the upper platen be raised to avoid over-curing of the adhesive. For any stop of 30 minutes or more, the machine must be emptied.

Final Shut-Down. The last panel should be driven into the heating chamber by dummy panels, allowed to heat for 3 to 10 minutes, and then be pushed out manually with a ram or poker pole. All glue is to be removed from applicator conveyor and rolls and from the Panel Flo.

Joint Cure & Cull Rate. A proper joint should attain 95 percent of its full strength within 30 minutes. If the cure of the adhesive is less than 3mm as a panel leaves the machine or if after one-half hour the center of the joint does not show full wood failure, an abnormal situation exists and must be located and corrected.

EQUIPMENT:

1. Steam Pressure. This should be in the range of 600 to 730kgs per square meter and controlled to within ± 50kgs per square meter during the operating period. Steam of at least 75kgs per square meter should be kept on the machine during non-operating intervals. Steam and water must not be in the platen at the same time.
2. Air Pressure. Satisfactory operation requires 440kgs per square meter.
3. Speed Changes. Speed control mechanism must be operated only when the Panel Flo is runring.

4. Repairs to Platen. It is absolutely mandatory that any repairs requiring welding on the platen be done by electric arc welding. No form of acetylene brazing or welding is permitted.

Drive Roll Marks

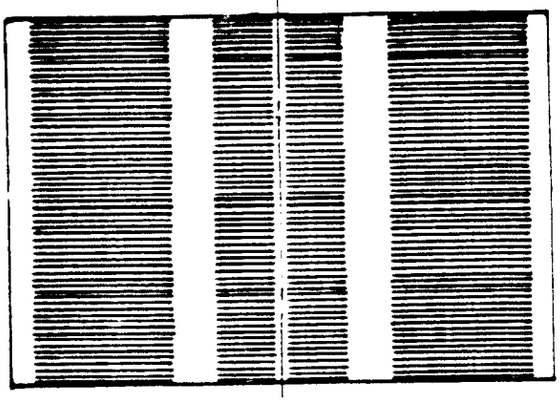


Fig. 2

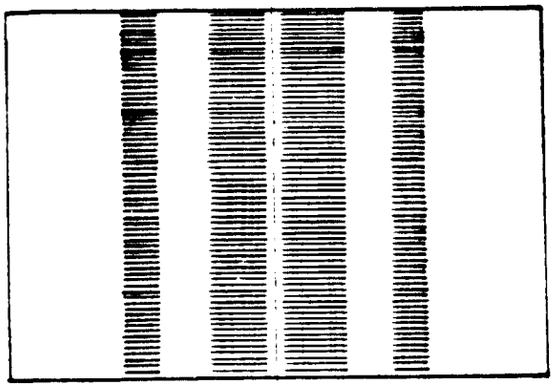


Fig. 5

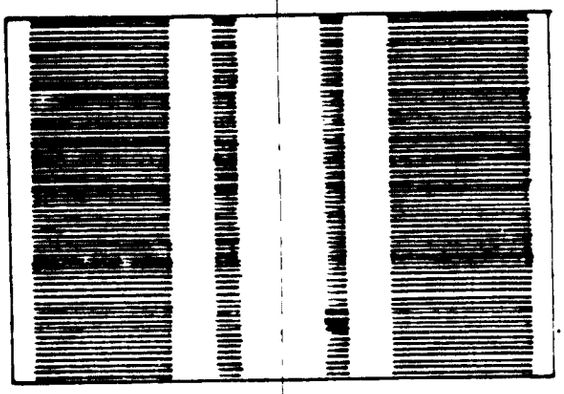


Fig. 3

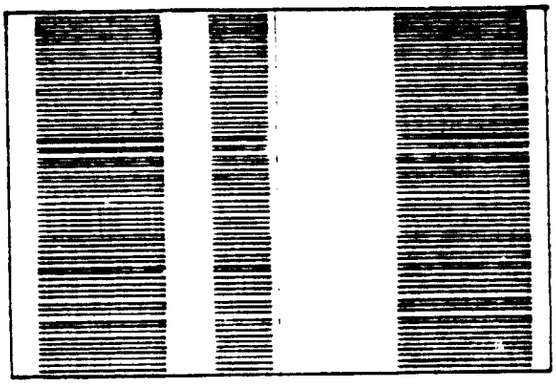


Fig. 6

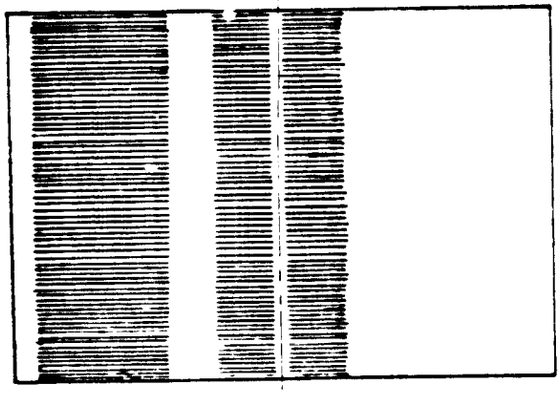


Fig. 4

Direction of Feed

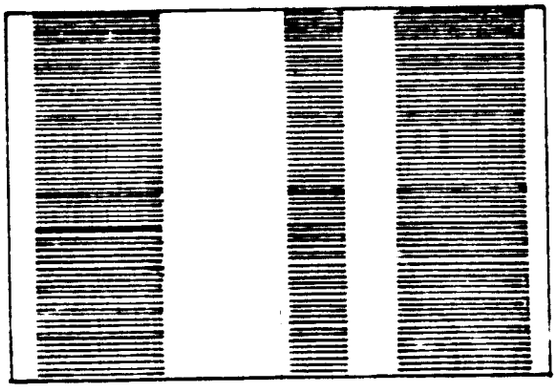


Fig. 7

7. Surfacing of Panels

Date Issued_____

Activities Affected: Planer Operation

Date Revised_____

Departments Affected: Rough Mill

Approved by_____

PURPOSE:

The purpose of this standard is to set forth the accepted procedures for surfacing of panels for standard knife planers.

METHOD:

The 3-pass system will be used, described as follows:

First Pass. A brush cut to remove the excess glue and not more than 0.8mm of wood. Defective pieces (open joints, tear-outs, nips, burns) are set aside by the Off-Bearer or Tailman for repair.

Second Pass. A cut of approximately 2.4mm is taken on the reverse side. Defective pieces are set aside for repair. Parts which fail to clean up on this pass are set aside for special treatment (4-pass system).

Third Pass. A cut is taken on face side (first pass side). The depth of this cut is sufficient to achieve nominal finished thickness. Off-Bearer sets aside defective panels for repair.

Panels which are to re-ripped for moulder stock will skip the third pass and be moved directly to the ripping operation.

Special Handling. Those pieces which were set out on second pass because of failure to clean up will be handled as follows.

These panels will be carefully inspected before any further work is done on them, as the taking of a finish cut will reduce the panel thickness to the point where it will no longer be possible to perform re-rip and repair operations.

Take third pass on same side as second pass, using a depth of cut which is the absolute minimum necessary to clean up this face. Off-Bearer inspects this cut.

Fourth pass on the face side with a cut depth to produce the nominal thickness required. Off-Bearer inspects this cut.

FEED SPEEDS AND CUTTER ANGLES:

These are to be adequate for the type of work and the species run. See section G.11 for details.

EQUIPMENT:

Heads are to be balanced and knives are to be kept sharp and are to be jointed in the head.

PERMISSIBLE DEVIATIONS:

On core stock, the second and third pass described above may be combined.

RECORDS:

Quantity of accepted pieces will be posted to the proper production control form. Rejects will be counted and posted to a reject report, giving both count of and reasons for the rejects.

RESPONSIBILITY:

Rough Mill Foreman, Planer Operator, Off-Bearer.

8. Moulder Operation

Date Issued_____

Activities Affected: Moulding

Date Revised_____

Departments Affected: Rough Mill

Approved by_____

PURPOSE:

The purpose of this standard is to set forth the accepted procedures for the moulding operations to give the highest yield of acceptable parts at the least overall cost.

METHOD:

Orientation of Parts

1. Parts coming from the tenon machine to the moulder shall be placed on the moulder with the "dog side" (marked) against the inside moulder fence.
2. Parts which have been rip-sawn from glued-up panels will be placed on the moulder, surfaced side down on the moulder bed.
3. Where there is a choice of positions of the part, the part should be placed so as to:

a. Machine out defects.

b. Place the defect in an unexposed location.

Contoured parts must be end trimmed prior to moulding.

FEED SPEEDS & KNIFE ANGLES:

See Section G.11.

EQUIPMENT:

All standard moulders are covered by this operation standard.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

Quantity of accepted parts is to be entered on the appropriate production control form. The number of rejects and the reasons therefore are to be listed on the "Reject Report".

RESPONSIBILITY:

The Foreman is responsible for the training and follow-up and for the condition of machinery and materials used.

The Operator is responsible for the satisfactory overall operation of the machine.

The Loader is responsible for keeping the machine loaded with correctly positioned parts.

The Off-Bearer is responsible for unloading, inspecting for defects, stacking, and counting both acceptable and rejected parts.

It is important that the Operator act as Off-Bearer at least for the start-up of a run and periodically throughout the run so that he may see that the parts are being produced as specified. The parts must be accurately measured and checked against the specifications for the part.

When automatic moulder return Tailboys are used, the Operator is responsible for both proper positioning of infeed parts and inspection of moulded parts. If the set-up has been approved and parts are correctly positioned on machine entry, final inspection usually does not need to be as thorough. Visual inspection without part handling will usually suffice.

9. Tenon Machine Operation

Date Issued_____

Activities Affected: End Trim, Dado, Cope, Tenon

Date Revised_____

Departments Affected: Finish Mill

Approved by_____

PURPOSE:

The purpose of this standard is to set forth the accepted procedures for the operation of tenon machines to give the highest yield of acceptable parts at the least over-all cost.

METHOD:

All parts to be run on a tenon machine shall be faced one surface at least. That side shall be placed down on the chain and the part firmly against the dogs to assure that accurately square cuts are made.

When the tenon machine operation is to be followed by a moulding operation, all completed parts are to be stacked with the same orientation and the dog side marked.

Whenever possible, reject parts from the previous operation will be used as test pieces.

FEED SPEEDS AND KNIFE ANGLES:

Tool angles and feed speeds are to be those specified for the work and species. (See section G.11.)

EQUIPMENT:

All heads must be balanced and all knives must be jointed in the head.

PERMISSIBLE DEVIATIONS:

None.

RECORDS:

Quantity of accepted parts is to be entered on the appropriate production control form.

RESPONSIBILITY:

The Foreman is responsible for the training and follow-up of the Operators and Off-Bearers and for the satisfactory over-all operation of the machines.

The Loader is responsible for keeping the machine loaded with correctly positioned parts.

The Off-Bearer is responsible for unloading, inspecting, stacking, and tallying both accepted and defective parts. He is responsible for systematically orienting all pieces and marking all parts whose subsequent machining is based on the dog or chain sides of parts off the tenon machine.

The Tenon Machine Operator is responsible for verifying that parts being produced are according to specification, both at the start of the run and periodically throughout the run. Parts should be

checked as follows:

1st five

2 of each 10 through 50

1 of each 50 through 100

1 of each 100 from then on.

If any sample is out of tolerance, the next piece must be checked. If it is also out of tolerance, the operation must be stopped and the trouble corrected. After adjustment, the sampling must begin as if the first piece after adjustment was the first to be run; i.e., the first five are to be checked, etc.

10. Overage Allowances

Date Issued_____

Activities Affected: All Operations in the Rough Mill

Date Revised_____

Departments Affected: Rough Mill, Production Control

PURPOSE:

The purpose of this standard is to establish a guide for the number of pieces to be provided for overage allowances.

METHOD:

Spoilage of parts through the normal sequence of operations is basically dependent upon two factors. The first of these is set-up. Losses here are not dependent upon the size of a run. The second factor is production. Parts are spoiled in the normal course of good production and are normally directly proportional to quantity.

Both of these factors are seriously affected by a third factor, complexity: complexity of both number and type of operation. A part involving a series of operations, or very delicate operations, or operations where tear-out or breakage are likely will incur greater spoilage than a simple, rectangular part.

Also, end use and finish will affect spoilage. Inside, hidden frame parts can contain defects that cannot be tolerated in a high finished, exposed part.

Allowances must then be based on these factors: End Use, Complexity, Volume, and Set-Up. Roughly speaking, Volume and Set-Up losses are affected equally by End Use and Complexity.

A flat percentage allowance will result in some shortages and some overages, depending upon the circumstances. This new standard is designed to narrow the error.

The following table will be used in determining allowances until such time as results of experience and detailed studies modify it.

	For Set-Up[1]	Production	Production	Production
1. Simple Interior Parts[2]	3 Pcs	+ 3% of 1st 100	+ 2% of next 900	+ 1.0% of all over 1,000
2. Simple Exterior Parts[3]	5 Pcs	+ 5% of 1st 100	+ 4% of next 900	+ 2.5% of all over 1,000
3. Complex Exterior Parts[4]	10 Pcs	+ 8% of 1st 100	+ 6% of next 900	+ 4.5% of all over 1,000

---

[1] Rejected pieces from a previous operation are to be used where wherever possible for set-up. For example, a moulded part rejected because of tear-outs may still be used as set-up stock for the operations of coping and tenoning on a tenon machine.

[2] "Simple Interior Parts" are those on which few (1-5) straight-forward operations are performed on wood that is easily machined, and where minor defects may be tolerated. Example: Interior Frame Parts.

[3] "Simple Exterior Parts" are those on which few straight-forward operations are performed on wood that is easily machined, where minor defects may not be tolerated, and where defects may be revealed in the machining operations. Example: Mouldings, Doors, Tops.

(4)"Complex Exterior Parts" are those on which a larger number of operations are to be performed and/or where part design results in fragility of the part or difficulty of machining, and/or where the species used is difficult to machine. Example: Intricately shaped parts; band sawn legs, rails; turnings; and, beech table tops.

EQUIPMENT:

None.

PERMISSIBLE DEVIATIONS:

Upon the development of substantiating data, the values in the above table may be changed for general use or for specific situations.

RECORDS:

The number of pieces rejected at cabinet planer and at moulders and the reasons therefor will be recorded.

RESPONSIBILITY:

The overage allowances shall be established by the Production Control Department on the basis of the above tables and upon the basis of feed-back information concerning the actual spoilages on previous runs. Additional overage allowances will not be placed on top of the scheduled allowances.

It is the responsibility of the Department Foreman to determine the reason for all actual spoilages that exceed the standard allowance.

Where the actual spoilage exceeds the standard by 100 percent or more, the Plant Superintendent must be notified. Corrective action of process, or of standards, is to be taken.

It is the responsibility of the machine Operators or the Off-bearers to separate, count, and record the spoiled parts.

Allowance	= Set-Up	+ X% 1st 100	+ Y% Next 900	+ Z% All Over 1,000
Complex, Exposed Parts	10 Pcs.	+ 8% 1st 100	+ 6% Next 900	+ 4-1/2% All Over 1,000
Simple, Exposed Parts	5 Pcs.	+ 5% 1st 100	+ 4% Next 900	+ 2-1/2% All Over 1,000
Simple, Interior Parts	3 Pcs.	+ 3% 1st 100	+ 2% Next 900	+ 1% All Over 1,000

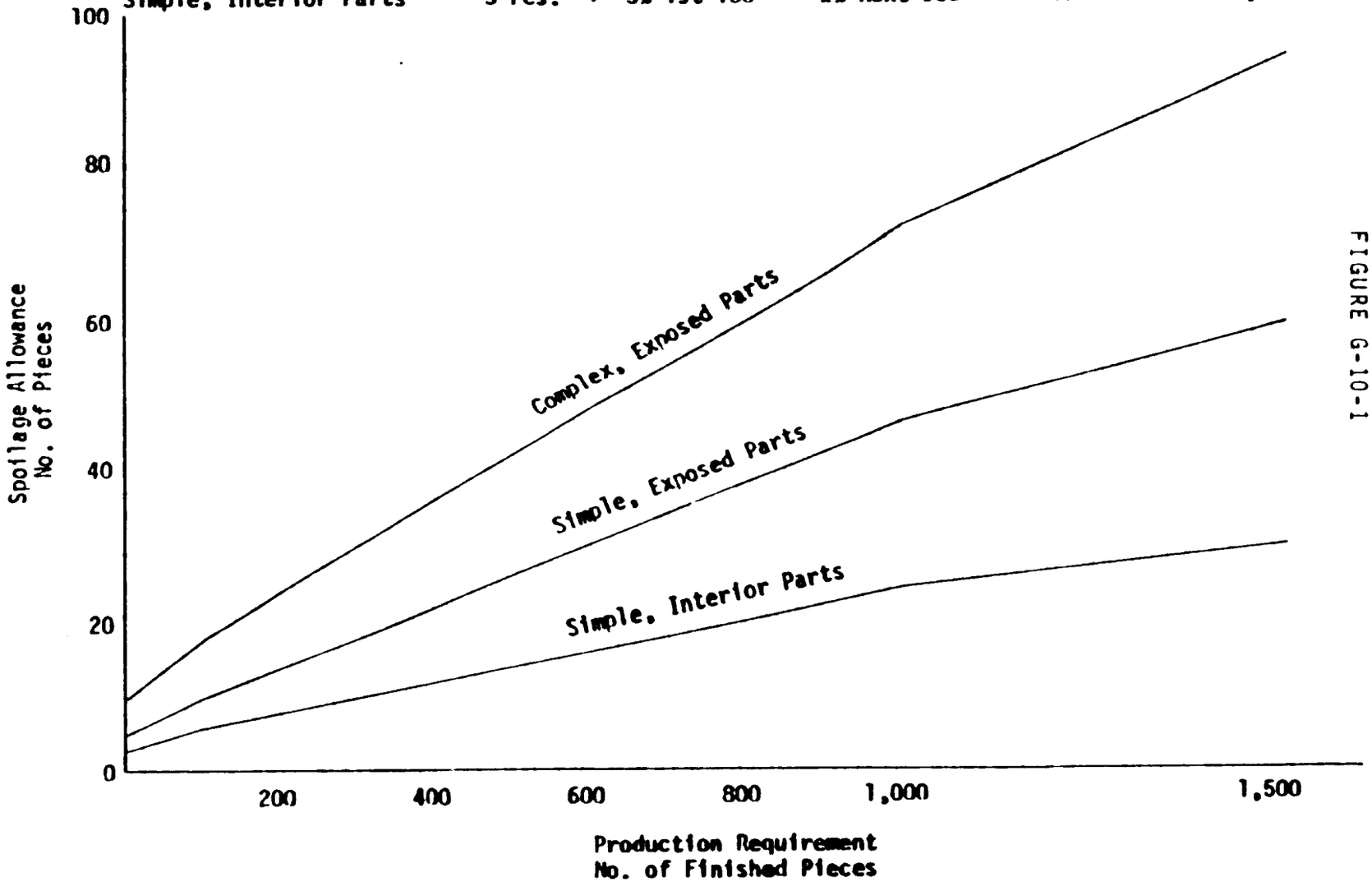


FIGURE G-10-1

11. Knife Angles Feed Speeds

Date Issued_____

Date Revised_____

Approved by_____

Activities Affected: Planing, Moulding, Tenoning, Coping

Departments Affected: Rough Mill, Finish Mill

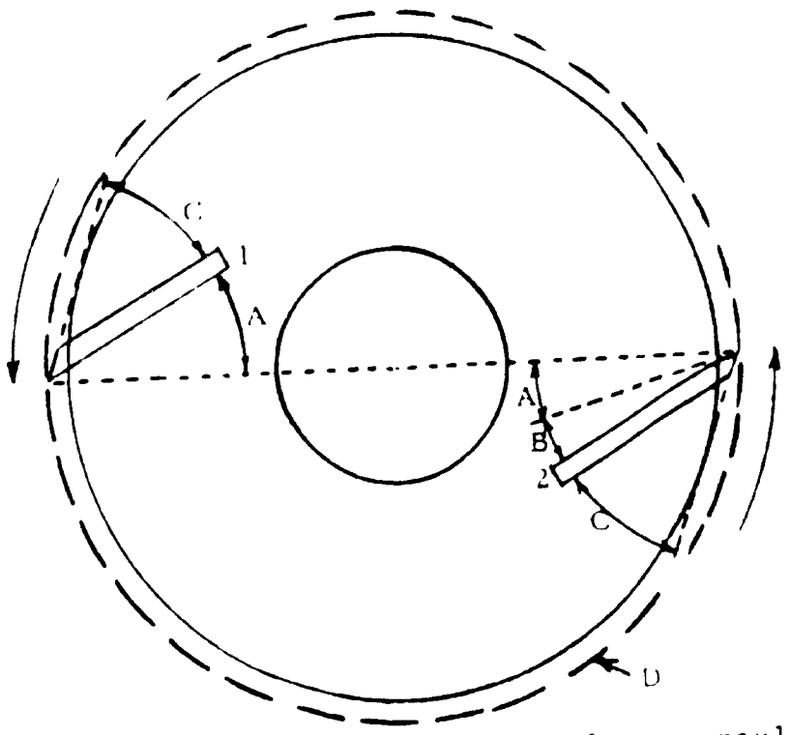
PURPOSE:

This standard sets forth the knife angles and the feed speeds to be used in planing, moulding, tenoning, and coping, unless experience indicates otherwise.

DEFINITIONS:

The following nomenclature will be used in standards pertaining to knives and to planer-moulder operations.

FIGURE G-11-1



Terms used in connection with knives for planer, moulder, etc.: A, Cutting Angle; B, Cutting Bevel; C, Clearance Bevel; D, Cutting Circle; 1 and 2, Planer Knives.

CUTTING ANGLES:

There is a best angle for each species and each condition of that species. However, it is impractical to change angles as frequently as species are changed in the various machines. Therefore, compromise angles must be adopted which give the best average conditions. There are:

	Hardwoods	Softwoods
Cutting Angle	20^{o} 1/	30^{o} 1/

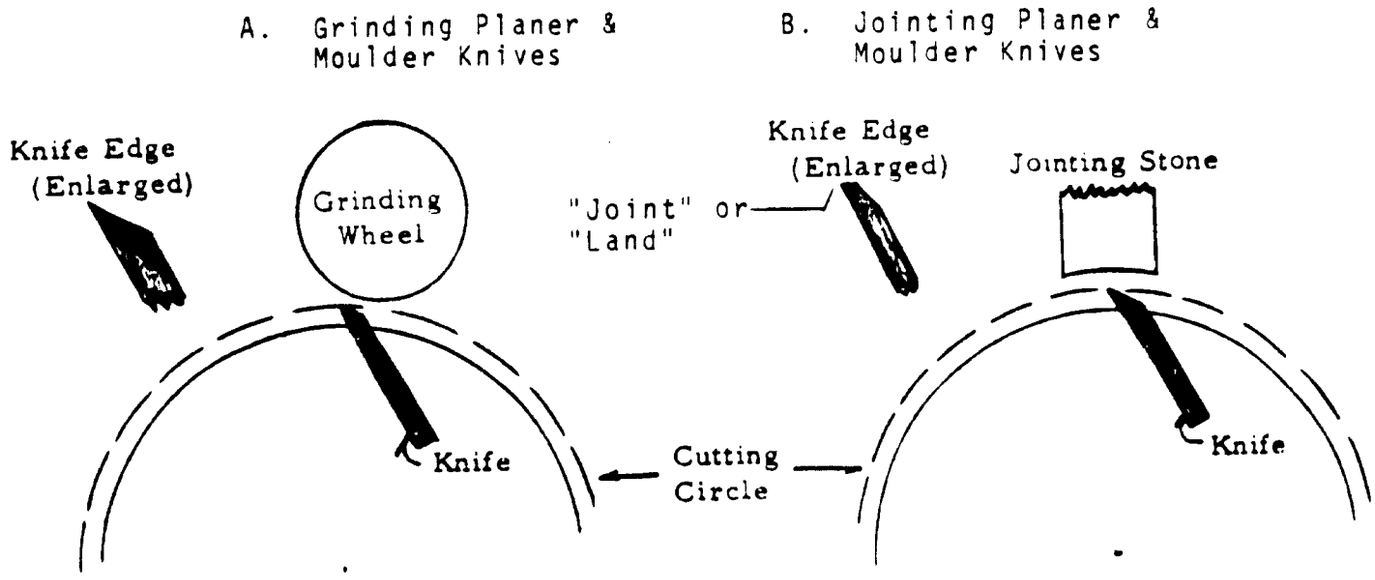
JOINTING:

The purpose of jointing is to equalize the projection of the knives so that all will cut equally and give good work and good volume at the same time.

In jointing, a carrier holding an abrasive stone is attached to the grinding and jointing bar, and the cutter head is set in motion. The stone is then lowered until it barely touches a knife edge and is then traversed along the edge of the knives. This is continued until a fine line, called a joint or land, is produced the full length of each knife. (See Figure G-11-2 following).

1/ USDA Forest Service Technical Bulletin No. 1267.

FIGURE G-11-2



As the knives gradually dull, jointing may be repeated several times as a sharpening process until the joint or land is a pronounced heel. Re-grinding must take place before the joint reaches a maximum width of 0.80mm.

Referring to the formula on cuts per centimeter (see below), note that a machine with a 4-knife head that has been jointed can be operated at feed speeds of up to four times that of the same machine with unjointed knives.

PRESSURE BARS, CHIP BREAKERS, & FEED ROLLS:

The bottom feed rolls shall be set not less than 0.076mm nor more than 0.20mm above the bed, with adjustments between these limits as

necessary. The top infeed roll shall be adjusted so that it will feed the stock yet leave no corrugation marks. The outfeed roll must be adjusted to allow the lumber to pass between it and the lower roll singly and without any plan or clearance.

The chip breaker must be adjusted as close to the cutter head as practical and adjusted to hold the board firmly against the platen with no vibration.

The pressure bar is designed to prevent spring-up as either end of the board leaves the cutter head. The bar must be adjusted to hold the board firmly against the platen until it reaches the outfeed rolls.

CUTTER & FEED SPEEDS:

Quality of work on planers, tenoners, and moulders is directly related to the number of knife cuts per centimeter of stock. This is shown in the attached chart (from USDA Forest Service Bulletin No. 1267), Figure G-11-3.

The number of knife cuts per centimeter is the result of this relationship:

$$\frac{\text{Cutter Head RPM} \times \text{Number of Effective Knives}}{\text{Stock Feed Speed in Centimeters/Minute}}$$

Thus, the same quality of work can result from these four conditions:

1. $\frac{3,600 \text{ RPM} \times 2 \text{ Knives}}{1500 \text{cms/Minute}}$ = 4.8 Knife Cuts/Centimeter

2. $\frac{3,600 \text{ RPM} \times 1 \text{ Knife}}{750 \text{cms/Minute}}$ = 4.8 Knife Cuts/Centimeter

3. $\frac{7,200 \text{ RPM} \times 2 \text{ Knives}}{3000 \text{cms/Minute}}$ = 4.8 Knife Cuts/Centimeter

4. $\frac{3,600 \text{ RPM} \times 4 \text{ Knives}}{3000 \text{cms/Minute}}$ = 4.8 Knife Cuts/Centimeter

Note that condition 2. above exists in any multiple knife head where there is one high knife. This is a normal condition where knives are not jointed.

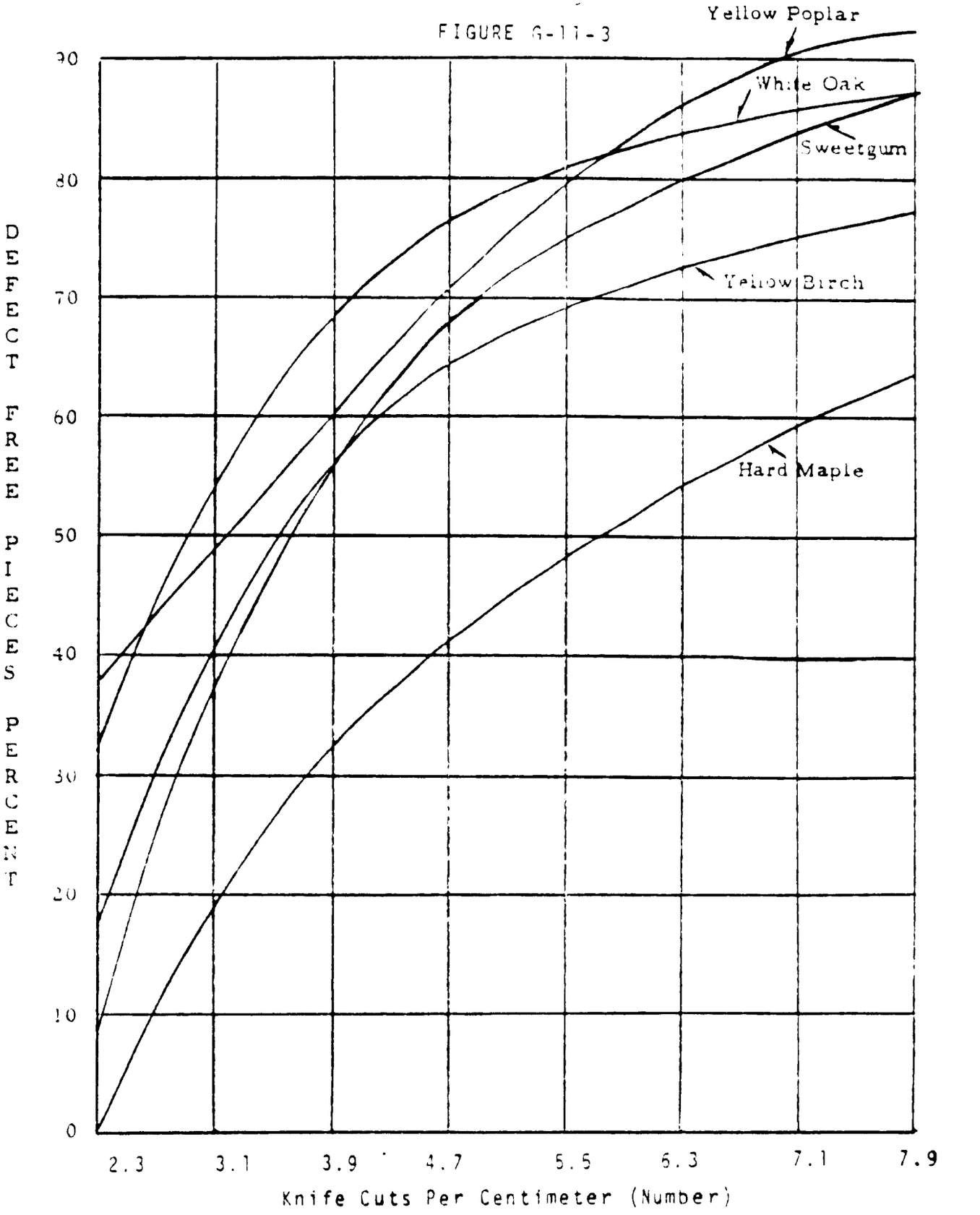
Too slow a feed speed will result in a scraping action by the knives. A glazing of the stock results, along with burning of the knives and excessive power consumption. This condition may also occur if knives are not jointed.

Planers and moulders must be run at the fastest feed speed of which the machine is capable, consistent with the finish desired and the species used.

PERMISSIBLE DEVIATIONS:

Where experience with individual species has developed knife angles which give better performance, these shall be used and the standards coordinator notified.

FIGURE G-11-3



Effect of Number of Knife Marks Per Centimeter Upon Quality of Finish

RECORDS:

None.

RESPONSIBILITY:

It will be the responsibility of the Rough Mill Foreman to see that Operators and Set-up Men are properly instructed in knife grinding and in jointing and to see that knives are jointed each time they are sharpened.

APPENDIX

Annex

DRYING OF LUMBER - KILN SAMPLES[a/]

The temperature and relative humidity schedules used in a dry kiln affect the drying stresses that develop in the wood (ch. 8). Such stresses follow a well-defined pattern closely associated with the changing moisture content of the wood. Therefore, moisture content, which can be determined easily at any stage of drying is a logical basis for applying a drying schedule.

Since it is impractical to make moisture determinations on all the lumber in a kiln charge, samples are cut from boards representative of the material being dried. These samples, called kiln samples, are so placed in the charge that they can be removed easily for weighing, examination, and testing periodically during drying. Thus, the moisture content of the charge can be estimated and the progress of drying charted.

The handling of kiln samples requires much of an operator's time, and sometimes additional manpower is needed. Also, some material is lost when kiln samples are taken. These disadvantages, however, are more than offset by several advantages. The selection, preparation, placing, and weighing of kiln samples, if properly done, provide information that enables a kiln operator to (1) reduce kiln degrade, (2) obtain better control of the desired final moisture content, (3) reduce drying time and improve quality, (4) develop time schedules, and (5) locate sources of trouble that affect kiln performance. All of these advantages add up to lower drying costs and more uniformly dried, stress-free material.

This chapter covers selection and preparation of kiln samples; the number of samples required in a kiln charge; determination of moisture content and ovendry weight of kiln samples; how to use samples during drying; how to make intermediate moisture determinations; final test procedures; and the recording and plotting of drying data.

Variability of Material

In order that full use be made of known drying techniques and equipment and that good drying be assured in the shortest time, each kiln charge should consist of material having about the same drying characteristics. In order to do this and to select representative kiln samples, the operator must consider certain variables in wood that affect drying: (1) Species; (2) thickness; (3) moisture content; (4) heartwood and sapwood; (5) grain (plainsawed or quartersawed); and (6) final moisture content.

Species

Woods of the many species that grow in this country have a wide range of physical properties (5).[1] Several physical properties influence the ease of drying; among them are specific gravity, shrinkage, moisture diffusion, and strength perpendicular to the grain. Such woods as basswood, yellow-poplar, and the pines are relatively easy to dry with few or no serious drying defects. Others, such as the oaks, black walnut, and redwood, are more likely to check, honeycomb, and collapse during kiln-drying. For this reason, dry only one species in a kiln at a time or, at most, a few that have similar drying characteristics.

Thickness

When lumber dries, the moisture evaporates from all surfaces, but principally from the broad faces. Thickness, therefore, is the most critical dimension. The thicker the stock, the longer the drying time and the more difficult the drying job. Lumber of different thicknesses cannot be dried in the same kiln charge without either prolonging the drying time or risking drying degrade.

Badly manufactured lumber needs to be watched for. Even nominal 1-inch-thick lumber may, if badly sawn, vary in thickness from ¾ to 1½ inches in the same board. The thinner parts will dry more rapidly than the thicker ones. Dress such lumber to a more uniform thickness or segregate it from well-cut material.

Moisture Content

The extent to which lumber has been dried before it is put in the kiln must also be considered, because moisture content governs the drying conditions that can be used. If all the free water has already been removed, more severe drying conditions can be used in the initial stages of kiln-drying with little or no danger of producing the usual drying defects (ch. 9). Further, a uniform initial moisture content makes drying to a uniform final moisture content much

[1] Italic numbers in parentheses refer to Literature Cited.

a/This is chapter 6 of a dry kiln operator's manual, published by the United States Department of Agriculture in Agricultural Handbook, no. 188

faster. If the boards vary considerably in initial moisture content, a longer equalizing time may be required at the end of the run.

Heartwood and Sapwood

Sapwood usually dries considerably faster than heartwood. Resins, tannins, oils, and other extractives retard the movement of moisture in the heartwood. Tyloses and other obstructions may be present in the pores of the heartwood of some species, notably white oak and the locusts. Sometimes it is practical to segregate the heartwood and sapwood boards. The green moisture content of sapwood is usually higher than that of heartwood, particularly in the softwoods. For these reasons, heartwood lumber may not reach the desired final moisture content as soon as sapwood, or vice versa. One or the other may therefore be overdried unless an equalizing treatment is used.

Grain

Quartersawed boards generally dry more slowly than plainsawed, but they are less susceptible to surface checking. Therefore, a more severe drying schedule can be used on quartersawed boards to reduce drying time. For this reason, in the drying of such items as vertical-grained flooring strips it is advantageous to segregate flat- from vertical-grained material.

Final Moisture Content

As a rule, two or more classes of material should not be put in the same kiln charge if they are to have different final moisture content values. If the stock to be dried to the highest final moisture content reaches that value at about the same time that the rest of the charge becomes adequately dried, no harm will result. If, however, this stock reaches the desired moisture content first, it must be removed from the kiln to prevent overdrying. Its removal leaves empty spaces in the kiln that can disrupt air circulation through the remainder of the charge, with resultant nonuniform drying and prolonged drying time.

Drying Mixed Charges

Ideally, segregation of lumber is based on all of the factors that affect drying rate and drying quality. Since this is frequently not possible or practical, a kiln operator must be guided in his selection of kiln samples primarily by the drying rate of the most critical, slowest drying material. That is, he must select the largest number of samples from the slowest drying material. Some samples of the fastest drying material are also needed, however, since these will determine the time when the equalizing treatment should be started (ch. 8).

Number of Kiln Samples

The number of kiln samples needed for any kiln charge depends upon the condition and drying characteristics of the wood being dried, the performance of the dry kiln, and the final use intended for the material.

Drying a Charge by a Prescribed Kiln Schedule

By far the most important purpose of kiln samples is to enable a kiln operator to dry a charge of lumber in accordance with a predetermined schedule. Such schedules generally call for changes in drying conditions that are based on the moisture content of the stock during various stages of drying.

Because of the many variables that affect drying results, the specific number of kiln samples required for each kiln charge must be determined through experience. A rule of thumb is to use at least four samples in charges of 20,000 board feet or less. For charges of 100,000 board feet or more, 10 to 12 kiln samples per charge are usually satisfactory. Use more samples, however, when (1) drying a charge of material composed of different species, thicknesses, moisture content levels, grain, or mixed heartwood and sapwood; (2) drying a kind of wood not previously handled; (3) drying costly special items, such as gunstock, bowling-pin, and shoe-last blanks; (4) obtaining drying data for use in modifying a drying schedule or in developing a time schedule; and (5) when the performance of the dry kiln is unknown or erratic.

Developing a Time-Temperature Schedule

At plants where certain items are regularly dried in sufficient quantity, the operator can utilize kiln samples to develop time-temperature schedules for subsequent charges of the same item dried to the same moisture content in the same kiln. This may involve extra sampling work to measure the full range of variables, but after sufficient information and experience have been obtained, kiln sampling can be dispensed with for future charges of the item. Obtain drying data on at least eight charges of the item before deciding on a time schedule.

Time schedules are generally used in the drying of softwoods. It is possible, however, to develop satisfactory time schedules for some of the more easily dried hardwoods. Some samples should, of course, be used occasionally to check the performance of the kiln and the final moisture

content of the stock. Some operators using time schedules for drying softwoods employ kiln samples to determine when to equalize, condition, and shut off the kiln.

Checking Kiln Performance

Studies of kiln performance show that dry-bulb temperature and rate of air circulation throughout a kiln may vary considerably and affect the time and quality of drying (*2*). Variations in temperature and circulation can be determined with testing equipment (pages 57–62) (*1*). If such equipment is not available to the operator, kiln samples can be used to check kiln performance. Cut all samples for this purpose from the same board or from boards having much the same drying characteristics. Place them near the top and bottom and on both sides of each load, at intervals of 10 to 16 feet along the length of the kiln.

Kiln samples that dry slowly indicate zones of low temperature or low air circulation, and those that dry rapidly indicate zones of high temperature or high rates of air circulation. If the drying rates of the samples vary greatly, find and correct the causes (*4*). Differences in drying rates between the samples on the entering- and leaving-air sides of the loads will assist the operator in determining how often to reverse the airflow. The greater the difference in drying rate between the entering- and leaving-air samples, the more frequently should the direction of air circulation be reversed.

Selection of Kiln Samples

Boards from which kiln samples are to be cut should be selected while the lumber is being stacked for drying. This can be done by a trained stackerman. The operator cuts kiln samples from those boards most representative of the heavier, wetter, and thicker stock of the charge and containing a comparatively high percentage of heartwood. Usually one kiln sample is cut from each sample board to assure a representative group of kiln samples (fig. 93). In random-width material, kiln samples are cut from boards about 7 to 9 inches wide.

Some kiln samples are also cut from boards that represent the drier and faster drying stock. Such boards will generally be flatsawed, narrow, or scant in thickness, will contain a high percentage of sapwood, or be drier than the rest at the time the lumber is stacked for kiln drying. These kiln samples are used during the final stages of drying (ch. 8).

For studies of kiln performance, two or more matched samples are cut from the same board (fig. 93).

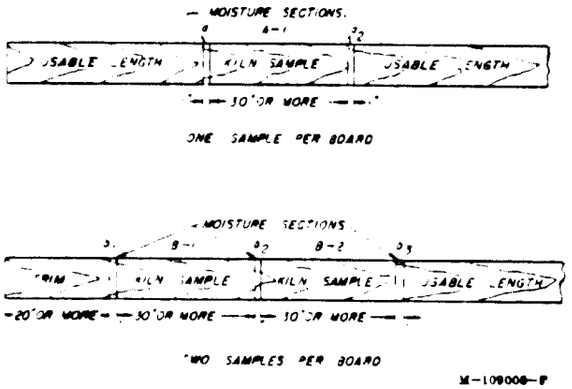


FIGURE 93.—Method of cutting and numbering kiln samples and moisture content sections.

Preparation of Kiln Samples

Knots, bark, pitch, and even a small amount of decay should preferably not be included in the parts of boards cut for kiln samples, except when drying lumber of common grades. The moisture sections that are cut from each end of a kiln sample (fig. 93) must be of clear, sound wood. Completely remove any bark present on the moisture sections and kiln sample before they are weighed. The bark interferes with moisture content determinations and the rate of drying of the kiln samples.

Cutting the Moisture Sections and Kiln Samples

Mark the moisture sections and kiln samples for identification, as shown in figure 93, before they are cut. Usable lengths of lumber can be salvaged from each end of the board when the moisture sections and kiln samples are cut. If no usable lengths would be left, cut the moisture sections and kiln samples about 20 inches or more back from the ends of the boards to eliminate the effects of end drying.

With certain exceptions, moisture sections are cut not less than 1 inch along the grain and across the full width of the board. It may be necessary to cut moisture sections less than 1 inch along the grain, particularly for obtaining quick moisture determinations and when using a self-calculating moisture content scale. To minimize errors, take extra precautions in cutting, handling, and weighing these thinner sections. In dimension stock 1 inch square or less in cross section, moisture sections are cut 2 inches or more in length along the grain. Cut the moisture sections on a sharp, cool-running saw and weigh them immediately. If it is necessary to cut a number of sections at a time before weighing

them, wrap each one separately in aluminum foil to prevent drying.

Keeping saw, scales, and oven close together in a well-lighted, draft-free area is helpful in obtaining accurate moisture content determinations. If the sample boards must be cut some distance from the scale, cut long pieces from the boards and take them to the weighing area, where the moisture sections and kiln samples can be cut from them with a bandsaw. In such cases, trim and discard a section at least 1 inch long from one end of each piece.

Determining Moisture Content and Ovendry Weight of Samples

The moisture content of a kiln sample is determined from the moisture sections cut from each end of the kiln sample. The average moisture content of these two sections and the weight of the kiln sample at the time of cutting are used to calculate the ovendry weight of the kiln sample. This calculated ovendry weight and the subsequent weights of the kiln sample obtained at intervals during the drying—called current weights—are used to compute the moisture content at those times.

Weighing Moisture Sections.—After the moisture sections are cut, rapidly remove all bark, loose splinters, and sawdust adhering to them, and weigh them immediately. Weigh each section to ½ of 1 percent of its weight; it is necessary to use a scale capable of weighing within this degree of precision. Obtain the weights in grams, instead of grains or ounces, so that calculations will be simplified by using the decimal system. A triple-beam balance (fig. 38, p. 49) is a convenient type to use for weighing moisture sections. Other types of balances are illustrated in figures 39 and 40.

To remain accurate, the knife-edge bearing surfaces of a triple-beam balance must be kept free of dirt, oil, grease, and corrosion. Protect the scale with a dustproof cover when it is not in use, and check its accuracy and sensitivity at least once a year against standard weights. The scale should be balanced on zero before each series of weighings.

To save weighing and calculating time, the two moisture sections cut from each kiln sample can be weighed together. This, however, does not give the difference in moisture content usually present between the two moisture sections. After weighing them, mark the weight on each section and, when weighings are completed, enter the weight on tabulation paper or a data form drawn for the purpose.

Weighing Kiln Samples.—After the kiln samples are cut, remove all bark, loose splinters, and sawdust adhering to them and apply a good end coating. Many effective end coatings are available (*2*). They should be used as recommended by the manufacturer. Immediately after end coating, weigh the kiln samples on a scale or balance that is sensitive to 0.01 pound or approximately 5 grams, and that has a capacity of about 25 pounds (fig. 41, p. 52). The weights should be in either the metric system or in pounds and hundredths of a pound, but not in pounds and ounces. Mark the weight on the kiln sample and also record it on a data form.

Usually, the weight of the end coating can be disregarded. In drying some special items, however, it may have to be considered. When that is necessary, weigh the kiln sample before and after it is end coated, the difference being the weight of the coating. Record that weight and subtract it from all subsequent weights of sample obtained during drying.

Ovendrying Moisture Sections.—After weighing them, dry the moisture sections until moisture-free in an oven maintained at 214° to 221° F. (101° to 105° C.). This usually takes 24 to 48 hours. To test whether they are thoroughly dry, weigh a few sections, replace them in the oven for about 3 or 4 hours, and reweigh them. If they have lost no weight, the entire group of sections can be assumed to be moisture-free. Electric ovens suitable for ovendrying are illustrated in figures 45 and 46, pages 55 and 56.

Open-pile the moisture sections in the oven to permit air to circulate around each (fig. 45). Avoid excessively high temperatures or prolonged drying, because they cause destructive distillation and oxidation of the wood. Never place newly cut moisture sections in the oven with sections already partly dry; the drier sections would temporarily absorb moisture from the newly cut sections, and this would prolong the drying time. Newly cut moisture sections, once weighed, need not be put in the drying oven immediately. Kiln operators short on drying-oven capacity frequently place them on radiators until oven space is available. This reduces ovendrying time.

Weighing Ovendry Moisture Sections.—It is essential that moisture sections be rapidly weighed immediately after they are removed from the oven. Weighing is done as described for freshly cut moisture sections.

Calculating Moisture Content of Sections.—Moisture content of the moisture sections is calculated by dividing the weight of the water removed by the ovendry weight of the section and multiplying the quotient by 100. Since the weight of the water equals the original weight of the section minus its ovendry weight, the formula for this calculation is:

$$\text{Moisture content in percent} = \frac{\text{original weight} - \text{ovendry weight}}{\text{ovendry weight}} \times 100 \quad (1)$$

Example: Calculate the average moisture content of two moisture sections (fig. 93, top) when:

Green weight of moisture section a_1 = 98.55 grams

Ovendry weight of moisture section a_1 = 59.20 grams

Green weight of moisture section a_2 = 86.92 grams

Ovendry weight of moisture section a_2 = 55.02 grams

Wanted: The average moisture content of moisture sections a_1 and a_2.

Two methods of calculating average moisture content in percent can be used.

Method 1

Moisture content of section a_1 =

$$\frac{98.55-59.20}{59.20}\times 100 = 66.5 \text{ percent}$$

Moisture content of section a_2 =

$$\frac{86.92-55.02}{55.02}\times 100 = 58.0 \text{ percent}$$

The average moisture content of moisture sections a_1 and a_2 is:

$$\frac{66.5+58.0}{2} = 62.2 \text{ percent}$$

Method 2

If the sections are weighed together, the combined green weight of sections a_1 and a_2 is 185.47 grams and their combined ovendry weight is 114.22 grams. Then:

Average moisture content =

$$\frac{185.47-114.22}{114.22}\times 100 = 62.4 \text{ percent}$$

While the average moisture content of moisture sections a_1 and a_2 calculated by method 2 results in a slightly higher value than that obtained by method 1, the calculated ovendry weight of the kiln sample using either method will be the same when corrected to the nearest 0.01 pound.

It is sometimes convenient, when making slide-rule or machine calculations, to use a shortcut method of calculating moisture content by the formula:

$$\text{Moisture content} = \left(\frac{\text{original weight}}{\text{ovendry weight}} - 1\right)\times 100$$

Substituting the weights for moisture section a_1 in this formula:

Moisture content in percent of section a_1 =

$$\left(\frac{98.55}{59.20} - 1\right)\times 100 = (1.6647 - 1)\times 100 = 66.5$$

Calculating Ovendry Weight of Kiln Sample.—The moisture content of a kiln sample at the time of cutting and weighing is assumed to be the same as the average of the moisture content values of the two moisture sections cut from each end of the sample. Knowing this value and the weight of the sample at the time the sections were cut, the ovendry weight of the kiln sample can be calculated by using the following formula:

$$\text{Ovendry weight of sample} = \frac{\text{Original weight of kiln sample}}{100 + \text{moisture content of sample in percent}}\times 100 \quad (2)$$

Example: Calculate the ovendry weight of kiln sample A-1 (fig. 93, top), the original weight of which is 4.46 pounds, using the average moisture content calculated for moisture sections a_1 and a_2, 62.2 percent:

Ovendry weight of sample =

$$\frac{4.46}{100+62.2}\times 100 = 0.02749\times 100 = 2.75 \text{ pounds}$$

Placing Samples in Kiln Charges

After kiln samples are cut, end coated, and weighed, they are placed in sample pockets built into the loads or packages of lumber during the stacking operation (fig. 94). Since the kiln sam-

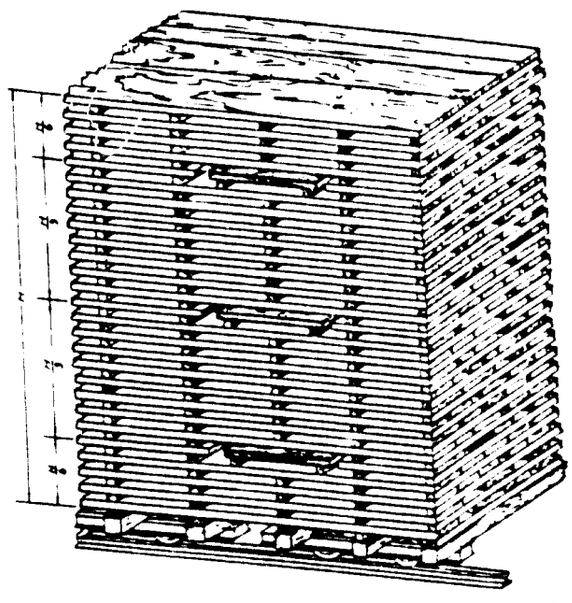


FIGURE 94.—Placement of three kiln samples in sample pockets built in the side of an end piled load of lumber. The pockets should be deep enough so that the kiln samples do not project beyond the edge of the load.

ples are representative of the stock being dried, they must at all times be exposed to the same drying conditions or they will give a false indication of the moisture content of the charge. For example, considerable moisture may be lost from kiln truckloads or packages of lumber that are not loaded into the kiln for several days or weeks after the samples are cut and weighed. The kiln samples representing this stock must be in the loads or packages during this period. Since kiln samples may dry faster than the lumber in the central parts of a load, it may be desirable to shield the sample pocket to slow up air circulation at that point.

Locate the sample pockets at places in the loads where the samples can be easily removed and replaced. In end-piled forced-circulation kilns the locating of sample pockets is relatively easy, because there is usually a walkway alongside the loads. In a double-track kiln, the pockets are placed in the sides of the loads nearest the walls. In natural-circulation kilns and most kilns of the external-blower type, however, the entering-air side of the loads is usually not accessible, and the kiln samples have to be placed on the leaving-air side.

In cross-piled dry kilns of both natural- and forced-circulation types, there is seldom sufficient room between the ends of the loads and the walls to allow the operator to walk into the kiln. Only the load nearest the door is accessible. Samples can be placed in the ends of this load, or in the side facing the door. These locations are not the most deseirable, but there is usually no other choice. In such kilns, the operator can get a good idea of how the dryness of the samples compares with that of the stock in other parts of the charge by making a thorough check of the final moisture content and quality of the kiln-dried stock. With this information he may, when drying future charges, be better able to judge from the moisture content of the samples when to change drying conditions or pull the charge.

If a mixed kiln charge is being dried, place the samples representing each type of material in the truckloads or packages containing that material. For example, if 4/4 and 6/4 pine lumber are being dried in the same charge, put the 4/4 samples with the 4/4 lumber and the 6/4 samples with the 6/4 lumber.

Some operators of unlighted kilns use small colored-glass reflectors or reflective tape on the edge of the sample or the edges of boards above or below the sample pocket. These reflectors are easily found with a flashlight. To guard against replacing samples in the wrong pocket after weighing them, put the number or letter of each sample on the edge of the board immediately above or below its pocket.

Using Kiln Samples During Drying

As drying progresses, the drying conditions in the kiln are changed on the basis of the moisture content of the samples at various times during the run. How frequently the samples must be weighed will depend on the rate of moisture loss; the more rapid the loss, the more frequently they must be weighed. Immediately after they are weighed, they must be returned to their pockets.

Calculating Current Moisture Content of Sample

To calculate the current moisture content of a sample, two weights are required; the current weight and the calculated ovendry weight. The formula used is as follows:

$$\text{Current moisture content} = \frac{\text{Current weight} - \text{calculated ovendry weight}}{\text{Calculated ovendry weight}} \times 100 \quad (3)$$

Thus, if the calculated ovendry weight of the sample is 2.75 pounds and its current weight 4.14 pounds, then:

$$\text{Current moisture content} = \frac{4.14 - 2.75}{2.75} \times 100 = 0.5054 \times 100 = 50.5 \text{ percent}$$

After another day of drying, this sample may weigh 3.85 pounds. The current moisture content of the sample will then be:

$$\frac{3.85 - 2.75}{2.75} \times 100 = 0.400 \times 100 = 40.0 \text{ percent}$$

If a slide rule or machine is used in calculating the current moisture content, the following short-cut formula can be used:

$$\text{Current moisture content} = \left(\frac{\text{Current weight}}{\text{Calculated ovendry weight}} - 1 \right) \times 100$$

Substituting the above values in this formula:

$$\left(\frac{3.85}{2.75} - 1 \right) \times 100 = (1.400 - 1) \times 100 = 0.400 \times 100 = 40.0 \text{ percent}$$

Use of Samples to Follow Kiln Schedules

Kiln schedules provide for changes in kiln conditions as drying progresses. If the Forest Products Laboratory schedules are used, it is recommended that drying conditions be changed when the average moisture content of the wettest 50 percent of the kiln samples equals a given moisture content in the schedule. Sometimes an

operator may change drying conditions according to the wettest one-third of the samples or the average moisture content of a smaller group of samples that may be distinctly wetter or more difficult to dry than the others. These are called the controlling samples. The moisture content of the driest sample determines when equalizing of the kiln charge should be started.

Intermediate Moisture Content Tests

If the moisture content of the moisture sections does not truly represent that of the kiln sample, the calculated ovendry weight of the kiln sample will be wrong. This may mislead the operator into changing kiln conditions at the wrong time, with such serious consequences as prolonged drying time, excessive amounts of drying defects, or nonuniformly dried stock. For example, if water pockets are present in the moisture sections but not in the sample, the calculated ovendry weight of the sample will be too low and its current moisture content too high. Conversely, if water pockets are present in the sample and not in the moisture sections, the calculated ovendry weight of the sample will be too high and its current moisture content too low. These potential ill effects may be avoided by making intermediate moisture content determinations.

When To Make Intermediate Tests

When the calculated moisture content of one or a few kiln samples is much higher than that of the other samples, or if their rate of drying appears to be much slower than the average rate, make a check moisture content test on those samples to obtain a better estimate of their calculated ovendry weight. The best time for making these intermediate determinations is when the average moisture content of most of the samples is at about 20 percent. The intermediate determinations can be made on all of the samples in the charge if the operator wants a precise estimate of the final moisture content.

How To Make Intermediate Tests

Trim a section about 5 inches long off one end of the kiln sample. Then cut a 1-inch-wide moisture section from the newly exposed end of the sample, weigh it immediately, and ovendry it. Coat the freshly cut end of the shortened sample and weigh it immediately. The new weight of the sample is the new "original" weight used in formula (2). After weighing the sample, place it in its pocket in the kiln charge. As soon as the moisture section has reached constant weight in the oven, weigh it and calculate its moisture content with formula (1). Substitute the new moisture content value, together with the new original weight of the sample, in formula (2) to obtain a new calculated ovendry weight. Use the new calculated ovendry weight in formula (3) to obtain the current moisture content of the sample in all subsequent weighings.

A moisture content test may be necessary near the end of the run to check the moisture content of the samples before starting equalizing and conditioning treatments.

Final Moisture Content and Stress Tests

After the lumber has been dried to the desired final moisture content, the drying stresses relieved by a conditioning treatment, and the charge pulled from the kiln, the final moisture content and stress tests can be made on the samples. Tests of boards selected at random from the charge can also be made.

Cut three 1-inch sections, several inches in from an end, from the samples and selected boards. Use one of these sections to determine the average moisture content by formula (1). Use the second section to determine the distribution of moisture in the section by cutting it into a core and shell (fig. 95). Weigh the core and shell separately; ovendry and reweigh them; and calculate their moisture content by formula (1). Use the third section for a stress test to deter-

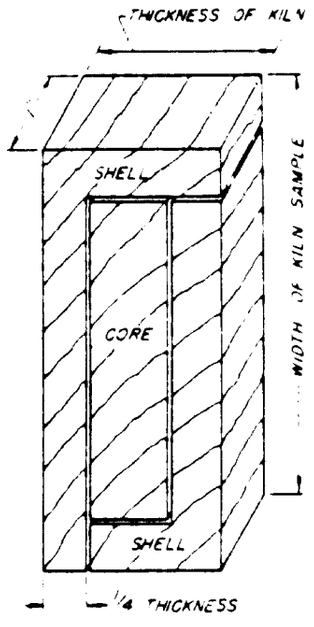


FIGURE 95.—Method of cutting section for determination of distribution of moisture in shell and core.

mine the effectiveness of the conditioning treatment in relieving casehardening (fig. 96).

Recording Drying Data

Properly recorded and evaluated kiln sample data assist the operator to (1) modify the drying schedule on subsequent charges to obtain faster drying without sacrificing quality; (2) develop time schedules for certain classes of material; (3) determine the effect of seasonal weather conditions on drying time; and (4) check the performance of the dry kiln and determine the causes for nonuniform drying and seasoning degrade.

The kinds of data to be recorded will vary with the drying job. On a test run in a new kiln, on a new class of material, or on a new or modified schedule more drying data are required than are ordinarily necessary. Likewise, the more precise the drying job, the more data needed.

The data can include such items as species, grade, origin of material, date of cutting, kind of grain (flat or quartered), percentage of sapwood, rings per inch, moisture content, thickness, date drying was started, the drying schedule used, drying time, drying defects, method and length of storage before and after drying, and shipping date.

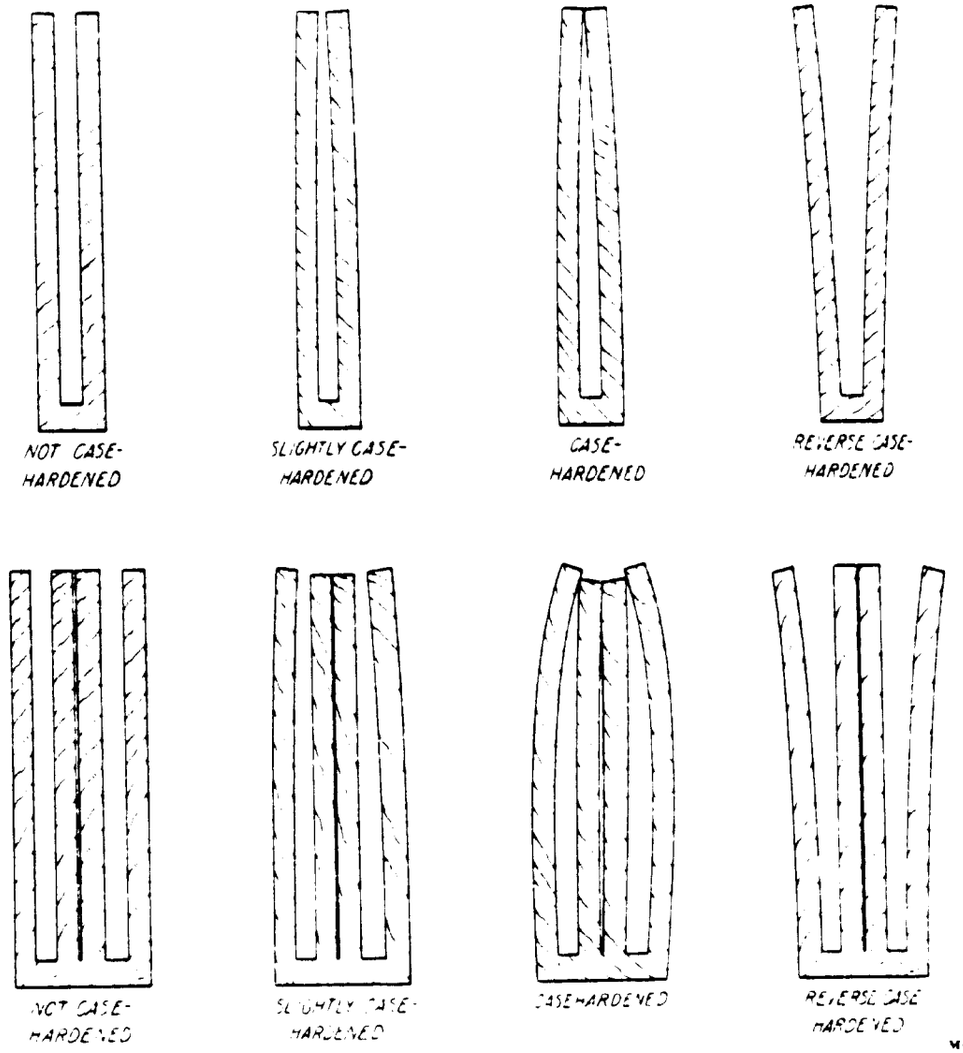


FIGURE 96.—Method of cutting specimens for casehardening tests. Material that is less than 1½ inches thick is cut into three prongs, and the middle prong is removed; material that is 1½ inches thick or thicker is cut into six prongs, and the second and fifth prongs are removed.

Kiln sample data should be recorded on suitable forms, such as those supplied by dry kiln manufacturers. Many kiln operators develop their own data forms, or modify available forms to fit their specific needs. Forms for recording drying data on 3 of 10 samples in an experimental charge of 4/4 soft maple are shown in figures 97, 98, and 99.

Preliminary kiln sample data should include moisture section and kiln sample numbers and other data shown in figure 97. Origin of material, grain, rings per inch, defects, and other data can be added if required.

Drying data obtained for each sample during the kiln run are entered on a kiln sample record form (fig. 98). Other data, including kiln number, board footage in the charge, species and thickness, and date drying was started, can be entered as required. Some of the data recorded on the kiln sample preliminary data form (fig. 97) can also be entered on the sample record form. Also recorded are the data covering the intermediate moisture determinations and the data for the moisture regained during the conditioning treatment. If a record of the weight of the end coating used on the kiln samples is required, it also would be entered on this form.

Moisture and Stress Data.—The data for the final moisture and stress determinations can be recorded on a form like the one shown in figure 99. The degree of casehardening present in the stock is noted in this form. Supplemental moisture data, such as those obtained with moisture meters, should also be recorded.

KILN SAMPLE

PRELIMINARY DATA FORM

Sheet No. 1

Species SOFT MAPLE Origin WISCONSIN

Grade MIXED Nominal thickness 4/4

Grain MIXED Date 10/30/51

Remarks: PARTIALLY AIR DRIED

Sample No.	Moisture content sections: Section No.	Green or initial weight	Ovendry weight	Moisture content	Kiln sample: Green or initial weight	Calculated ovendry weight	Rings per inch	Defects
		Gm.	Gm.	Percent	Lb.	Lb.		
1	1a and 1b	225.20	165.04	36.4	7.96	5.84	14	NONE
2	2a and 2b	195.34	147.41	32.5	6.95	5.24	18	SLIGHT CHECKING
3	3a and 3b	199.04	135.86	46.5	10.43	7.12	15	NONE

M-115515-F

FIGURE 97.—Data form filled in with preliminary data on 3 of 10 kiln samples representing a charge of 4/4 soft maple. The 2 moisture sections cut from each sample were weighed together.

KILN SAMPLE RECORD

Company FOREST PRODUCTS LABORATORY Species SOFT MAPLE Kiln No. 4

Charge Footage 1500 B.F. Material Size 4/4 Date Started 10/31/51 4PM

Sample No.		Moisture sections Wt.	Moisture sections O.D. Wt.	Green wt. of sample	Calc. O.D. wt.	End coat corr. wt.	End coat correction weight subtracted from daily weights							Remarks
							Date:	10/31	11/1	11/2	11/3	11/4	11/5	11/6	
							Hour:	4P	1P	9A	9A	9A	4P	2P	
							Total hours:	0	21	41	65	89	120	142	
		Gm.	Gm.												
1	Wt.	225.20	165.04	7.96	5.84	—		7.96	7.55	7.44	7.30	7.08	6.72	6.41	MADE INTERMEDIATE MOISTURE TESTS AT 2PM - 11/6
	M.C.	36.4						36.4	29.3	27.4	25.0	21.2	15.1	9.8	
2	Wt.	195.34	147.41	6.95	5.24	—		6.95	6.90	6.83	6.72	6.51	6.13	5.80	
	M.C.	32.5						32.5	31.7	30.3	28.2	24.2	17.0	10.7	
3	Wt.	199.04	135.86	10.43	7.12	—		10.43	9.74	9.40	9.05	8.71	8.22	7.82	
	M.C.	46.5						46.5	36.8	32.0	27.1	22.3	15.4	9.8	
	Wt.														
	M.C.	AFTER INTERMEDIATE					DATE	11/6	11/7	11/8		11/9			
	Wt.	MOISTURE TESTS					HOUR	2P	2P	2P	STARTED CONDITIONING 11/8 - 1P	3P			
	M.C.						TOTAL HOURS	142	166	190		215			
1	Wt.	84.67	77.29	4.78	4.37	—		4.78	4.69	4.64		4.79			KILN SHUT OFF 11/9 - 3P
	M.C.	9.5						9.5	7.3	6.2		9.6			
2	Wt.	79.54	72.30	4.30	3.91	—		4.30	4.21	4.17		4.30			
	M.C.	10.0						10.0	7.7	6.6		10.0			
3	Wt.	101.90	92.78	5.78	5.26	—		5.78	5.68	5.63		5.80			
	M.C.	9.8						9.8	8.0	7.0		10.3			
	Wt.														
	M.C.														

M 115536 F

FIGURE 98 -Form used for recording kiln sample data in a dry kiln run of ¼ air-dried soft maple. Data for 3 of 10 kiln samples are shown.

MOISTURE AND STRESS RECORD

Kiln No. 4 Run started 10/31/51

Date 11/9/51 After conditioning

Sample No.	Shell Wt.	Shell O.D. wt.	Shell M.C.	Core Wt.	Core O.D. wt.	Core M.C.	Average Wt.	Average O.D. wt.	Average M.C.	Casehardening
	Gm.	Gm.	%	Gm.	Gm.	%	Gm.	Gm.	%	
1	35.80	32.81	9.1	36.55	33.60	8.8	75.19	68.74	9.4	NONE
2	38.59	35.77	7.9	29.57	27.35	8.1	75.37	69.85	7.9	SLIGHT
3	43.70	40.70	7.4	44.81	41.59	7.7	104.16	96.70	7.7	NONE

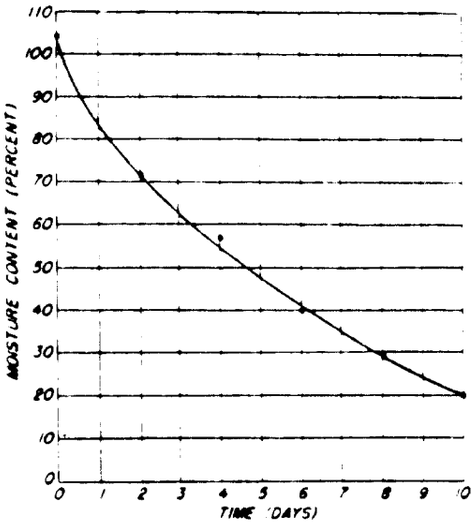
M-115834-F

FIGURE 99.—Form for recording final moisture content and stress data for three kiln samples.

Plotting of Data

Plots of drying data show at a glance the time required to reach a certain moisture content. A plot of the average moisture content of the controlling samples in a kiln charge of 2-inch black tupelo is shown in figure 100. The curve shows the moisture loss to be fast and steady. Curves plotted from data obtained from each sample are useful for checking kiln performance and the reliability of the moisture content values of the samples. For example, if the moisture loss data on samples in the same zones in a kiln consistently indicate, on several charges, a slower or faster drying rate than the other samples in the charge, it is evidence of a cold or a hot zone in that location. The source of trouble can usually be found and corrected. On the other hand, if it is known, or an investigation shows, that the cause is not associated with a cold or hot zone in the kiln, it can be suspected that the calculated ovendry weight of this sample is inaccurate and an intermediate moisture content determination is needed.

Drying data obtained for an experimental kiln charge of green 4/4 northern red oak are plotted in figure 101. The drying conditions during the run are plotted, along with the moisture loss of the controlling samples and the driest and wettest samples. The effect of changes in drying conditions on the rate of moisture loss from the samples is apparent. Also shown is the effect of the equalizing and conditioning treatments in reducing the difference in average moisture con-



M-109007-F

FIGURE 100.—Moisture content-time curve for 2-inch black tupelo, showing a fast, steady loss of moisture.

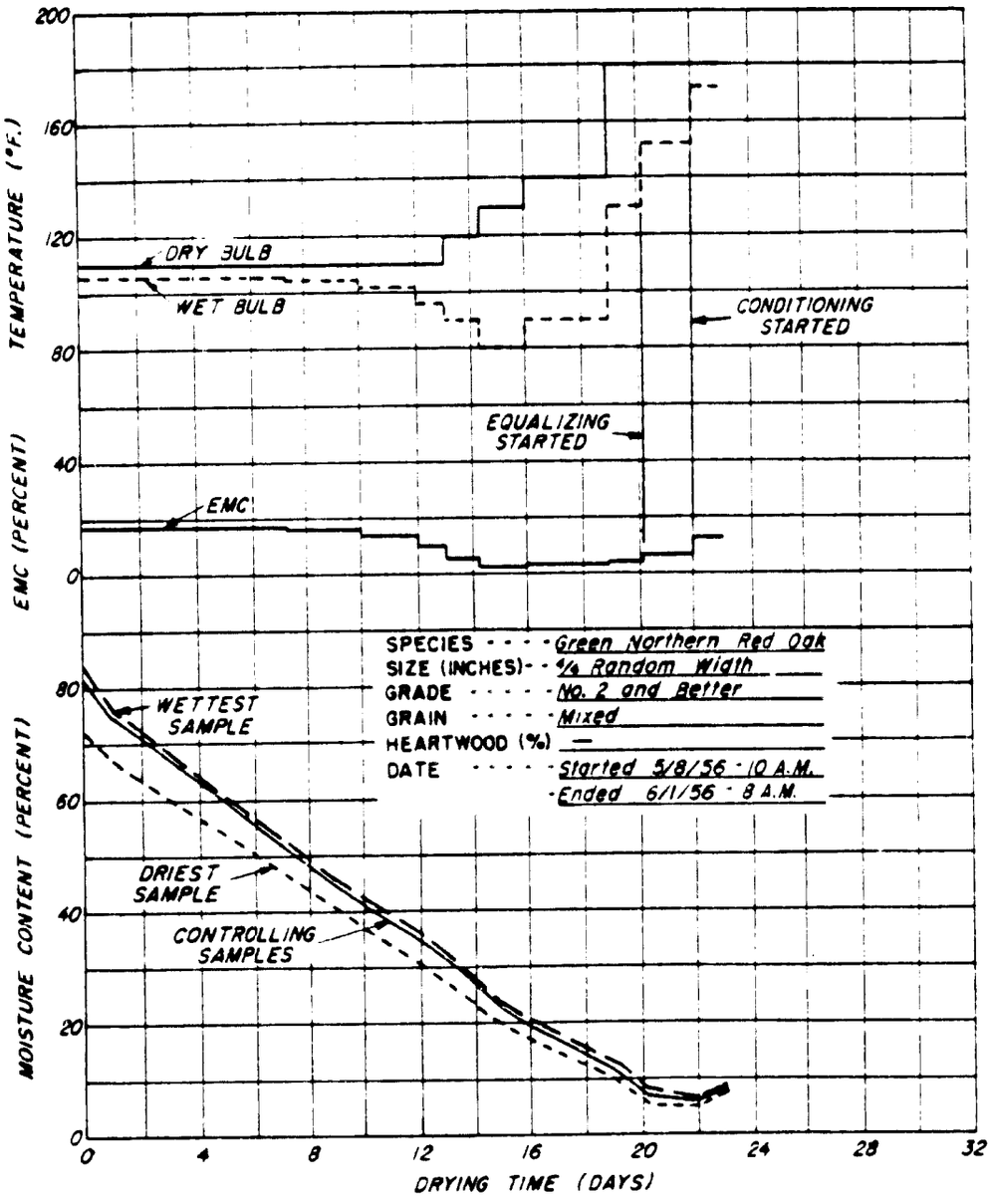


FIGURE 101.—Chart showing kiln-drying schedule and moisture content at various times during drying of 4/4 northern red oak.

tent between the driest and wettest samples in the kiln charge.

Literature Cited

(1) KIMBALL, K. E.
1955. TESTING COMMERCIAL KILNS FOR UNIFORMITY OF DRYING CONDITIONS. U.S. Forest Serv. Forest Prod. Lab. Rpt. 1643, 9 pp., illus. [Processed.]

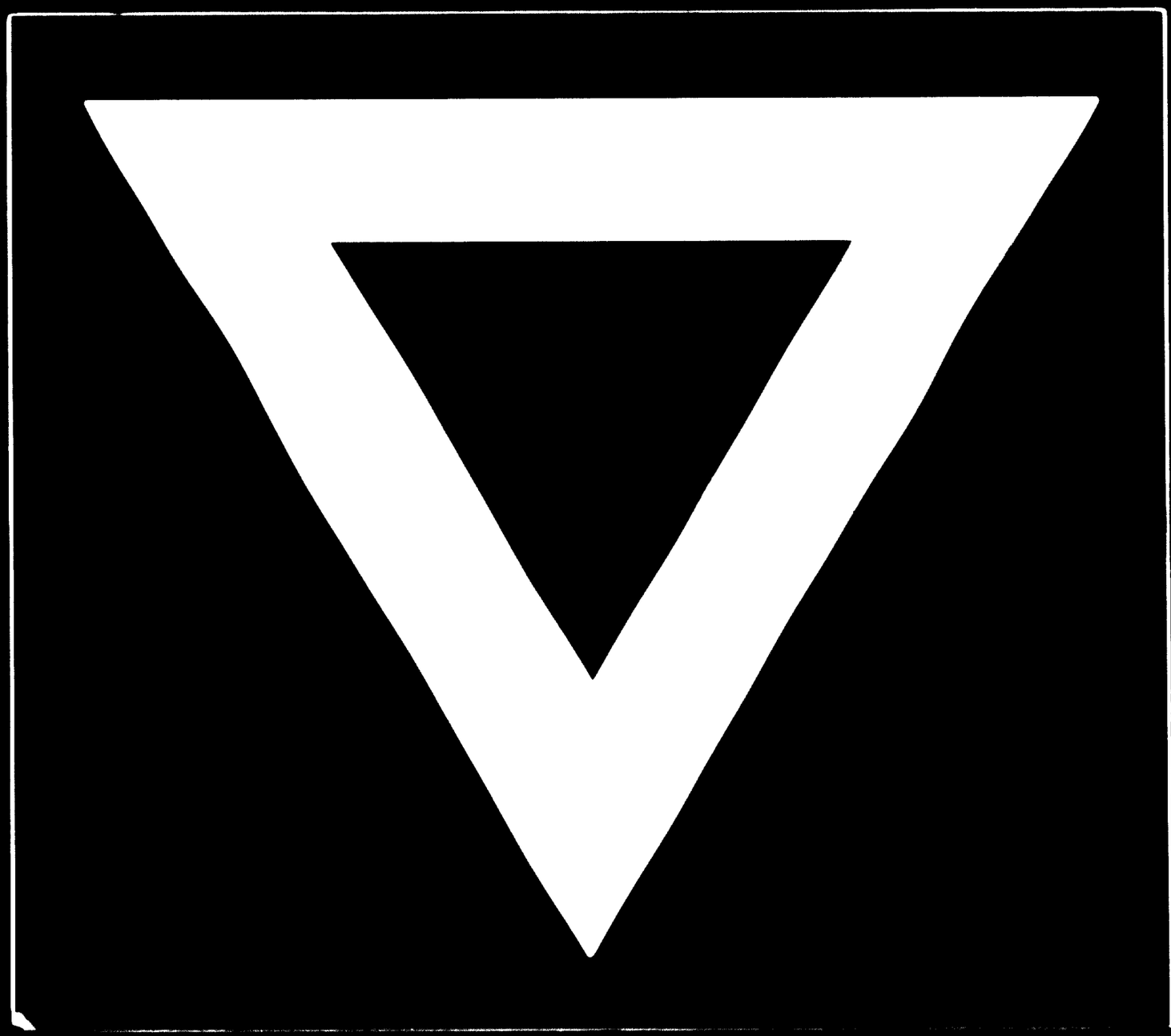
(2) MCMILLEN, J. M.
1956. COATINGS FOR THE PREVENTION OF END CHECKS IN LOGS AND LUMBER. U.S. Forest Serv. Forest Prod. Lab. Rpt. 1435, 13 pp., illus. [Processed.]

(3) RASMUSSEN, E. F.
1956. NEED FOR UNIFORMITY OF TEMPERATURE IN A FORCED-AIR-CIRCULATION, VENTILATED, COMPARTMENT DRY KILN. U.S. Forest Serv. Forest Prod. Lab. Rpt. 1669, 6 pp. [Processed.]

(4) ———
1955. ANALYSIS OF PROBLEMS RELATING TO UNIFORMITY OF KILN CONTROL. U.S. Forest Serv. Forest Prod. Lab. Rpt. 1645, 9 pp., illus. [Processed.]

(5) U.S. Forest Service Forest Products Laboratory.
1955. WOOD HANDBOOK. U.S. Dept. Agr. Handbook 72, 528 pp., illus.

B-363



80.12.01