

KILN DRYING OF ENGELMANN SPRUCE¹

By

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-----Sorting for Kiln Drying

To make best use of available dry-kiln equipment, the lumber should be sorted for drying classifications prior to piling. These seasoning classifications for segregation are (1) thickness, (2) sap and heart, and (3) Common and Select grades.

Since thick lumber, such as 2-inch dimension, requires a longer drying time in the kiln than 1-inch boards, these different thicknesses should be separated for kiln drying. This is a common practice in the softwood industry and should be applied to Engelmann spruce as well as to ponderosa pine, fir, and larch.

The purpose of separating sap and heart boards is to take advantage of the shorter time required to kiln-dry the heart stock. This is usually done in kiln drying ponderosa pine and, if at all practical, should be done with Engelmann spruce as well. The segregation of the sap boards into a special drying classification, distinctly different than that of the heart boards, is in reality a moisture content separation; and where lumber from bug-killed and nearly dry trees is mixed with lumber from live trees, the sap and heart separation may cause some trouble. The sapwood moisture content of lumber from killed and dried trees is probably more nearly that of the lumber from the heartwood of green trees and should be kiln dried with the heartwood. It is suggested, then, that separation of Engelmann spruce lumber from intermixed, killed, and live trees be based on moisture content estimates by using electric moisture meters or other means to make the separation. Partially dried sapwood lumber may merit segregation if the volume is great enough. Otherwise, the segregation generally recommended is (1) green and partially dried sapwood in one group and (2) dried sapwood and heartwood in another group.

¹-Original report dated September 1953.

²-Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Common and Select grades of lumber are separated in ponderosa pine, because usually a more severe drying schedule can be used on the Select grades so as to reduce kiln-drying time. Another reason for this separation is that the Select grades are often kiln dried to a lower moisture content than are the Common grades of lumber. A similar separation should be made for Engelmann spruce if the volume of Select grades warrants the segregation before kiln drying.

Piling for Kiln Drying

Softwood lumber is piled for kiln drying on kiln trucks, into unit packages for loading on kiln trucks, or for placement directly in a package loaded trackless lumber dry kiln. Whether the stock is piled on kiln trucks or into unit packages, a separation for lengths prior to piling is desirable. This is usually done at the time that the sort is made for thickness, moisture content, and grades. Softwoods are sawn to specific widths, which are often separated prior to kiln drying, as well as for length (fig. 1).

If it is impractical to separate lengths for piling, often called sorted-length piling, box piling of mixed lengths should be used (fig. 2). Instead of piling all lengths together, however, it is desirable to segregate the 8-, 14-, and 16-foot lengths into one group and the 6-, 10-, and 12-foot lengths into another group for piling. In box piling these mixed lengths, one or two extra tiers of stickers are needed to support properly the 14-foot boards in one case and the 10-foot boards in the other. Perhaps the most practical procedure is to use one extra tier of stickers to support the ends of the 14-foot boards, making one end of the load square, with the other end tending to be somewhat ragged. The objection to this method of piling, however, is the possibility of inadequate support at the ragged end, resulting in excessive sticker breakage and warped boards. True box piling, or a staggering of the shorter boards, with two extra tiers of stickers to give good support to both ends of the shorter boards, is the more desirable piling method for both kiln truckloads and unit packages.

In sorted-length piling, where the 16-foot stock is piled separately, 14-foot stock is piled separately, and so on, five tiers of stickers are recommended for the 14- and 16-foot boards, four stickers for the 10- and 12-foot boards, and three tiers of stickers for the 8-foot boards.

If the lumber in unit packages is air dried prior to kiln drying, the lengths of the unit packages and the number and spacing of the stickers will need to be adjusted to meet the requirements of both drying processes.

The recommended sticker size is 1 by 2 inches, with the strips dressed to produce a uniform width and thickness. The species used for stickers will depend upon available lumber of a grade that will produce a maximum number

of stickers at the least cost. The sticker should be made from dry lumber, and, if cut from lower grades, considerable breakage should be expected after the first few trips through the dry kiln.

Sticker guides are recommended for both kiln-truck and unit-package piling. The guides assure good alinement of the stickers in the tiers, which is essential if maximum warp control is to be obtained. Sometimes sticker guides are used on one side of the load only, and improved piling is obtained over loads built without guides (figs. 3, 4, and 5). With guides on both sides of the pile, however, the need for piling skill to obtain good sticker alinement is not so great.

Where kiln loads are built upon kiln trucks, the bunks between the first layer of lumber and the kiln truck should be of a uniform size to provide a flat platform. Otherwise, warped lumber may be produced. The assembly of the trucks and bunks should be so arranged that a bunk support is beneath each tier of stickers (fig. 6).

In placing unit packages on kiln trucks, the truck bunks again should be so arranged as to give support under each tier of stickers. Bolsters should be placed between each pair of unit packages, at the sticker tiers; and good alinement of the packages, one above the other, is necessary to get good support from top to bottom (figs. 7, 8, and 9).

Both loads on kiln trucks and unit packages should be edge to edge piled when the stock is to be kiln dried in internal-fan forced-air-circulation kilns. The unit packages should be placed on the kiln trucks with at least 4 inches between the packages. This is done to provide assurance that the circulation is not blocked when the layers are not at the same level. Most modern kiln installations of this type are designed for kiln loads two unit packages wide and three unit packages high.

If the stock is to be kiln dried in external-blower kilns that require an A-shaped flue to be built into the load, special piling guides are required for building up the kiln-truck load. Unit packages loaded on kiln trucks for kiln drying in these kilns must be separated at least 8 inches or more, and the space is capped to prevent air losses. It is also desirable to block the bolster spaces to prevent short circuiting of air.

Protection Prior to Kiln Drying

The lumber in kiln-truck loads that is waiting to be loaded into the kiln should be protected against too severe drying conditions. The outdoor relative humidity is frequently lower than that of the first step of the dry-kiln schedule, and this low relative humidity, especially when combined with exposure to direct sunshine, is likely to cause checking and splitting. Protection from sunshine, by a shed roof or by pile roofs, will decrease checking and splitting. Another scheme that is used by

some mills is to subject the truck loads of lumber to water sprays, operated continuously. By this method, the lumber is prevented from drying until it is placed in the kiln.

Kiln-Drying Schedules

In the kiln drying of Engelmann spruce, the schedules used should be moderate to prevent loss of knots in subsequent machining. This means using what might be termed a "low-temperature" schedule. As Engelmann spruce tends to end check, the relative humidity of the initial step should be high. With these requirements in mind, the kiln operator should adjust the actual kiln-drying schedule to fit the characteristics of the stock, to arrest drying at a moisture content level in accordance with its end use, or to reach a compromise between the moisture content requirement of the end use and that which produces good machining with a minimum of footage loss due to knot damage or roller splitting. The kiln operator should condition the stock to relieve stresses if resawing is planned.

Drying schedules that are recommended by the Forest Products Laboratory for Engelmann spruce in the upper grades are given in table 1. The schedules are based on moisture content changes requiring that the kiln operator use kiln samples until he has had sufficient experience to convert the schedules to what are called "time schedules." These schedules should enable the material to be dried with a minimum of damage to the low moisture content values required for paneling and other interior uses. Select grades dried by these schedules should be conditioned before pulling from the kiln to bring the very dry surfaces of the board back up to a moisture content slightly above the average moisture content desired. This conditioning process will also relieve case-hardening stresses. In drying a mixed charge of green sap, partially dried sap, and heart boards, it may be necessary to use an equalizing period prior to conditioning to prevent the overdrying of the heartwood boards. Equalizing periods are seldom used in the kiln drying of softwoods, but where the kiln charge is made up of sap and heart boards, with a considerable range in moisture content, the equalizing process may be necessary if uniformly dry lumber is to be produced.

A time schedule for kiln drying Select grades is given in table 2. This commercial schedule is being used in forced-air-circulation lumber dry kilns. Similar schedules are used by other kiln men.

Some commercial kiln-drying time schedules for 1-inch Common grade Engelmann spruce boards are given in table 3. They are characterized by the use of low dry-bulb temperatures, gradual wet-bulb depression changes, and moderate final wet-bulb depressions before conditioning, in order to prevent excessive damage to the knots in subsequent machining. In all cases, the schedules were used in forced-air-circulation lumber dry kilns

having good control of the dry- and wet-bulb temperatures. The moisture content of the kiln-dried stock varied from 12 to 18 percent moisture content.

At one plant where sap and heart boards were segregated, the schedule given in table 4 was used to hold the knots. The schedules given in table 4 are the basic ponderosa pine schedules used at that plant. The stock is kiln dried to a moisture content of 12 to 18 percent.

The kiln drying schedules used for 2-inch dimension at one commercial plant are given in table 5.

In summary, these commercial schedules generally indicate the following: (1) The initial dry-bulb temperatures seldom exceed 135° F. for sap and 140° F. for heart boards; (2) the initial wet-bulb depression for both the sap and the heart boards is about 10° F.; (3) the dry-bulb temperature is stepped up by 5° F. increments on a 12-hour basis, with the wet-bulb temperature kept at the starting value; (4) the dry-bulb temperature seldom exceeds 160° F., and, in most cases, the maximum temperature used on heart board is 155° F.; and (5) the moisture content of common grades of Engelmann spruce, when kiln dried by these commercial schedules, is from 12 to 18 percent.

Storage of Dried, Rough, and Dressed Lumber

Lumber that has been air or kiln dried to the desired moisture content should be protected from exposure to the weather. Stock that is expected to remain on the air-drying yard for some time should be roofed to minimize deterioration due to alternate wetting and drying. Rough-dried lumber, air or kiln dried, that has been solid piled should, if at all possible, be stored under cover to prevent losses due to excessive warp if the top layers are exposed to sun and rain, or due to stain if the piles are subjected to excessive wetting.

Dry, dressed lumber should likewise be protected in suitable sheds or by good pile covers if the stock must be stored in an open yard. If the protection is not adequate, an undesirable increase in moisture content and deterioration due to alternate wetting and drying are probable. At the larger softwood producing plants, sheds are usually provided for rough, dry stock and for dressed lumber. Similar protection should be given dried Engelmann spruce.

Table 1.--Forest Products Laboratory schedules for kiln drying Select grades of Engelmann spruce in forced-air-circulation dry kilns

1-inch lumber				2-inch lumber			
Moisture content at start of step				Moisture content at start of step			
Dry-bulb:Wet-bulb: Wet-bulb depression: temper-: ature : ature :				Dry-bulb:Wet-bulb: Wet-bulb depression: temper-: ature : ature :			
Percent	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Above 60	140	130	10	130	123		7
60	140	126	14	130	120		10
50	140	120	20	130	115		15
40	140	115	25	130	110		20
35	140	110	30	130	105		25
30	150	115	35	140	110		30
25	160	125	35	150	115		35
20	160	125	35	160	125		35
15	160	110	50	160	110		50
(1)							

¹Kiln charge is equalized and conditioned, if necessary, in accordance with instructions in Forest Products Laboratory Rept. No. 1652.

Table 2.--Time schedule for kiln drying Select grades of 1-inch Engelmann spruce. Commercial schedule used in forced-air-circulation dry kilns¹

Time in kiln	Kiln conditions			
	Dry-bulb:Wet-bulb:Wet-bulb depression:Relative humidity			
	temper-: temper-: : :			
	ature : ature : : :			
Hours	°F.	°F.	°F.	Percent
0-12	140	122	18	58
12-24	145	122	23	51
24-36	150	122	28	43
36-48	155	126	29	43
48-until dry	160	130	30	43

¹Schedule furnished by Palmer Knudson, J. Neils Lumber Co., Libby, Mont.

Table 3.--Time schedules for kiln drying Common grades of
1-inch Engelmann spruce. Commercial schedules
used in forced-air-circulation dry kilns

Time in kiln:		Kiln conditions						

		: Dry-bulb: Wet-bulb: Wet-bulb depression: Relative humidity						
		: temper-: temper-:						
		: ature : ature :						

<u>Hr.</u>	:	<u>°F.</u>	:	<u>°F.</u>	:	<u>°F.</u>	:	<u>Percent</u>
4/4 SAP BOARDS ¹								
0-12	:	140	:	125	:	15	:	64
12-24	:	145	:	125	:	20	:	55
24-36	:	150	:	125	:	25	:	48
36-48	:	155	:	130	:	25	:	50
48-72	:	160	:	130	:	30	:	43
72-78	:	160	:	153	:	7	:	83 (conditioning)
4/4 HEART BOARDS ¹								
0-12	:	135	:	125	:	10	:	74
12-24	:	140	:	125	:	15	:	64
24-36	:	145	:	130	:	15	:	65
36-44	:	150	:	130	:	20	:	57
44-48	:	150	:	145	:	5	:	87 (conditioning)
4/4 MIXED SAP AND HEART ²								
0-12	:	135	:	125	:	10	:	74
12-24	:	140	:	125	:	15	:	64
24-36	:	145	:	125	:	20	:	55
36-48	:	150	:	125	:	25	:	48
48-60	:	155	:	130	:	25	:	50
60-64	:	155	:	149	:	6	:	85 (conditioning)

¹Schedules furnished by Roland Lundblad, Pack River Lumber Co., Sandpoint, Idaho.

²Compromise schedule by Ruben Thompson, Northwest Timber Co., Coeur d'Alene, Idaho. Equalization prior to conditioning and longer time may be required to reduce sapwood moisture without overdrying heartwood boards.

Table 4.--Time schedules for kiln drying Common grades of 1-inch
Engelmann spruce. Commercial schedules used in
forced-air-circulation dry kilns to protect knots¹

Time in kiln:		Kiln conditions						

		:Dry-bulb:Wet-bulb:Wet-bulb depression:Relative humidity						
		: temper-: temper-: :						
		: ature : ature : :						

<u>Hr.</u>	:	<u>°F.</u>	:	<u>°F.</u>	:	<u>°F.</u>	:	<u>Percent</u>
4/4 SAP BOARDS								
0-12	:	130	:	114	:	16	:	60
12-24	:	135	:	114	:	21	:	52
24-until dry:	:	140	:	114	:	26	:	44
4/4 HEART BOARDS								
0-12	:	130	:	118	:	12	:	69
12-until dry:	:	135	:	118	:	17	:	59

¹Schedules furnished by Palmer Knudson, J. Neils Lumber Co., Libby,
Mont. The kiln charges are not conditioned.

Table 5.--Time schedules for kiln drying Common grades of 2-inch Engelmann spruce dimension. Commercial schedules used in forced-air-circulation dry kilns¹

Time in kiln:		Kiln conditions						

		Dry-bulb:	Wet-bulb:	Wet-bulb depression:	Relative humidity			
		temper-	temper-					
		ature	ature					

<u>Hr.</u>	:	<u>°F.</u>	:	<u>°F.</u>	:	<u>Percent</u>		
8/4 SAP DIMENSION								
0-12	:	140	:	125	:	15	:	64
12-24	:	150	:	125	:	25	:	46
24-72	:	160	:	135	:	25	:	50
72-76	:	160	:	160	:	0	:	100
² 76-108	:	160	:	130	:	30	:	43
8/4 HEART DIMENSION								
0-12	:	140	:	125	:	15	:	64
12-24	:	150	:	125	:	25	:	46
² 24-67	:	160	:	135	:	25	:	50

¹Schedules furnished by Clearwater Unit, Potlatch Forests, Inc., Lewiston, Idaho.

²Final drying conditions extended to obtain desired dryness. Stock is not conditioned.

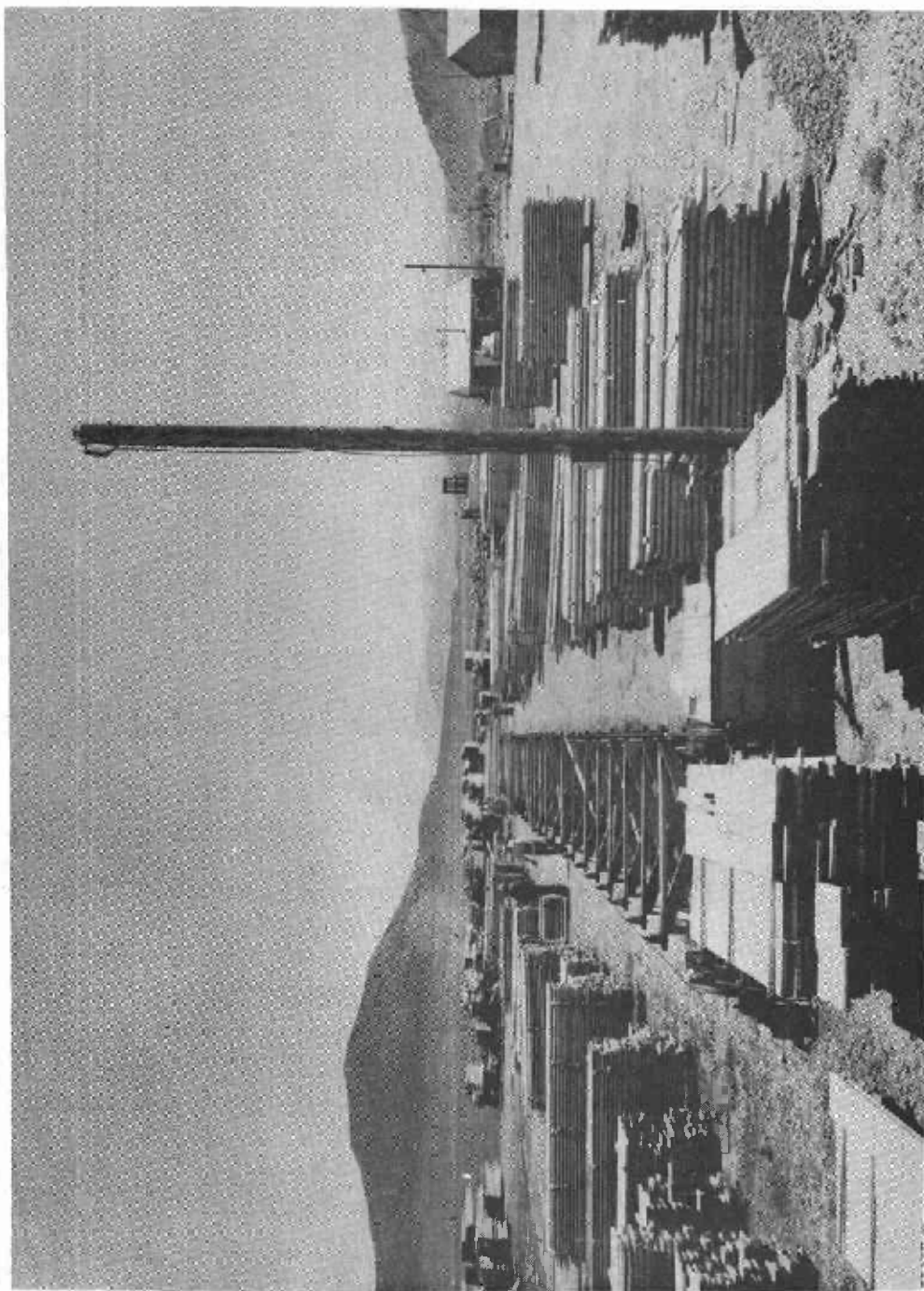


Figure 1. --Sorting table. Boards fed from truck onto cables at one end of table. Lumber sorted by species, thickness, width, moisture content, etc. Unit packages are built up beside sorter without sticker guides.

Z M 99298 F

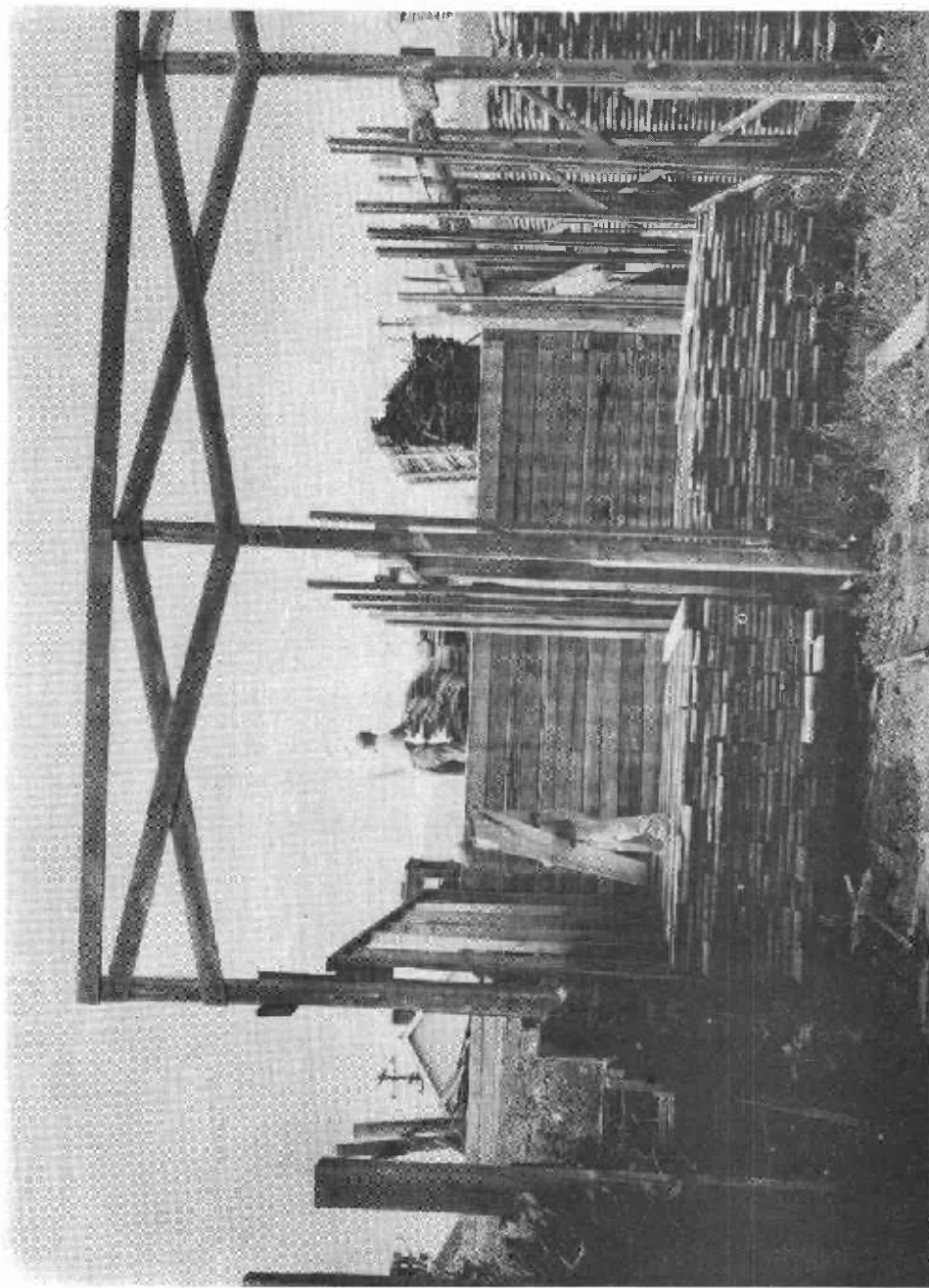


Figure 2. --Sorted length or box piling of kiln-truck loads in stalls with sticker guides on both sides of load. Stalls built into side wall to facilitate handling of lumber to stacker from dolly.

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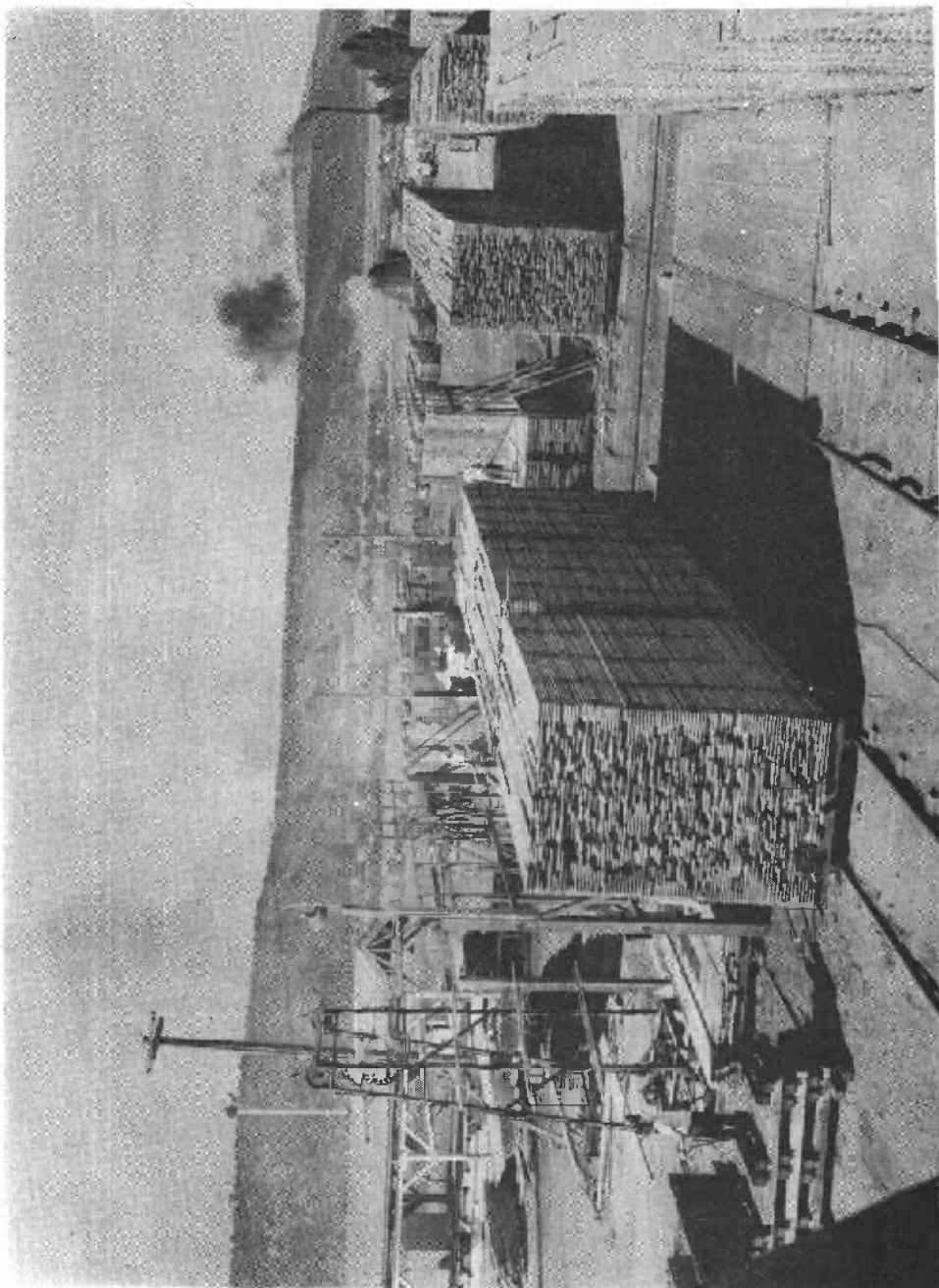


Figure 3. -- Kiln-truck loads box-piled using board lift. Sticker guide on one side, bumper on one end.

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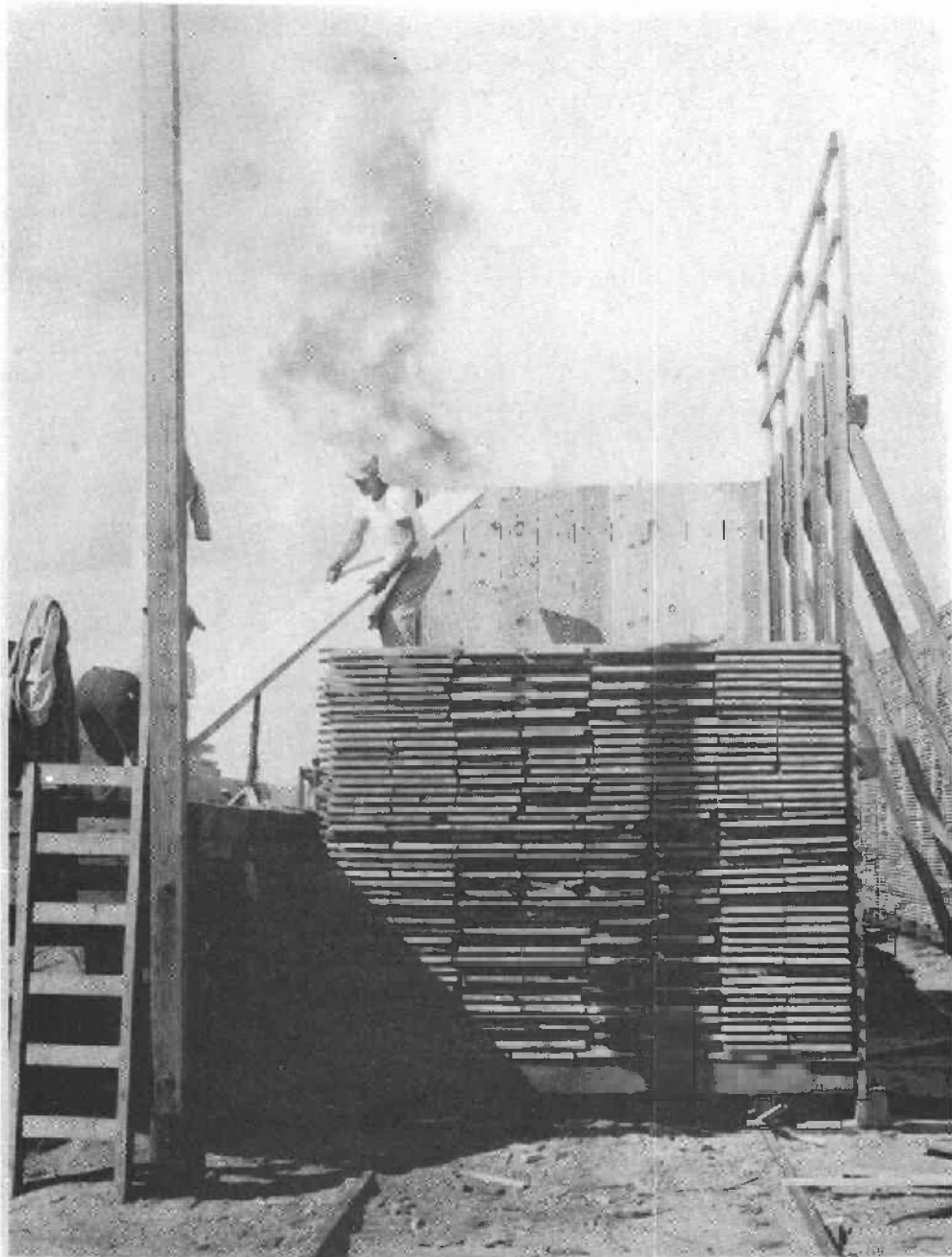


Figure 4. --Piling lumber from platform to kiln truck. Sticker guide on one side, bumper at one end.

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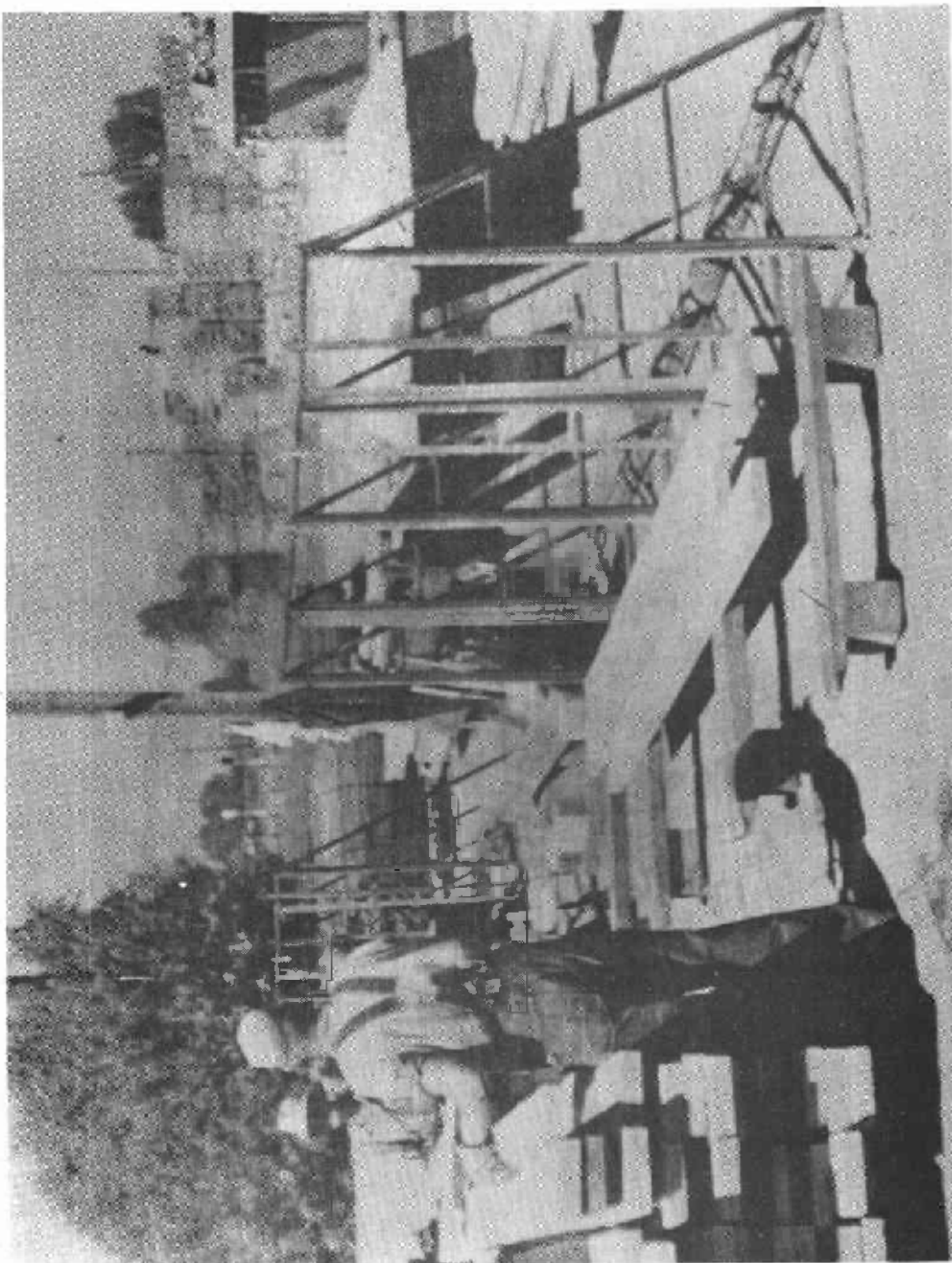


Figure 5. ---Portable sticker guide for building up unit packages.
Guide on one side only.

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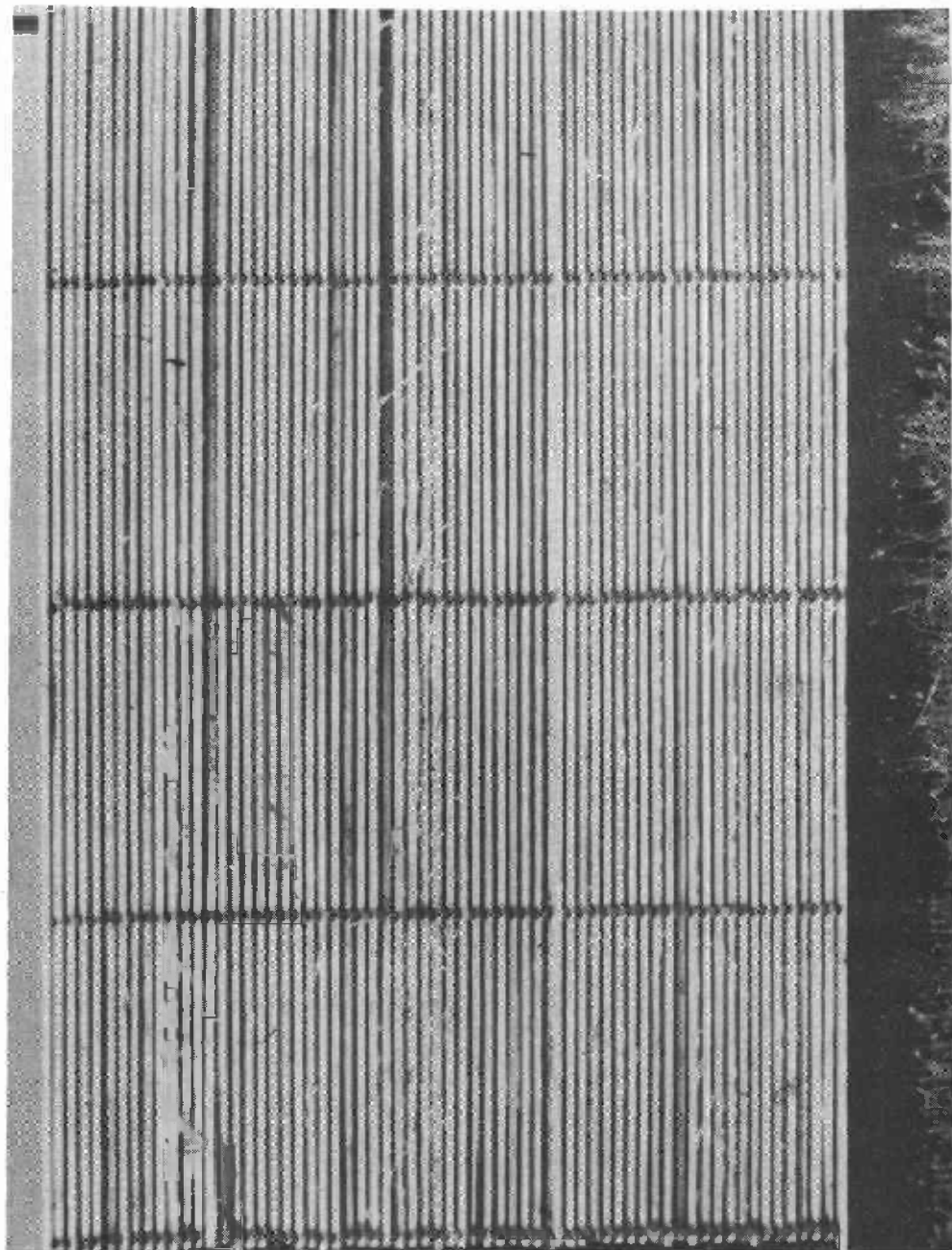


Figure 6. --Sorted-length piling on kiln trucks. Good sticker
alinement and support by bunks.

Z M 99303 F

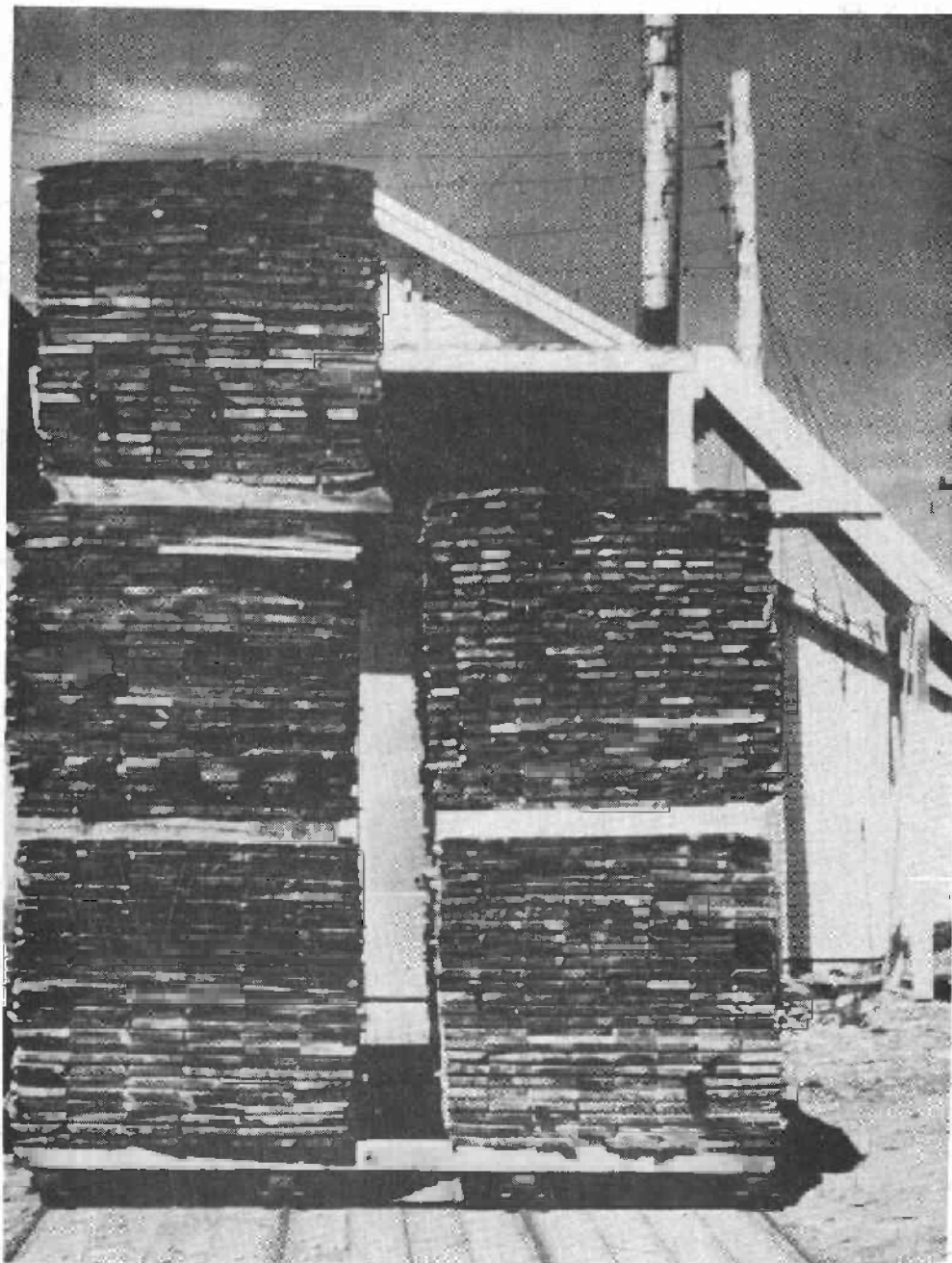


Figure 7. --Building up kiln-truck load with unit packages. Sorted-length unit-package piling with straps at ends to hold end sticks. Normal load two unit packages wide, three high.

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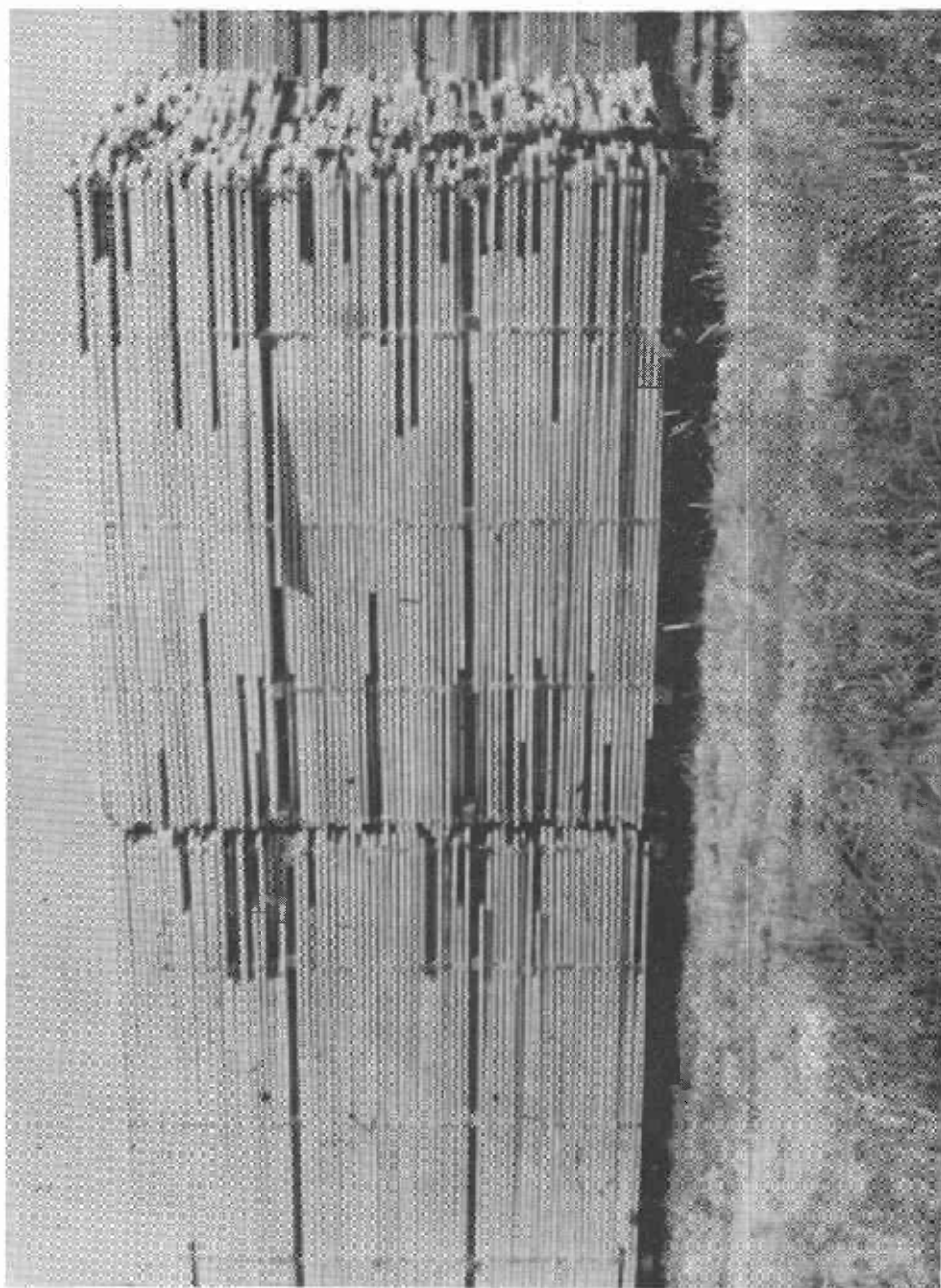


Figure 8. -- Kiln-truck loads built up from unit packages, two wide, three high.
Unit packages box-piled. Long boards should have been placed on outside.
Good sticker support by bunks and bolsters.

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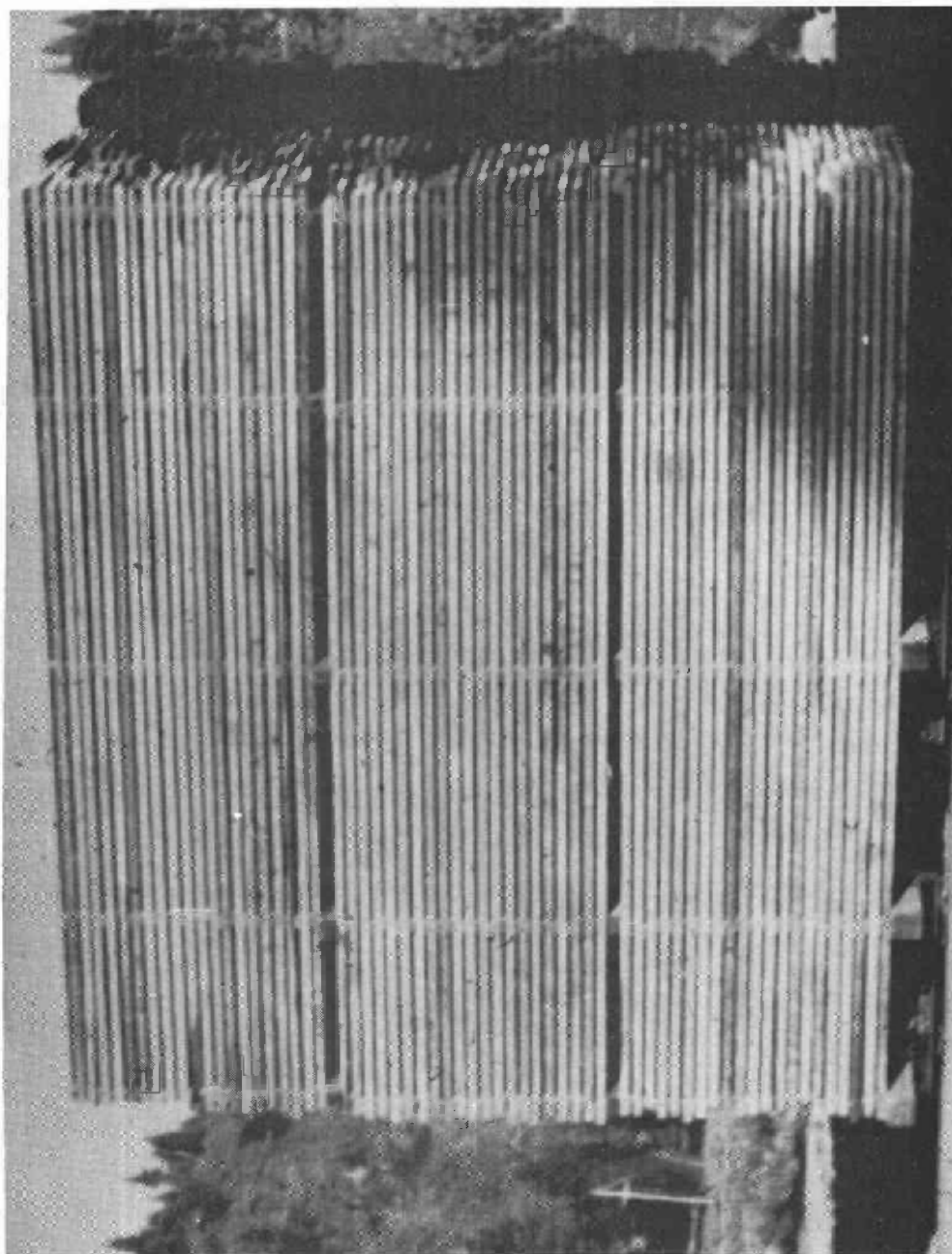


Figure 9. --Kiln-truck loads built up from unit packages, two wide, three high.
Unit packages sorted-length piled. Good sticker alinement and support by
bunks and bolsters.

Z M 99306 F

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