SOME DETAILS OF AN AFFAIR WITH SOUTH SEAS SPECIES

Robert W. Erickson
Technical Center
Weyerhaeuser Company
Longview, Washington

Introduction

On August 20, 1973 the M. S. Tauranga docked at the Port of Longview with a load of Indonesian hardwood logs. Four hundred and seventeen of these logs, representing nine species sorts, were processed into lumber. One of the sorts was identified as Malayan Light Hardwoods (MLH) and contained 20 individual species. Main objectives of the study were to determine lumber yields by species and log grade when sawing for domestic softwood clear end uses, and determining the ability to saw, dry and process this lumber in a West Coast Weyerhaeuser facility.

Some Vital Statistics

Green lumber volumes by species and log grades are summarized in Table 1.[1] Figure 1 shows an example of log grades, utilizing red meranti for this purpose.

Table 1. Green Lumber Volumes by Species and Log Grade.

Species - Common Name	Log Grade	Lumber Volume Bd. Ft.	Lumber Thickness Widths & Lengths
Red Meranti	1st	33,800	
	2nds	99,141	4/4 by 4" to 12"
	3rds	31,624	
White Meranti	2nds	30,970	6' to 20'
	3rds, locals	31,497	
Yellow Meranti	1st, 2nd, 3rd, locals	11,652	
Kapur[1]	2nds, 3rds	15,612	8/4 by 6" and 8"
	locals	15,871	8' to 20'
Keruing[1]	2nds	28,310	6/4 by 6" and 8"
	3rds, locals	6,355	8' to 20'
MLH	2nds	27,280	4/4 by 6" to 12" 6' to 20'
	3rds	13,818	5/4 by 10" and 12" 6' to 20'
Nyatoh	2nds, 3rds	4,154	4/4 by 6" to 12" 6' to 20'
Bangkirai	2nds, 3rds	19,038	5/4 by 4" to 12" 6' to 20'
Agathis[2]	2nds	4,085	4/4 by 6" to 12" 6' to 20'

[1] These 2 species were not dried at Longview.
[2] Classified as a softwood species.

[1]The author expresses his appreciation to Dick Ward and his group at the Technical Center for their contribution of data and photographs, and to John McMillen of the U. S. Forest Products Lab for supplying schedules and drying information.

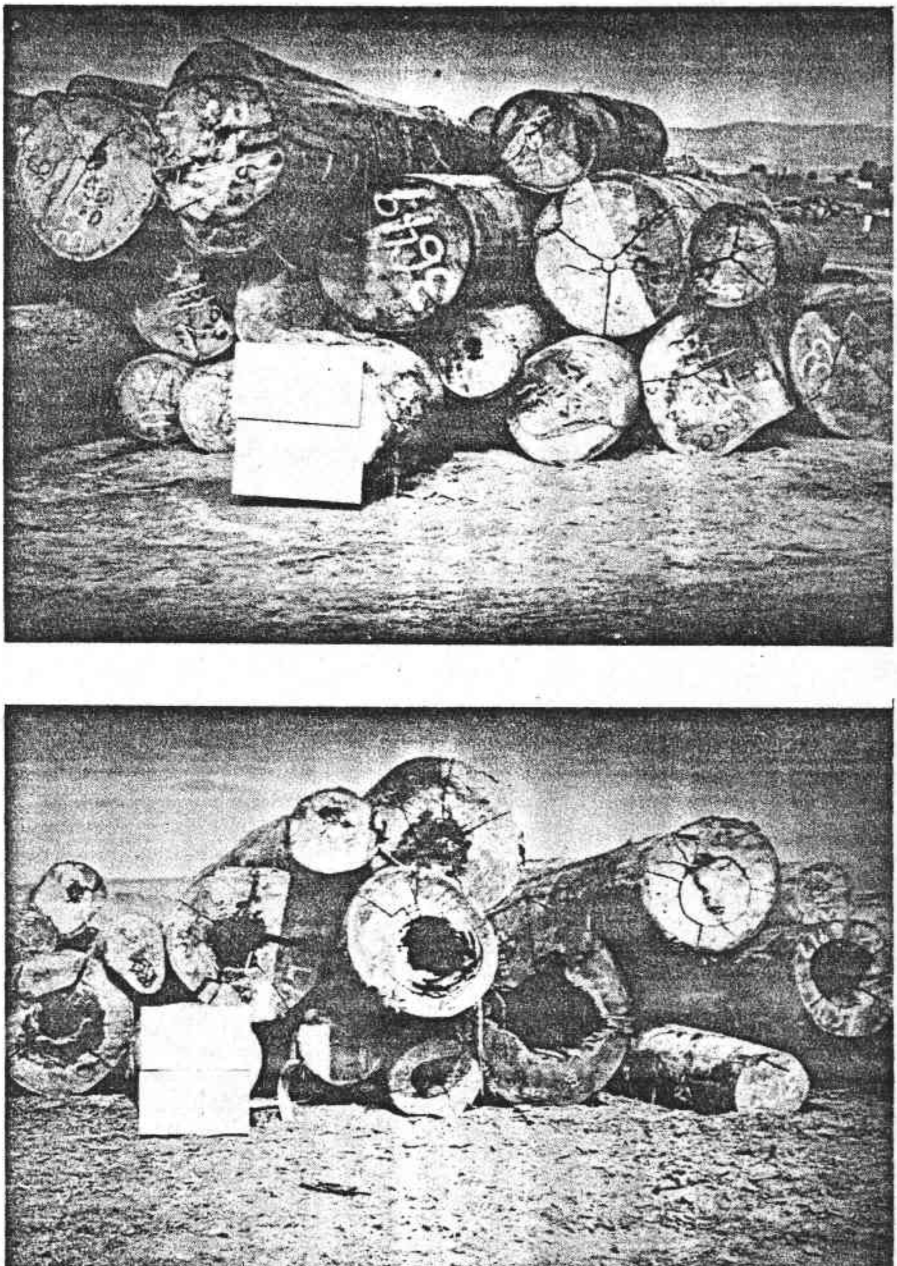

Figure 1. An example of log grades for the South Seas species. Log grades were designated as first, second, third and local. Top: First Bottom: Locals

Shrinkage, moisture content and specific gravity data obtained in accordance with ASTM procedures are summarized in Tables 2 and 3. The significant feature of both tables is the variability. In red meranti, e.g., the specific gravity ranged from 0.282 to 0.531. Equally striking is the situation for moisture content, with a range for the 48 samples of 44 to 149 percent. In general, the number of samples examined was comparatively small, so the ranges for the true populations are probably greater than those given. The implication of this variability to production drying is quite clear.

Information on Lumber Stacking and the Dry Kilns

The maximum duration of solid piling for any of the green lumber was about two weeks. Machine stacking was employed with 9/16" sticks on 4' centers. Kiln cribs were 8' wide but varied in length from 8 to 20 feet. Test conditions required the stacking of different board lengths in the same crib, resulting in air bypass areas between the ends of cribs plus overhanging, unsupported board ends. In some instances kiln cribs were also less than full height, creating additional paths for the short circuiting of kiln air.

The production kilns are single track, line shaft, with the fans, heating and spray lines housed below the charge. The plenum chambers are about 18" wide, and normal air velocity through a well-baffled charge is approximately 300 f.p.m. A full charge of 4/4 lumber contains 50 M bd. ft.

Result and Observations

The nine kiln runs are summarized in Table 4. The moisture content data was collected at the unstacker with a resistance meter and a probe with 1/4" uninsulated needles.

Red Meranti (Runs 1 through 5)

Runs 1 and 2: These were dried on a conventional moisture content schedule with six representative sample boards per run, three in each end car. The drying curves for the samples from run 1 are given in Figure 2, along with the record of kiln temperatures. The curves were constructed on the basis of the ovendry weights as estimated from green moisture content sections.

There were large differences in the green moisture content of the sample boards as well as in their drying rates. Quite probably the rate differences are closely related to large variations in specific gravity. A kiln residence time of 308 hours reduced the average moisture content to 10 percent.

Additional moisture content data for the sample boards are given in Table 5. At 210 hours of drying there existed significant differences in shell and core[2] moisture contents and in individual averages. At the end of drying and conditioning, approximately 100 hours later, these differences were comparatively small. This uniformity of final moisture content is reflected in the data for run 1 as shown in Table 4. With an average

[2]Shell and core sections were about 1/8" thick.

TABLE 2: PHYSICAL PROPERTIES DATA FOR EIGHT SPECIES SORTS OF THE SOUTH SEAS LOG TEST

SHRINKAGE, GREEN MOISTURE CONTENT, SPECIFIC GRAVITY

SPECIES	NO. OF SAMPLES	% SHRINKAGE - GREEN VOLUME TO OVEN DRY				GREEN MOISTURE CONTENT, % OD	SPECIFIC GRAV. GREEN VOLUME, OVEN DRY WT.
		LONGITUDINAL MEAN/RANGE	RADIAL MEAN/RANGE	TANGENTIAL MEAN/RANGE	VOLUMETRIC MEAN/RANGE	MEAN/RANGE	MEAN/RANGE
RED MERANTI	48	0.250	4.216	8.215	13.23	71.54	0.406
		0.122-0.451	2.426-6.883	5.379-11.682	9.60-18.12	44.44-149.00	0.282-0.531
WHITE MERANTI	52	0.158	3.168	6.585	10.13	69.94	0.441
		0.050-0.275	1.704-4.625	4.26 -10.249	6.991-14.05	50.38-126.88	0.277-0.545
YELLOW MERANTI	8	0.168	2.348	6.590	9.319	65.55	0.463
		0.075-0.259	1.880-3.315	5.220-9.071	7.445-12.97	50.71-107.82	0.372-0.594
KAPUR	38	0.168	2.80	6.87	10.19	73.35	0.476
		0.051-0.309	1.75 - 4.57	5.43 - 8.03	8.70 - 13.86	55.22-98.10	0.379-0.575
KERUING	104	0.153	5.17	9.00	14.77	54.6	0.588
		0.00-0.386	2.57 - 8.63	5.89-15.14	10.29-12.66	29.07-92.44	0.465-0.735
AGATHIS	17	0.438	3.64	4.91	9.22	64.07	0.396
		0.100-1.068	1.91 - 5.07	2.49 - 7.58	6.16 -12.75	30.19-125.96	0.347-0.517
NYATOH	56	0.240	4.00	6.91	11.37	55.32	0.579
		0.066-0.585	1.01 - 7.42	4.81 - 9.10	8.68-17.03	36.60-100.81	0.453-0.872
BANGKIRAI	82	0.126	2.88	5.17	8.35	26.72	0.830
		0.033-0.256	1.01 - 4.88	1.49 - 9.93	3.35-14.87	17.84-46.98	0.461-1.026

Table 3. Physical Properties Data for the MLH Sort.

Item	% Shrinkage - Green to Oven Dry				Green Moisture Content (%)	Specific Gravity - Green Volume & O.D. Wt.
	Longitudinal	Radial	Tangential	Volumetric		
Low Average:						
Tarap Hutan	0.133					
Jelutong		2.88				
Juji Girik			3.68	7.00		
Semampar					36.33	
Perupek						0.384
High Average:						
Semampar	0.449					
Durian		5.34				0.606
Keranji			10.30	15.66		
Tarap Hutan					89.21	
Range of Individual Values for all Species in the Sort	0.000 to 0.808	1.20 to 7.46	3.07 to 14.55	6.11 to 21.93	16.59 to 110.15	0.328 to 0.719

Note: Other common names in the MLH sort, not mentioned in the table, were: Binuang, Penaja, Rengas, Lanam, Mrt Tahan, Paru-Paru, Bawang, Kelempayan, Marsimpa, Keledang, Petai Hutan, Dusang and Mata Kucing.

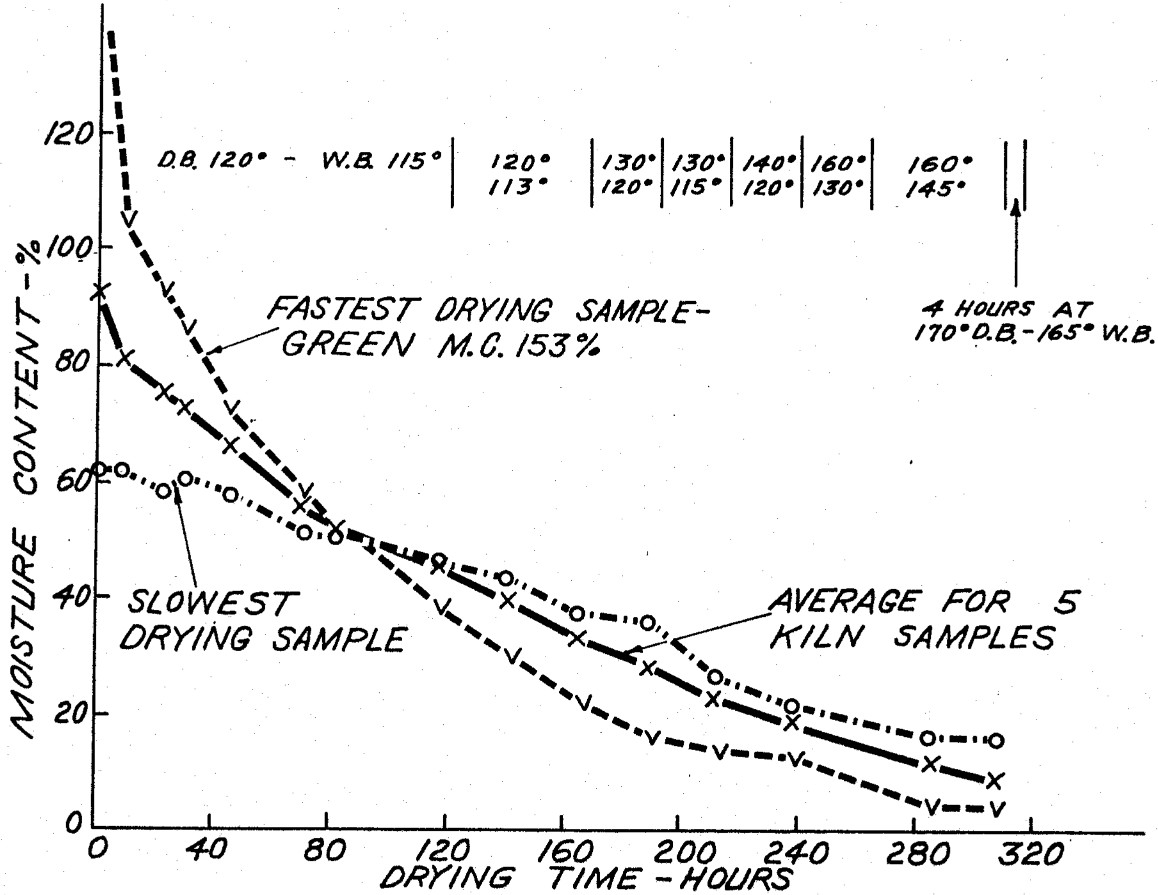

Figure 2. Drying curves and kiln conditions for the red meranti kiln samples dried under a conventional M.C. schedule

TABLE 4: SUMMARY OF DATA FOR THE 9 KILN RUNS

RUN NO.	THICKNESS (INCHES)	DAYS IN KILN	KILN SCHEDULE	FINAL MOISTURE CONTENT DATA				NO. OF BOARDS CHECKED FOR MOISTURE CONTENT
				AVERAGE MOISTURE CONTENT OF CHARGE (%)	RANGE OF BOARD MOISTURE CONTENT (%)	PERCENT OF BOARDS ABOVE 15% M.C.	STANDARD DEVIATION (%) MOISTURE CONTENT	
1	1 1/8	13.0	CONVENTIONAL	11.0	6-30	7.5	3.0	1465
2	"	12.5	SAME AS RUN 1	12.0	6-30	18.7	4.5	1627
3	"	10.9	TIME	LUMBER WAS WET AND SENT TO GAS KILN FOR REDRY. AVERAGE MOISTURE CONTENT AFTER REDRY OF 10%				2175 (TOTAL FOR REDRY FROM RUNS 3 AND 5)
4	"	11.0	SAME AS RUN 3	10.8	6-30	7.8	3.5	1085
5	"	5.0	CRT	CAR 1:9.1 CAR 2:10.7 CAR 3:14.9 REMAINING CARS TO REDRY	7-15 7-23 7-30	1.4 7.7 27.4	1.8 3.6 3.4	72 65 95
6	"	13.0	TIME - SIMILAR TO RUN 3	10.1	6-24	4.7	2.9	1675
7	"	22.0	NONDESCRIPT	12.6	7-27	14.5	3.6	1245
8	"	35.0	DITTO	13.1	8-24	14.4	2.4	885
9	1 3/8	49.0	CONVENTIONAL	9.1	6-20	0.9	2.0	352

moisture content for the charge of 11 percent, only 7.5 percent of the boards were above 15 percent moisture content. In fact, 77 percent of the boards were 12 percent or less. With a relatively small improvement the moisture content specifications for softwood clear lumber would have been met. Undoubtedly the two days of equalizing at 160° d.b. and 145° w.b. were instrumental in reducing the variation both within and between boards.

Figure 3 illustrates stress sections from the sample boards of run 1, which was conditioned four hours at 170° with a five degree wet bulb depression. Stress relief was highly dependent upon the final gradient in the board, as evidenced by relating the appearance of these sections to the data of Table 5. Sample 3 is essentially stress free and with equal shell and core moisture contents. Sample 2 has a four percent gradient between shell and core and remains severely casehardened after conditioning. Sample 5 is intermediate between samples 2 and 3 with respect to both parameters. This illustrates the well-known fact that the prerequisite to a good job of conditioning is proper equalizing. Since there appears to be greater variation in physical properties, proper stress relief may be more time consuming with meranti and other South Seas species than with many of our native woods of comparable densities.

Table 5. Moisture Content Data Collected in Kiln Run No. 1.

Kiln Sample	Moisture Content[1] - %			Moisture Content[2] - %		
	Shell	Core	Avg.	Shell	Core	Avg.
1	Sample not retrievable from charge					
2	10.6	37.8	27.0	9.5	13.6	11.5
3	8.7	29.0	14.0	8.4	8.4	8.4
4	17.2	28.6	24.0	10.4	12.1	11.2
5	17.9	35.2	25.0	9.6	11.8	10.6
6	17.7	32.9	27.0	11.0	12.4	11.6

[1] Intermediate moisture contents determined at 210 hours of drying. The average moisture contents given are based upon a whole cross section of the board.

[2] Moisture contents collected after drying and conditioning. Averages in this case were calculated from the shell and core data collected.

Run 2 was one-half day shorter than run 1, and with a higher percentage of boards in excess of 15 percent moisture content. Undoubtedly the shorter kiln residence was instrumental in producing a larger number of wet boards. However, inherent kiln differences plus less efficient air flow circumstances may have played a role.

Dry trim loss throughout the test was high, particularly since there was less than normal end trimming in the sawmill. End splitting was largely attributed to end checks in the logs plus overhanging board ends during kiln drying. Existing end checks in the green boards had a tendency to extend during drying, particularly in these overhanging ends. Placing stickers near the board ends would minimize end checks and splits, as well as providing needed restraint to warping. Due to natural grain characteristics, the unsupported ends of meranti boards will "propeller"

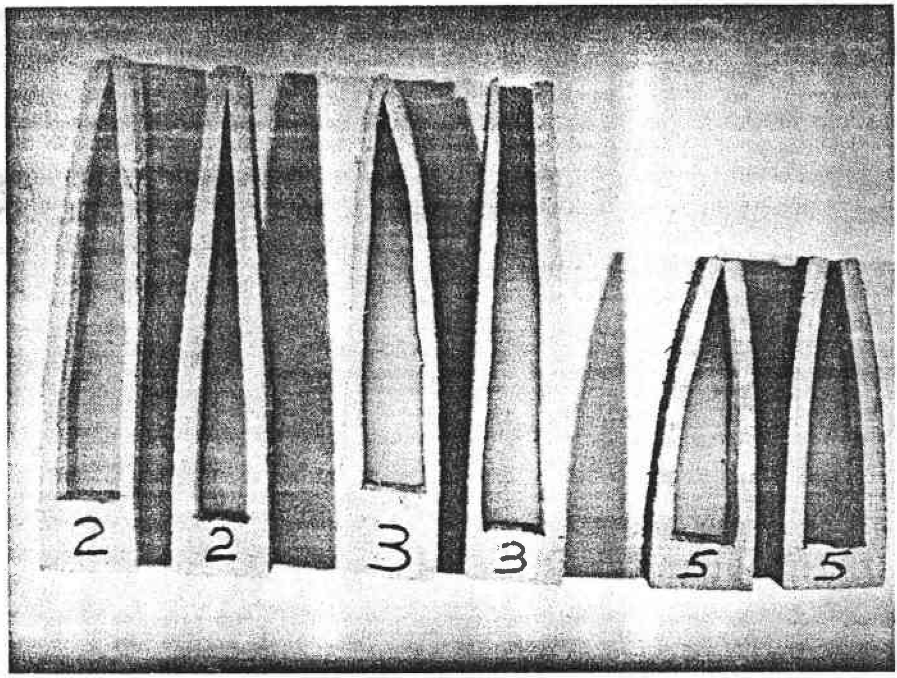

Figure 3. Stress sections from the sample boards employed in Run No. 1. Left hand member of each pair was cut before conditioning; right hand member after conditioning. From left to right the pairs are from kiln samples 2, 3 and 5.

severely. In addition to adequate sticking, and this means on 2' centers or less instead of 4', uniform lumber thickness is a money maker. Best use can then be made of the lumber weight as a warp restraint. Green blanking might even be advisable, as would weighting the stacks moderately to significantly reduce warp in the top several courses.

Runs 3 and 4: These were dried by the time schedule of Table 6. Results for moisture content in run 3 were poor, apparently due to uneven loads and poor air circulation. During unstacking the lumber was found wet and had to be sent to redry. Run 4 gave good moisture content results, comparable to those for run 1.

Table 6. Time Schedule Used for Drying Red Meranti in Run No. 4.

Hours	D.B.T. °F	W.B.T. °F
0-24	125 *	115
25-77	130	123
78-119	130	110
120-168	140	125
169-192	150	120
193-216	160	130
217-264	170	155
265-270	178	165

*Superheat pushed the dry bulb temperature 5° above the desired set point during this step.

Some internal degrade was observed at the planer in boards from these two runs. Unfortunately it couldn't be related back to a given kiln or kiln car, the redry schedule or whatever. Generally it occurred in the wide, flatsawn boards and probably from the use of a too high drying temperature in combination with too high of a board moisture content. It may have happened under the comparatively severe redry schedule. Without knowing the exact source, however, I must give a "caution" recommendation to the time schedule of Table 6.

Run 5: This was dried on a continuously rising temperature schedule (CRT) with only five days in the kiln. Table 4 shows that one-half of the charge went to redry. This was no fault of the schedule per se, for as indicated there was a progressive increase in moisture content by car. Obviously there was a non-uniform drying factor involved, such as air flow, temperature, or both. Even so, one additional day in the kiln probably would have been sufficient. Lumber quality was judged good and warp appeared to be less than in the previous runs. It is highly recommended, however, that a closer evaluation be made for possible degrade within the context of such accelerated drying. This initial CRT run was encouraging, though, and suggests the potential for a significant reduction in drying time for 4/4 meranti by comparison with contemporary schedules, with no loss in quality.

White and Yellow Meranti (Run 6)

This material was dried on the time schedule given in Table 7, and in the same kiln as that used for run 1. Similar results were obtained in runs 1 and 6, both with respect to final moisture content and lumber quality. White and yellow meranti are somewhat denser than red meranti, but they are also slightly lower in green moisture content (Table 2). These offsetting factors help to account for the nearly same average charge moisture content for the two runs after equivalent kiln residence times. The white and yellow meranti had a tighter grouping of final moisture content values than did the red, and this is in keeping with their narrower range of green moisture content as shown in Table 2.

Table 7. Time Schedule Used for Drying White and Yellow Meranti in Run No. 6.

Hours	D. B. T. °F	W. B. T. °F
0-72	120	115
73-120	130	123
121-168	130	115
169-216	140	125
217-240	150	120
241-264	160	130
265-309	170	150
310-317	170	162

MLH, Agathis and Nyatoh Plus Some Meranti (Runs 7 and 8)

This was indeed a variety of species, densities, moisture content, etc. Quantities were such that incomplete kiln cars and charges resulted, and the drying was slow and variable. It would serve no useful purpose to record here the kiln conditions employed since it would not constitute a recommended schedule--simply something we ended up using and living with. However, there were some observations and encounters from these two runs which seem worthy of note.

One difficulty encountered in each run was that of mold growth on board surfaces. There appeared to be differences between species as to the ability to support this growth, but a four-hour steaming treatment at 150° F arrested it.

Figure 4 illustrates the problem with drying a large number of these species in the same charge. Board V, which we identified as mata kucing, dried extremely slowly. After 22 days it was still above 50 percent M.C. When crosscut it revealed a distinct wet core plus honeycomb. The core was well defined and about 1/2" in width. There was ample evidence of degrade and high final moisture content in other boards of this species from the two runs. No doubt a close evaluation of all species within the MLH sort would reveal other significant differences in drying rate and degrade potential. For drying purposes it would certainly be helpful to reduce a large MLH sort to smaller sorts, each of which would contain species of reasonably comparable drying characteristics.

Bangkirai (Run 9)

This material was dried as less than a full kiln charge in the gas fired experimental kiln. This probably worked to our advantage since we needed to minimize the air velocity because of the great propensity of this dense species to surface check. Initially, as best we could determine it with a pocket velometor, velocity through the courses was 50 to 100 f. p. m. Velocity was increased at two later stages, with the final velocity being perhaps 150 to 200 f. p. m.

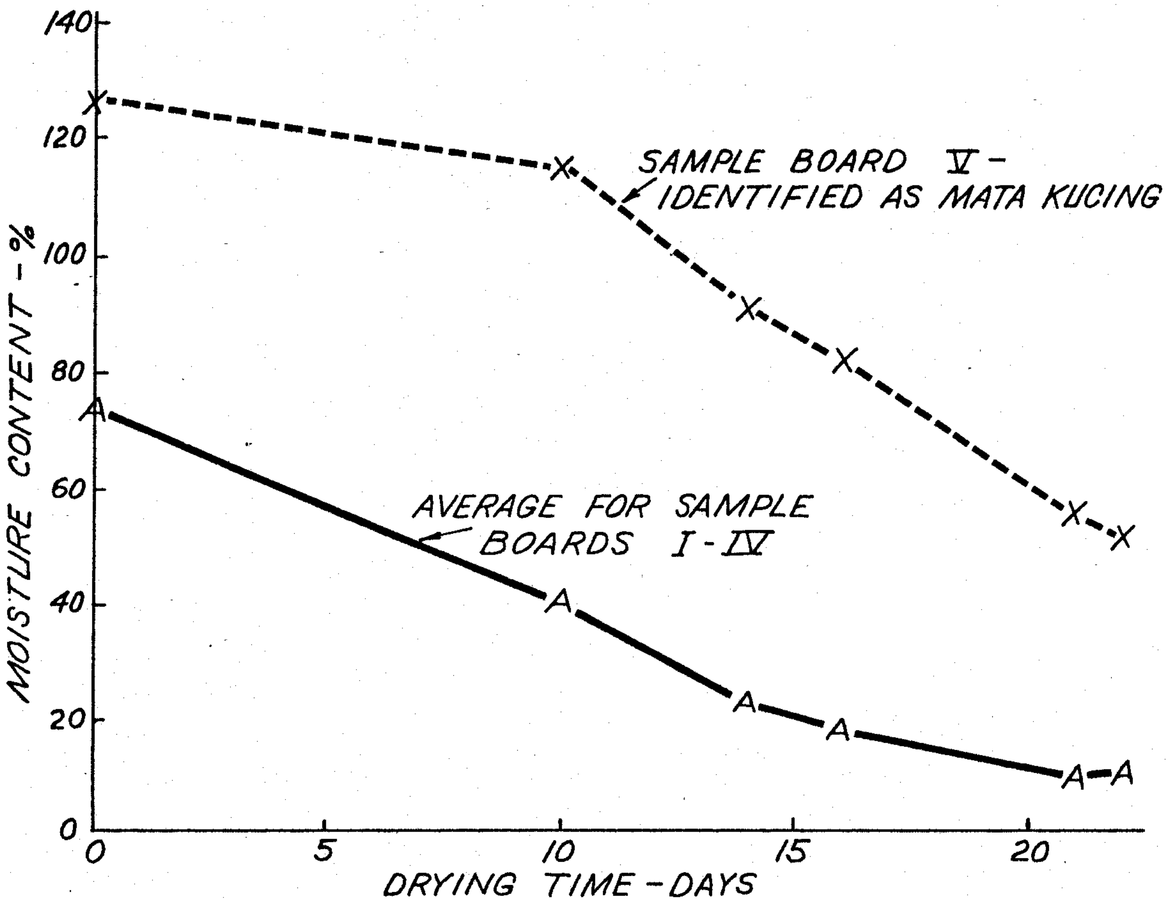

Figure 4. Drying curves from the sample boards employed in drying the MLH, etc. of Run No. 7.

Five sample boards were employed throughout the early part of the run. One was eventually cut periodically to track the progress of stress development and eventual reversal of stresses. Data for the four remaining samples is summarized in Figure 5.

There was a surprisingly rapid reduction in moisture content initially even though drying was at a low d.b.t. and high relative humidity. It is obvious that after about the first week of drying, the rate became diffusion dependent. Total kiln residence time was about 50 days. Stress reversal occurred, in the one board that was examined, at about one-half of its total moisture loss.

Table 4 shows the tightness of the final moisture content distribution. Less than one percent of the pieces were above 15 percent M.C. This was somewhat surprising in view of the rather large variation in green lumber thickness.

The great difficulty in drying bangkirai is its propensity to surface and end check. In spite of the very cautious schedule there was checking observed at the planer that was not apparent in the rough lumber. This may have been due in part to the loss of steam spray for a four-hour period fairly early in the run and a resulting wet bulb depression of 35°.

Table 8 contains M.C. data for the sample boards after conditioning. This data can be related to the stress sections illustrated in Figure 6. Again, the importance of a uniform gradient to good stress relief is apparent. Undoubtedly a higher conditioning temperature would have been more efficient, but steam spray limitations did not allow that.

Table 8. Moisture Content Data for the Bangkirai Samples Boards After Conditioning.

Kiln Sample	Moisture Content - % Shell	Core	Average
I	10.4	11.2	10.8
II	11.2	12.6	11.9
III	10.1	12.3	11.4
IV	11.2	14.0	12.8

Conclusions

(1) With good baffling, red meranti lumber was dried green from the saw to an average 10 percent M.C. under a conventional M.C. schedule in about 13 days. Lumber quality was good and the moisture content distribution approached the requirements for softwood clear lumber. About 10 to 12 hours conditioning at 160 d.b.t. and 152 w.b.t. is recommended for stress relief.

(2) The initial production kiln run with CRT suggests the possibility of drying red meranti lumber green from the saw in six days or less. Confirmation of good quality under such accelerated drying is recommended.

(3) White and yellow meranti have somewhat higher specific gravity than red meranti. Consequently they might require slightly less severe drying conditions than red meranti even though such was not detected in this test.

(4) The Malayan Light Hardwoods sort contains species of greatly different drying rates and degrade potential. If dried as a single sort, certain species will prove to be very limiting as to the severity of drying conditions allowable.

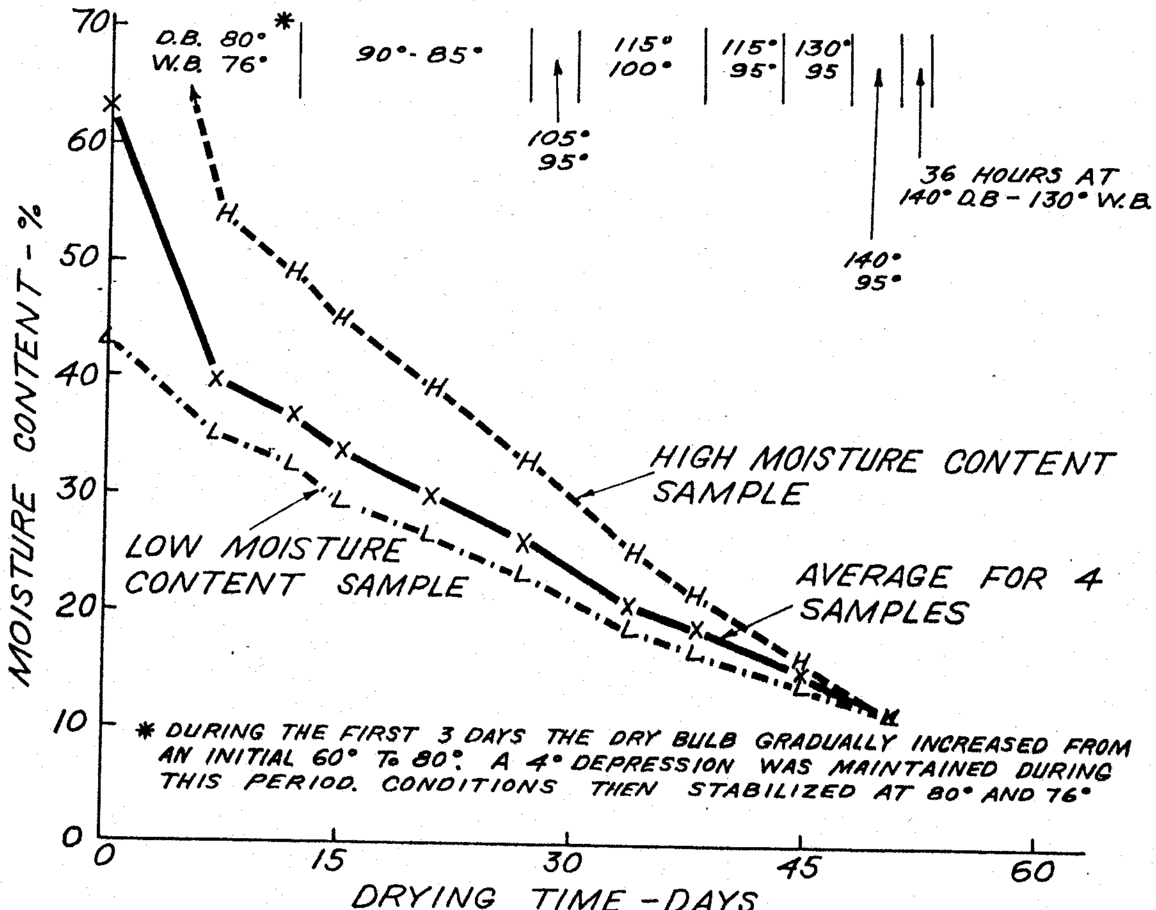

Figure 5. Drying curves and kiln conditions for the bangkirai dried in Run No. 9.

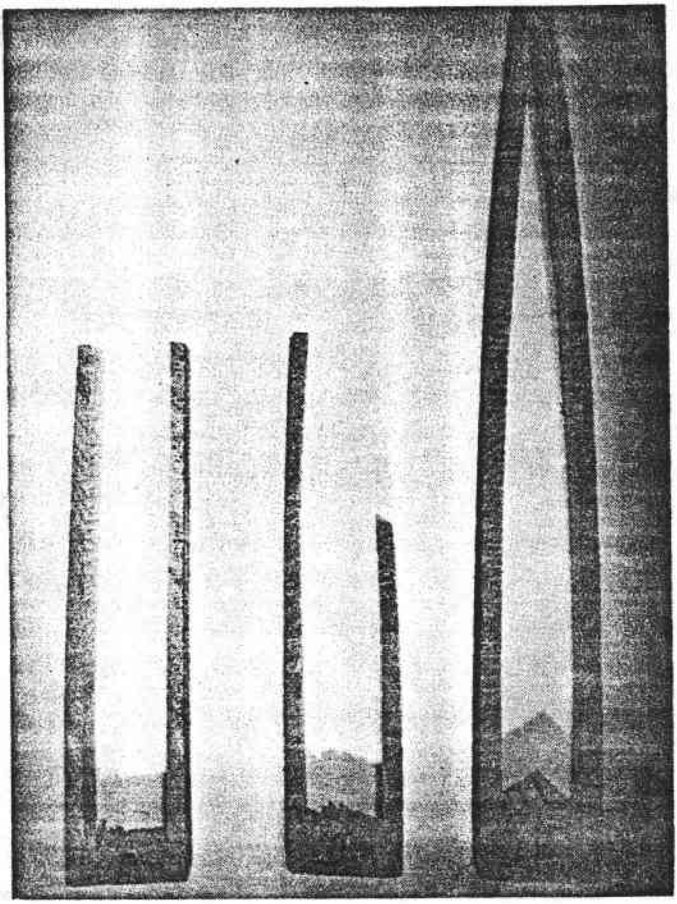

Figure 6. Stress sections after conditioning for the bangkirai sample boards of Run No. 9. Left to right: samples I, II and IV.

(5) Bangkirai has a severe tendency to surface check when kiln dried green from the saw. Low air velocity and high humidity is recommended until at least one-half of the moisture to be lost has been removed.

(6) Good stacking is essential to minimize warp in all of the South Seas species examined. This includes uniform thickness for the green lumber, stickers at or near board ends, sticks on 2' centers or less, and ideally the top weighting of kiln cars.

(7) Severe log stresses exist and are probably instrumental in causing log end checks and eventual end splits in boards. Quick processing of logs into lumber, plus the use of end coating, appear desirable for these species.