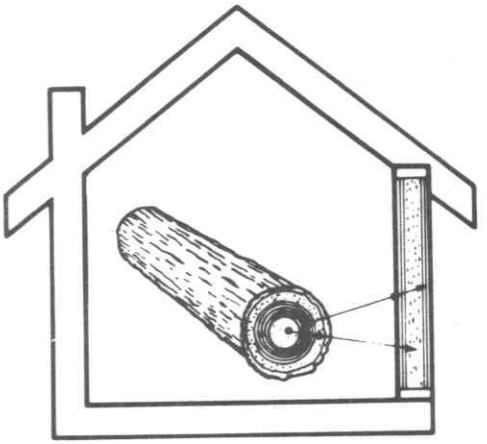
U.S. Department
of Agriculture

Forest Service
Research Paper SE-220



COM-PLY® REPORT 19

Evaluation of Veneer Yields and Grades from Yellow-Poplar, White Oak, and Sweetgum from the Southeast

COOPERATIVE RESEARCH

COM-PLY® is a registered trademark of the American Plywood Association.

ACKNOWLEDGMENT

The Forestry Sciences Laboratory, Wood Products Research Unit, acknowledges the valuable assistance and guidance of:

Orville G. Lee, AIA
Howard C. Hilbrand, PE
U.S. Department of Housing and Urban Development

Charles R. Morschauser, Technical Director
National Particleboard Association

Cooperative Research by
U.S. Department of Agriculture, Forest Service
Southeastern Forest Experiment Station

and

U.S. Department of Housing and Urban Development
Division of Energy, Building Technology
and Standards

April 1981
Southeastern Forest Experiment Station
Asheville, North Carolina

PREFACE

This report is one of a series on the possibilities of producing house framing and structural panels with particleboard cores and veneer facings. These COM-PLY or composite materials were designed to be used interchangeably with conventional lumber and plywood in houses. Research on structural framing is currently limited to COM-PLY studs but will be extended to include larger members such as floor joists.

In 1973, the home-building industry faced a shortage of lumber and plywood and consequent rising prices. Both industry and government recognized that this situation was not a temporary problem and that long-range plans for better use of the Nation's available forest resources would be necessary.

The Forest Service of the U.S. Department of Agriculture and the U.S. Department of Housing and Urban Development accelerated cooperative research on ways to utilize the whole tree. They concentrated on composite wood products made with particleboard and veneer as a way of using not only more of the tree stem, but also of using less desirable trees and a greater variety of tree species than would conventional wood products. The particleboard, which forms a large portion of COM-PLY studs and joists, is made from chipped-up wood that comes from forest residues, mill residues, or low-quality timber. Thus, such composites could greatly increase the amount of lumber and plywood available for residential construction, our major use of wood, without eroding the Nation's timber supply.

Research on composite wall and floor framing was performed by the Wood Products Research Unit, Southeastern Forest Experiment Station, Athens, Georgia. The American Plywood Association cooperated in these studies by designing and testing composite panel products that are interchangeable with plywood. Both types of products have been incorporated in demonstration houses.

Included in this series will be reports on structural properties, durability, dimensional stability, strength, and stiffness of composite studs and joists. Other reports will describe the overall project, compare the strength of composite and solid-wood lumber, suggest performance standards for composite lumber, and provide construction details for incorporating such lumber in houses. Still others will explore the economic feasibility of manufacturing composite lumber and panels, and will estimate the amount and quality of veneer available from southern pines. These reports, called the COM-PLY series, will be available from the Southeastern Forest Experiment Station and the U.S. Department of Housing and Urban Development.

Evaluation of Veneer Yields and Grades from Yellow-Poplar, White Oak, and Sweetgum from the Southeast

by
Robert H. McAlister, Research Scientist
Forestry Sciences Laboratory
Athens, Georgia

ABSTRACT.—The dry volume yield and standard grades of veneer are given for yellow-poplar, sweetgum, and white oak by tree diameter and location within the stem. Manufacture of composite structural lumber and panels can effectively utilize available hardwood stands. The lower 26 feet of the stem of trees 16 inches d.b.h. and smaller yield a high proportion of grade C and better veneer that is desirable for COM-PLY lumber, while veneer of all grades can be used for the panels, and the particleboard cores can be made from both forest and mill residues. Although the total veneer yield from hardwoods is generally less than that from loblolly and slash pines, typical stands of mixed southern pine and hardwood timber yield enough veneer to utilize almost 90 percent of the stand volume in the production of COM-PLY products.

Keywords: COM-PLY, lumber, panels, *Liriodendron tulipifera* L., *Liquidambar styraciflua* L., *Quercus* sp.

Forest products are mostly used in residential and commercial construction. Practically all of the wood products that are used in construction are softwoods. This dependence on softwood is based on its availability, ease in nailing, ease of drying, and generally lighter weight than common hardwoods. Projections of future demand for softwood forest products indicate that demand for timber will exceed supply (USDA FS 1973).

Hardwoods predominate in the forests of the United States. Ninety percent of the hardwood forests are found east of the Mississippi River (USDA FS 1978). If future demands for forest products are to be satisfied, some methods must be found for using more of our hardwood. Select hardwood lumber and veneer have always had a ready market for their use in furniture, cabinets, and paneling. For centuries the hardwood forests have been selectively cut so that the more valuable trees are taken, and the cull trees and less desirable species are left. The residual hardwood stands are a major forest management problem. In many cases, the present hardwood stands are a losing proposition: it would cost more to harvest the present stands and prepare them for restocking than could be realized by the sale of their timber.

The COM-PLY approach to the manufacture of composite structural lumber and panels is ideally suited to the efficient use of available hardwood stands. COM-PLY lumber requires about 25 percent of veneer to provide strength and stiffness (fig. 1). The particleboard making up the remaining 75 percent of COM-PLY lumber volume can be made from low-quality forest or manufacturing residues. Composite products minimize the major problems of using hardwoods for lumber such as long drying time, poor dimensional stability, and difficulty in obtaining large sizes and long lengths. Tests of the structural properties of COM-PLY studs made with yellow-poplar, white oak, and sweetgum (McAlister 1979) indicate that COM-PLY lumber made with these species are comparable with COM-PLY lumber made from southern pine (McAlister 1978).

The Southeastern States (Alabama, Georgia, Florida, North Carolina, South Carolina, and Virginia) have large areas of hardwood forests. These forests are extremely diverse, ranging from swamps to mountain ridgetops, and they include dozens of commercially important hardwood species. However, most of the growing-stock volume consists of only a few species: For example, in the mountains and the Piedmont, seven species account for over 50 percent of the total wood volume, of which yellow-poplar *(Liriodendron tulipifera* L.), sweetgum (*Liquidambar styraciflua* L.), and white oak (*Quercus sp.*) account for about 40 percent. Information on these species is needed in order to evaluate the hardwood resource.

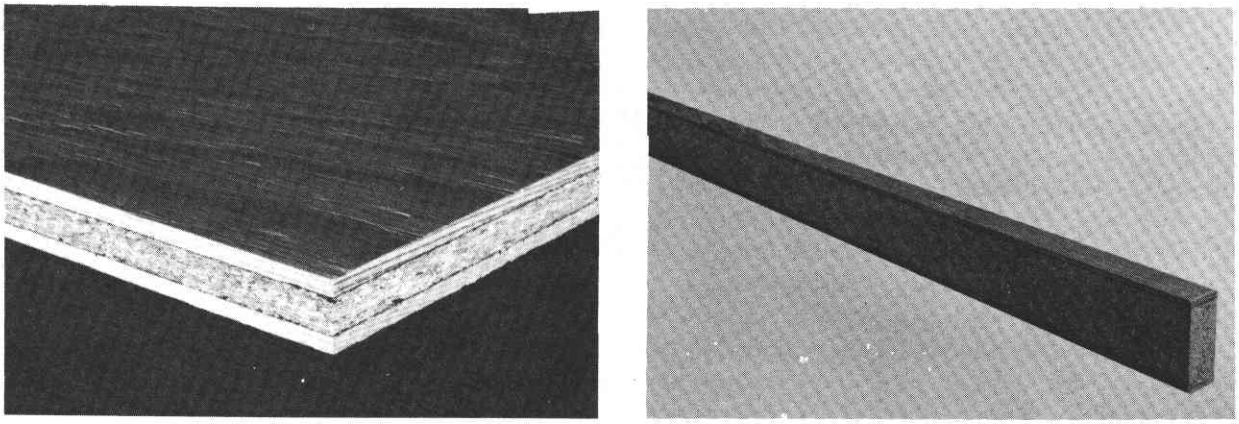


Figure 1.—Construction of a COM-PLY panel (left) and a COM-PLY stud (right).

Previous research on the hardwood veneer resource has been concerned with high-quality face veneers and the veneer for core and crossband stock for paneling and furniture. This study describes the dry cubic footage and grades of veneer that are available from yellow-poplar, sweetgum, and white oak according to tree diameter at breast height (d.b.h.) and location within the stem. Similar to COM-PLY 9, "Yield of Southern Pine Veneers Suitable for Composite Lumber and Panels" (McAlister and Taras 1978), this report can be used along with COM-PLY 9 to study potential yields from mixed hardwood and softwood stands.

PROCEDURES

The trees for this hardwood veneer yield study were selected as part of a total tree (above ground) biomass study (Clark and Phillips, unpublished[1]). Trees from two geographical areas were sampled: yellow-poplar, white oak, and sweetgum from the central Georgia Piedmont (Oconee National Forest); and yellow-poplar and white oak from the southwestern North Carolina mountains (Nantahala National Forest). For each location and species, we selected three trees from each of the six even-inch (12, 14, . . . 20) diameter classes from 12 to 22 inches d.b.h. For example, the 12-inch d.b.h. class includes trees from 11 to 12.9 inches d.b.h. The trees were felled and bucked into veneer-length logs. A veneer block is 8.75 feet long. As far as practical, we cut two and three block-length logs for ease in skidding and hauling. The minimum top diameter was about 8 inches. We cut 1-inch sample disks at each bucking cut. These disks were used to determine specific gravity, bark thickness, growth rate, and moisture content. The logs were individually weighed and then hauled to a cooperating southern pine plywood plant. The logs were cut into veneer blocks 103 to 104 inches long and debarked. We marked each block with the tree and block number of the stem (fig. 2). The end diameters of each block were recorded to the nearest 0.1 inch. All blocks were heated in 180°F (82°C) water for 15 to 16 hours before peeling. The veneer lathe was set to produce 0.167- to 0.170-inch-thick veneer. The peeler core diameter was recorded for each block and averaged about 5.4 inches.

Veneer from individual blocks was color coded with strips of water-soluble dye so that the veneer that was produced could be related to the block from which it was peeled (Schroeder and Clark 1970). Veneer was clipped

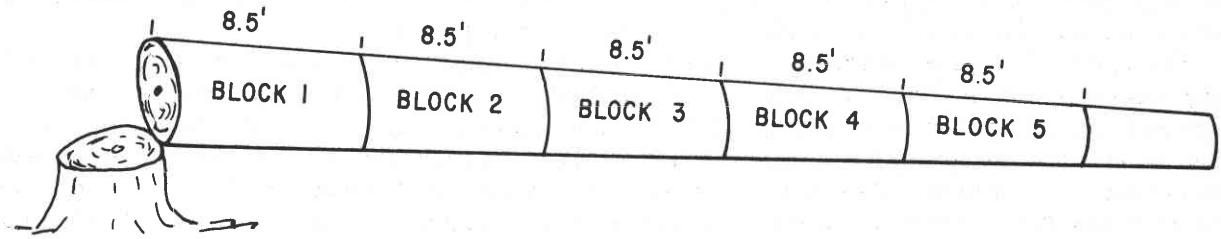


Figure 2.—Diagram of veneer blocks measured on stem.

[1]Data on file Southeast. For. Exp. Stn., For. Sci. Lab., Athens, Ga.

into full sheets, half sheets, and strip according to standard mill practice for softwood veneer-grade defect limitations. Veneer was dried for 12 minutes at 385°F in a commercial steam-heated, jet-type veneer dryer to an average moisture content of less than 6 percent. Veneer was graded after drying as per softwood veneer grades (American Plywood Association 1974). Dry veneer volumes and grade were recorded for veneer 0.160 inch thick and for sheet sizes as follows:

Full sheets — 50 by 102 inches
Half sheets — 26 by 102 inches
Strip — actual width by 102 inches
Fishtail — actual width by 54 inches

All strip and fishtail were graded as C- or D-grade veneer. Actual widths for strip and fishtail ranged between 12 and 25 inches.

RESULTS AND INTERPRETATION

The results of this study represent a wide range of tree diameters from two geographic locations. The main body of the report includes only data by tree-diameter class (table 1) and derived information from the central Georgia Piedmont. Yield tables from the southwestern North Carolina mountains by tree-diameter class are presented in the Appendix. The Appendix also includes yield tables from both areas by veneer-block diameter. The trees from the mountains were generally taller and had more veneer blocks per stem than did those from the Piedmont.

Information in table 1 can be used to estimate the quantity of veneer that can be produced from natural hardwood stands in the Piedmont. Species distribution by diameter class is usually available from timber-cruise data or from forest statistical information published by the U.S. Forest Service as part of their forest survey data.

For example, Cathey (1972) estimates the diameter distribution for oak, sweetgum, and yellow-poplar in diameter classes 12 to 20 inches d.b.h. in central Georgia to be:

d.b.h.	*Percent*
12	49
14	26
16	14
18	7
20	4

Further, the estimated species distribution is 49 percent oak, 37 percent sweetgum, and 14 percent yellow-poplar. Similar calculations can be made for any area and mix of species for which forest survey data are published. These estimates were used to construct table 2, which assumes 100 woods-run trees from a hardwood logging operation in central Georgia.

From table 2, it is evident that, although oak accounts for almost half of the number of trees, only 25 percent of the C and better grade veneer is oak. This means that oak peeling and log residues will make up a large proportion of the total. Because of the high density of oak, it may not be practical to use more than 15 to 20 percent oak in the particleboard furnish to maintain the desired density (37 pounds per cubic foot) of the particleboard core that is used in COM-PLY products.

This typical mix of 100 hardwood trees yields about 375 cubic feet of dry C and better veneer from a total tree volume of 3,000 cubic feet. Notice that the veneer-block volume is 1,770 cubic feet. Thus, logging to a 4-inch diameter inside bark (d.i.b.) top would provide an additional 1,300 cubic feet of green wood in addition to that in the veneer blocks.

We estimate that the 375 cubic feet of dry veneer loses about 10 percent in manufacturing, leaving about 338 cubic feet of veneer in the finished product. The 3,008 cubic feet of green tree volume shrank (12 percent volumetric) to about 2,650 cubic feet after drying.

The 2,650 cubic feet of dry tree volume would yield about 375 cubic feet of C grade and better veneer. This is not enough veneer to fully utilize the residues. Table 3 shows the problem: only 23 percent of the total tree volume is converted to full-length veneer, while 41 percent of the total tree volume is top-log residue. Southern pine stands yield 44 percent full-length veneer and have only 15 percent top-log residue (McAlister and Taras 1978). Therefore, it is likely that hardwoods can best be used in combination with softwoods—a concept unique to the COM-PLY system. Table 4 gives the average veneer yields per 100 stems for central Georgia when southern pine is included (Cathey 1972). The yields are much different because southern pine makes up almost 78 percent of the number of trees. The use of southern pine and hardwoods in proportion to their distribution yields 562 cubic feet of dry veneer for a total green tree volume of 2,558 cubic feet.

Table 1.—Average dry cubic feet of veneer by grade and diameter class in yellow-poplar, sweetgum, and white oak (central Georgia Piedmont)

Tree d.b.h. (inches)	Dry veneer volume[1]				Green block volume	Green tree volume[2]	Veneer-recovery factor[3]
	AB	C	D	Fish-tail			
	Cubic feet						*Percent*
YELLOW-POPLAR							
12	0.2	1.5	0.7	0.4	11.7	24.7	20.5
14	0	6.4	2.6	.6	21.8	33.0	41.3
16	.2	10.1	3.9	1.3	34.0	45.4	41.8
18	.5	15.3	7.7	1.4	52.6	61.5	44.7
20	1.9	14.5	9.1	1.4	56.5	73.4	45.1
SWEETGUM							
12	.2	2.2	.3	.3	7.0	19.3	38.6
14	.9	8.4	1.9	.9	24.2	34.4	46.3
16	.2	5.9	4.5	1.4	31.9	42.8	33.2
18	1.1	9.8	4.1	1.3	35.7	53.8	42.0
20	1.3	10.7	11.1	1.6	48.5	66.9	47.6
WHITE OAK							
12	0	.72	.51	.37	8.74	17.9	14.1
14	0	~~2.39~~ 2.25	~~.63~~ 2.39	~~15.68~~ .63	~~28.6~~ 15.68	28.6	29.6
16	0	3.15	5.33	1.19	27.61	41.9	30.7
18	0	3.43	8.80	1.31	34.96	52.4	35.0
20	0	5.89	9.04	.84	40.54	68.9	36.8

[1]Full-length veneer: 102 inches long; fishtail: 54 inches long; all veneer: 0.160 inch thick and dry.
[2]Volume to a 4-inch (d.i.b.) top.
[3]Ratio of dry, full-length veneer (grades A, B, C, and D) to green block volume (Smalian).

Table 2.—Average veneer yield per 100 stems from typical natural hardwood stands in central Georgia, by species and tree diameter class

Tree diameter class (inches)	Species	No. of stems	Dry veneer volume[1]				Green block volume	Green[2] tree volume
			AB	C	D	Fish-tail		
			Cubic feet					
	Oak	23.1	0	16.6	11.8	8.6	201.9	427.8
12	Sweetgum	19.5	3.9	42.9	5.8	5.8	136.5	376.4
	Yellow-poplar	6.9	1.4	10.4	4.8	2.8	80.7	170.4
	Oak	12.9	0	29.0	30.8	8.1	202.3	170.4
14	Sweetgum	10.3	9.3	86.5	19.6	9.3	249.3	354.3
	Yellow-poplar	3.2	0	20.5	8.3	1.9	69.8	105.6
	Oak	7.0	0	22.0	37.3	8.3	193.3	293.3
16	Sweetgum	4.1	.8	24.2	18.4	5.7	130.8	175.5
	Yellow-poplar	2.5	.5	24.2	9.8	3.2	85.0	113.5
	Oak	4.2	0	14.4	37.0	5.5	146.8	220.1
18	Sweetgum	1.6	1.8	15.7	6.6	2.1	57.1	86.1
	Yellow-poplar	1.1	.6	16.8	8.5	1.5	57.9	67.6
	Oak	2.2	0	13.0	19.9	1.8	89.2	151.6
20	Sweetgum	.9	1.2	9.6	10.0	1.4	43.6	60.2
	Yellow-poplar	.5	1.0	7.2	4.6	.7	28.2	36.7
	Total	100.0	20.5	354.0	233.2	66.7	1,772.4	3,008.0
	Total oak	49.4	0	95.0	136.8	32.3	833.5	1,461.7
	Total sweetgum	36.4	17.0	178.9	60.4	24.3	617.3	1,052.5
	Total yellow-poplar	14.2	3.5	80.1	36.0	10.1	321.6	493.8

[1]Full-length veneer: 102 inches long; fishtail: 54 inches long; all veneer: 0.160 inch thick.
[2]Volume to a 4-inch (d.i.b.) top.

Table 3.—Average dry volume of veneer and residue from 100 trees of a typical hardwood stand in central Georgia

Item	Oak	Sweetgum	Yellow-poplar	Total	Proportion of stand volume
	Cubic feet				*Percent*
A and B veneer	0	17.0	3.5	20.5	0.8
C veneer	95.0	178.9	80.1	354.0	9.6
D veneer	136.8	60.4	36.0	233.2	8.8
Total full-length veneer[1]	231.8	256.3	119.6	607.7	23.0
Fishtail[2]	32.3	24.3	10.1	66.7	2.5
Total veneer	264.1	280.6	129.7	674.4	25.5
Peeling residue	469.4	262.6	153.3	885.3	33.4
Total block volume	733.5	543.2	283.0	1,559.7	58.9
Top log residue	552.8	383.0	151.5	1,087.3	41.1
Total tree volume[3]	1,286.3	926.2	434.5	2,647.0	100.0

[1]Full-length veneer: 102 inches long.
[2]Fishtail: 54 inches long.
[3]Volume to a 4-inch (d.i.b.) top.

Table 4.—Average veneer yield per 100 stems of mixed pine and hardwood for typical timber stands in central Georgia, by species and tree diameter class

Tree diameter class (inches)	Species	No. of stems	Dry veneer volume[1]				Green block volume	Green tree volume[2]
			AB	C	D	Fish-tail		
			Cubic feet					
10	Pine	35.3	21.2	63.5	14.1	10.6	345.9	533.0
	Pine	21.8	34.9	100.3	28.3	10.9	416.4	475.2
	Oak	5.2	0	3.7	2.7	1.9	45.4	93.1
12	Sweetgum	4.4	.9	9.7	1.3	1.3	30.8	84.9
	Yellow-poplar	1.6	.3	2.4	1.1	.6	18.7	39.5
	Pine	12.2	30.5	96.4	58.6	14.6	395.3	422.1
	Oak	2.9	0	6.5	6.9	1.8	45.5	82.9
14	Sweetgum	2.3	2.1	19.3	4.4	2.1	55.7	79.1
	Yellow-poplar	.7	0	4.5	1.8	.4	15.3	23.1
	Pine	5.3	23.3	53.5	47.7	8.5	243.8	254.9
	Oak	1.6	0	5.0	8.5	1.9	44.2	67.0
16	Sweetgum	.9	.2	5.3	4.0	1.3	28.7	38.5
	Yellow-poplar	.6	.1	6.1	2.3	0.8	20.4	27.2
	Pine	2.2	17.8	22.0	29.0	4.4	125.8	139.5
	Oak	.9	0	3.1	7.9	1.2	31.5	47.2
18	Sweetgum	.3	.3	2.9	1.2	.4	10.7	16.1
	Yellow-poplar	.2	.1	3.1	1.5	.3	10.5	12.3
	Pine	.8	8.0	8.6	14.6	1.8	55.0	67.4
20	Oak	.5	0	2.9	4.5	.4	20.3	34.4
	Sweetgum	.2	.3	2.1	2.2	.3	9.7	13.4
	Yellow-poplar	.1	.2	1.4	.9	.1	5.6	7.3
	Total	100.0	140.2	422.3	243.5	65.6	1,975.2	2,558.1
	Total pine	77.6	135.7	344.3	192.3	50.8	1,582.2	1,892.1
	Total oak	11.1	0	21.2	30.5	7.2	186.9	324.6
	Total sweetgum	8.1	3.8	39.3	13.1	5.4	135.6	232.0
	Total yellow-poplar	3.2	.7	17.5	7.6	2.2	70.5	109.4

[1]Full-length veneer: 102 inches long; fishtail: 54 inches long; all veneer: 0.160 inch thick.
[2]Volume to a 4-inch (d.i.b.) top.

Table 5 shows the breakdown by species. If it is assumed that the 562 cubic feet of C and better veneer would lose about 10 percent in manufacturing losses, 506 cubic feet would be left, which means that 87 percent of the total volume would be utilized in composite lumber. The harvesting of the hardwood trees at the same time as the pine and the removal of all material down to a 4-inch (d.i.b.) top would leave sites in better condition for the planting of trees. The comparatively small volume of oak residues (about 16 percent of the total) might be incorporated in the particleboard core without significant problems.

A 1/2-inch-thick COM-PLY panel with 0.1-inch-thick veneer faces requires about 40 percent veneer and 60 percent particleboard. Producers of COM-PLY panels would use veneer of all grades. The volume of full-length veneer available from peeling a typical mix of 100 trees would be 806 cubic feet. Woodfin (1973) has estimated softwood plywood manufacturing losses of about 16 percent in a panel operation. The net volume of veneer that is utilized would be 677 cubic feet, or 30 percent of the total dry volume of the timber mix. Consequently, a producer of COM-PLY panels could use about 75 percent of the total stand volume and 97 percent of the total veneer-block volume. Southern pine plywood plants achieve yields of 45 percent plywood based on veneer-block volume of southern pine alone. Therefore, a plant producing COM-PLY panels would require less than one-half the timber volume to produce an equivalent volume of pine plywood.

Hardwood veneer blocks from the lower part of the stem produce the greatest yield of C and better grade veneer. As was the case with southern pine, the first three veneer blocks (26 to 27 feet) in the stem yield most of the C grade and better veneer.

Researchers may be interested in grade yields for hardwood species based on block diameter instead of tree diameter class. These data are presented in the Appendix, tables 7 and 8.

Table 5.—Average dry volume of veneer and residue from 100 stems of mixed pine and hardwood for a typical timber stand in central Georgia

Item	Southern pine	Oak	Sweet-gum	Yellow-poplar	Total	Proportion of stand (all species)	Total hardwood	Hardwood proportion of stand volume
	Cubic feet					*Percent*	*Cubic feet*	*Percent*
A and B veneer	135.7	0	3.8	0.7	140.2	6.2	4.5	0.2
C veneer	344.3	21.2	39.3	17.5	422.3	18.8	78.0	3.5
D veneer	192.3	30.5	13.1	7.6	243.5	10.8	51.2	2.3
Total full-length veneer[1]	672.3	~~51.7~~ 41.7	56.2	25.8	806.0	35.8	133.7	6.0
Fishtail[2]	50.8	7.2	5.4	2.2	65.6	2.9	14.8	.6
Total veneer	723.1	58.9	61.6	28.0	871.6	38.7	148.5	6.6
Peeling residue	669.2	115.6	57.7	34.0	866.6	38.5	197.3	8.8
Total block volume	1,392.3	~~174.5~~ 164.5	119.3	62.0	1,738.2	77.2	345.8	15.4
Top log residue	272.7	121.1	84.9	34.3	512.9	22.8	240.3	10.7
Total tree volume[3]	1,665.0	~~295.6~~ 285.6	204.2	96.3	2,251.1	100.0	586.1	26.1

[1]Full-length veneer: 102 inches long.
[2]Fishtail: 54 inches long.
[3]Volume to a 4-inch (d.i.b.) top.

CONCLUSIONS

The following conclusions can be drawn from the data:

1. In a typical distribution of oak, sweetgum, and yellow-poplar from central Georgia, nearly 75 percent of the total tree volume would be either tops too small to peel into veneer or peeling residue. This means that complete conversion of hardwood timber stands to COM-PLY products is not possible from hardwoods alone.

2. From the proportions of species found in a typical timber stand in central Georgia, southern pine and hardwoods can yield 87 percent of the total tree volume in COM-PLY lumber products. This percentage compares with a 25-percent yield for sawed lumber from southern pine and a 31-percent yield if both pine and hardwoods are sawed into lumber.

3. The production of COM-PLY panels from mixed pine and hardwoods in the proportions found in a typical timber stand in central Georgia would yield about 75 percent of the total stand volume. This percentage compares with a 28-percent yield of southern pine plywood and a 35-percent yield if both pine and hardwoods are made into plywood.

4. Almost all of the oak veneer and residue can be used in COM-PLY products if it is combined with mixed southern pine and hardwoods that are found in the typical stands of central Georgia.

LITERATURE CITED

American Plywood Association
1974. U.S. Products Standard PS 1-74 for construction and industrial plywood with typical APA grade-trademark. 35 p. Am. Plywood Assoc., Tacoma, Wash.

Cathey, Robert A.
1972. Forest statistics for central Georgia 1972. USDA For. Serv., Resour. Bull. SE-22, 34 p. Southeast. For. Exp. Stn., Asheville, N.C.

McAlister, Robert H.
1978. Structural properties of COM-PLY studs. USDA For. Serv., Res. Pap. SE-180, COM-PLY Rep. 12, 15 p. Southeast. For. Exp. Stn., Asheville, N.C., and U.S. Dep. Housing and Urban Dev., Washington, D.C.

McAlister, Robert H.
1979. Structural performance of COM-PLY studs made with hardwood veneers. USDA For. Serv., Res. Pap. SE-199, COM-PLY Rep. 16, 15 p. Southeast. For. Exp. Stn., Asheville, N.C., and U.S. Dep. Housing and Urban Dev., Washington, D.C.

McAlister, Robert H., and Michael A. Taras
1978. Yield of southern pine veneer suitable for composite lumber and panels. USDA For. Serv., Res. Pap. SE-179, COM-PLY Rep. 9, 15 p. Southeast. For. Exp. Stn., Asheville, N.C., and U.S. Dep. Housing and Urban Dev., Washington, D.C.

Schroeder, James C., and Alexander Clark III
1970. Predicting veneer grade-yields for loblolly pine. For. Prod. J. 20:37-39.

U.S. Department of Agriculture, Forest Service
1973. The outlook for timber in the United States. U.S. Dep. Agric., For. Serv., Resour. Rep. 20, 367 p.

U.S. Department of Agriculture, Forest Service
1978. Forest statistics of the United States, 1977. Review draft—all data subject to revision. 133 p. U.S. Dep. Agric., For. Serv., Washington, D.C.

Woodfin, Richard O., Jr.
1973. Wood losses in plywood production: four species. For Prod. J. 23:98-105.

APPENDIX

The Appendix tables provide detailed information on veneer yields by tree diameter from the mountain areas and for veneer yields based on block diameter from both areas.

Table 6.—Average dry cubic feet of veneer by grade and d.b.h. class in yellow-poplar and white oak (southwestern North Carolina mountains)

Tree d.b.h. (inches)	Dry veneer volume[1]				Green block volume	Green tree volume[2]	Veneer recovery factor[3]
	AB	C	D	Fish-tail			
	Cubic feet						*Percent*
YELLOW-POPLAR							
12	0	1.18	0.46	0.30	11.50	22.88	14.3
14	0	10.44	2.35	.82	31.79	44.02	40.2
16	0	15.54	10.45	1.26	51.76	57.91	50.2
18	0	16.36	12.81	2.50	64.78	77.36	45.0
20	0	18.34	18.78	1.74	76.86	96.81	48.3
22	0	20.28	31.65	2.35	98.20	110.69	52.9
WHITE OAK							
12	0	1.82	1.69	.80	16.87	23.51	21.0
14	0	2.31	5.33	.80	28.47	36.19	26.8
16	0	3.39	8.45	.77	38.57	45.78	30.7
18	0	2.40	12.47	.62	40.83	66.58	36.4
20	0	4.90	12.24	1.72	44.30	69.27	38.7
22	0	6.97	22.48	1.76	63.05	91.43	46.7

[1]Full-length veneer: 102 inches long; fishtail: 54 inches long; all veneer: 0.160 inch thick.
[2]Volume to a 4-inch (d.i.b.) top.
[3]Ratio of dry, full-length veneer to green block volume.

Table 7.—Average veneer yield by grade and block diameter for yellow-poplar, sweetgum, and white oak (central Georgia piedmont)

Block diameter (inches)	Dry veneer volume[1]				Green block volume	Residue[2]	Veneer recovery factor[3]
	A+B	C	D	Fish-tail			
	Cubic feet						*Percent*
				YELLOW-POPLAR			
9	0	0.41	0.38	0.14	4.44	3.65	18.1
10	.05	.91	.55	.18	5.13	3.63	29.4
11	.04	1.14	.94	.20	6.36	4.24	32.8
12	0	2.34	1.24	.34	7.40	3.82	48.2
13	.08	1.93	1.75	.24	8.93	5.17	41.9
14	.19	3.53	.95	.24	10.25	5.58	46.1
15	.48	4.54	1.18	.17	11.87	5.67	52.3
16	.24	4.86	1.65	.37	13.59	6.84	49.8
17	.95	6.97	1.41	.32	16.27	6.93	57.3
				SWEETGUM			
9	0	.89	.27	.20	4.63	3.47	23.8
10	.13	1.38	.65	.24	5.15	2.99	42.0
11	.17	1.66	.66	.18	6.11	3.62	39.7
12	.17	1.93	1.21	.29	7.67	4.36	42.5
13	.07	2.06	1.27	.37	9.03	5.64	37.6
14	.76	2.89	1.27	.25	10.42	5.50	48.1
15	.38	3.24	2.78	.42	11.70	5.30	54.8
16	0	1.66	4.65	.62	15.78	9.48	40.3
17	0	7.35	.22	.98	16.45	8.88	46.0
				WHITE OAK			
9	0	0	.18	.30	4.06	3.87	4.4
10	0	.49	.69	.15	5.27	4.09	21.9
11	0	.78	1.11	.30	6.81	4.91	27.0
12	0	.17	1.50	.50	7.38	5.71	22.3
13	0	1.55	2.16	.30	9.30	5.58	39.7
14	0	1.04	2.42	.39	10.05	6.59	34.4
15	0	1.56	3.00	.33	12.67	8.10	36.0
16	0	0	1.38	.07	13.48	12.10	10.2
17	0	.52	5.55	.29	15.04	8.97	40.3
18	0	4.79	3.08	.52	17.32	9.46	44.6

[1]Full-length veneer: 102 inches long; fishtail: 54 inches long; all veneer: 0.160 inch thick.
[2]Green block volume minus full-length veneer volume.
[3]Full-length veneer volume/green block volume × 100.

Table 8.—Average veneer yield by grade and block diameter from yellow-poplar and white oak from mountain area (southwestern North Carolina mountains)

Block diameter (inches)	Dry veneer volume[1]				Green block volume	Residue[2]	Veneer-recovery factor[3]
	AB	C	D	Fish-tail			
	Cubic feet						Percent
YELLOW-POPLAR							
9	0	0.16	0.38	0.10	4.31	3.77	12.0
10	0	.52	1.18	.17	5.16	3.45	32.5
11	0	1.72	.74	.12	6.27	3.81	39.8
12	0	1.49	1.40	.28	7.39	4.50	39.5
13	0	2.44	1.96	.20	8.67	4.27	51.0
14	0	2.33	2.77	.24	9.86	4.76	51.6
15	0	2.38	3.66	.32	11.48	5.44	52.4
16	0	3.42	3.78	.42	12.89	5.69	56.0
17	0	4.70	3.11	.23	14.05	6.23	55.7
18	0	4.33	3.50	.52	16.43	8.61	47.8
19	0	5.91	4.08	.48	17.90	7.92	55.6
20	0	8.74	3.27	.20	20.81	8.80	57.7
WHITE OAK							
9	0.57	.57	.55	.09	4.15	2.45	40.7
10	0	.25	.47	.16	5.13	4.41	14.1
11	0	.57	1.58	.24	6.31	4.16	34.1
12	0	1.06	2.04	.22	7.59	4.49	40.6
13	0	.42	1.72	.27	8.77	6.63	24.8
14	0	1.22	3.49	.22	10.62	5.91	43.7
15	0	.33	3.39	.22	11.23	7.51	33.2
16	0	1.91	4.62	.20	12.61	6.08	51.7
17	0	1.63	4.31	.56	15.01	9.07	~~30.0~~ 40.0
18	0	1.44	8.14	.62	17.76	8.18	55.9
19	0	6.62	3.76	.33	20.38	10.0	50.9

[1]Full-length veneer: 102 inches long; fishtail: 54 inches long; all veneer: 0.160 inch thick.
[2]Green block volume minus full-length veneer volume.
[3]Full-length veneer volume/green block volume × 100.

U.S. Government Printing Office: 1981- 735-056/4002 Region No. 3-11

McAlister, Robert H.
1980. Evaluation of veneer yield and grades from yellow-poplar, white oak, and sweetgum from the Southeast. USDA For. Serv., Res. Pap. SE-220, COM-PLY Rep. 19, 12 p. Southeast. For. Exp. Stn., Asheville, N.C., and U.S. Dep. Housing and Urban Dev., Washington, D.C.

Dry volume yields and standard grades of veneer are given for yellow-poplar, sweetgum, and white oak by tree diameter and location within the stem. Results show that the typical stands of mixed southern pine and hardwood timber yield enough veneer to utilize almost 90 percent of the stand volume in the production of COM-PLY lumber and panels.

KEYWORDS: COM-PLY, lumber, panels, *Liriodendron tulipifera* L., *Liquidambar styraciflua* L., *Quercus* sp.

McAlister, Robert H.
1980. Evaluation of veneer yield and grades from yellow-poplar, white oak, and sweetgum from the Southeast. USDA For. Serv., Res. Pap. SE-220, COM-PLY Rep. 19, 12 p. Southeast. For. Exp. Stn., Asheville, N.C., and U.S. Dep. Housing and Urban Dev., Washington, D.C.

Dry volume yields and standard grades of veneer are given for yellow-poplar, sweetgum, and white oak by tree diameter and location within the stem. Results show that the typical stands of mixed southern pine and hardwood timber yield enough veneer to utilize almost 90 percent of the stand volume in the production of COM-PLY lumber and panels.

KEYWORDS: COM-PLY, lumber, panels, *Liriodendron tulipifera* L., *Liquidambar styraciflua* L., *Quercus* sp.

The Forest Service, U.S. Department of Agriculture, is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.