Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP42 Section:	10.5
Reference:	5
Title:	A. Mick, and D. McCargar, *Air Pollution Problems In Plywood, Particleboard, And Hardboard Mills In The Mid-Willamette Valley*, Mid-Willamette Valley Air Pollution Authority, Salem, OR, March 24, 1969. 2002 supplement

A-2993

This article Summary of Emission Factors for process Plywood

PLYWOOD VENEER A
LAYOUT OPERATION
AP-42 Section 10
Reference Number
#5

MID-WILLAMETTE VALLEY AIR POLLUTION AUTHORITY

2585 State Street
Salem, Oregon 97301

Y-82 Emission Inventories
GY-25 Particulates
GY-28 Spots
Y-33 Open Burning
Y-01 Incinerators
GR-92 Wood

March 24, 1969

Received this one E.E.S.

Plywood Act, Chapter 3
Reference 31

AIR POLLUTION PROBLEMS IN PLYWOOD, PARTICLEBOARD, AND HARDBOARD MILLS IN THE MID-WILLAMETTE VALLEY

GY-53 Boilers

See exp. pp. 12-14

By
Allan Mick Air Engineer
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Oregon Counties
Benton
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Marion
Polk
Yamhill

SUMMARY

Comprehensive field surveys of the wood products industry has resulted in the completion of plywood, particleboard and hardboard emission inventory. This inventory has been invaluable in defining air pollution in the Mid-Willamette Valley and the Authority has designated three separate problem areas for enforcement action or continued study. These are wigwam waste burners, air transfer systems, and veneer dryers. Collectively, all sources annually emit 10,680 tons of particulate, 18,690 tons of carbon monoxide, 11,040 tons of hydrocarbons, 427 tons of nitrogen oxides, and 52 tons of sulfur dioxide.

Annually, these mills generate 954,000 tons of waste of which 377,000 tons are sold, 296,000 tons are utilized in steam and power production. Thus, 281,000 tons are now incinerated. By 1972 the Authority expects a reduction to 100,000 tons or less. In addition to solving the wigwam burner problem, in the next few years the industry will have to control the other major emission problems.

INTRODUCTION

This report was intended to survey all sources of emissions in the plywood-particleboard-hardboard manufacturing plants in the Mid-Willamette Valley of Oregon.

Emission inventory of such a comprehensive nature has no known precedent for these industries and is a direct development of the recent enforcement powers granted this Authority.

The Mid-Willamette Valley Air Pollution Authority began its enforcement program on wigwam waste burners in July, 1968. In spite of a slow start, this program will have achieved a broad impact on air pollution abatement by the end of the first year.

However, field contracts, public complaints, and professional publications increasingly indicated many additional pollutants and emission creating processes in the wood products industry, over and beyond the wigwam waste burner.

This report, basically an emission inventory, attempts to examine and draw conclusions about the whole spectrum of air pollution problems in these plywood and board manufacturing plants.

PROCEDURES AND METHODS

This survey was conducted in a similar manner to other source studies of air pollution problems: (1) specific emission processes were identified, (2) process weights were determined, (3) emission factors were selected and applied to process weights to obtain total emission of specific pollutants.

All available literature was surveyed for studies on emission creating processes in these industries. Field inspections were made of all production facilities. These efforts resulted in the selection and analysis of those emission processes discussed in this report. To assist the reader, process flow-diagrams for typical plywood, particleboard, and hardboard plants are shown in Figures 1, 2, and 3.

Determination of process weights and volumes was a complicated task. In plywood veneer plants, the disposal of wood waste creates the major emission problems. For this reason, wood-waste survey factors were developed. In plywood layout and finishing plants, some emission processes again involve wood-wastes so further survey factors were developed. Other plywood processes, and all particleboard-hardboard processes, involve all finished products, so total

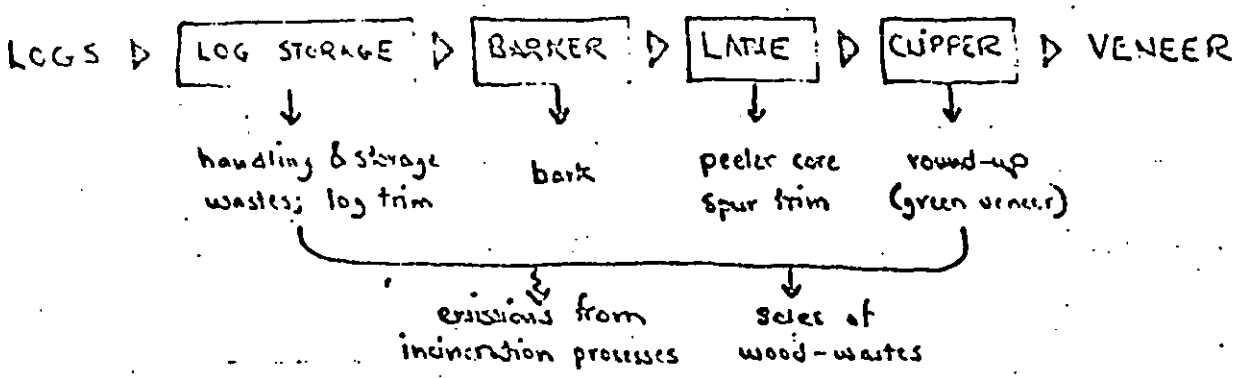

FIGURE 1. PROCESS FLOW-DIAGRAM FOR PLYWOOD VENEER PLANT

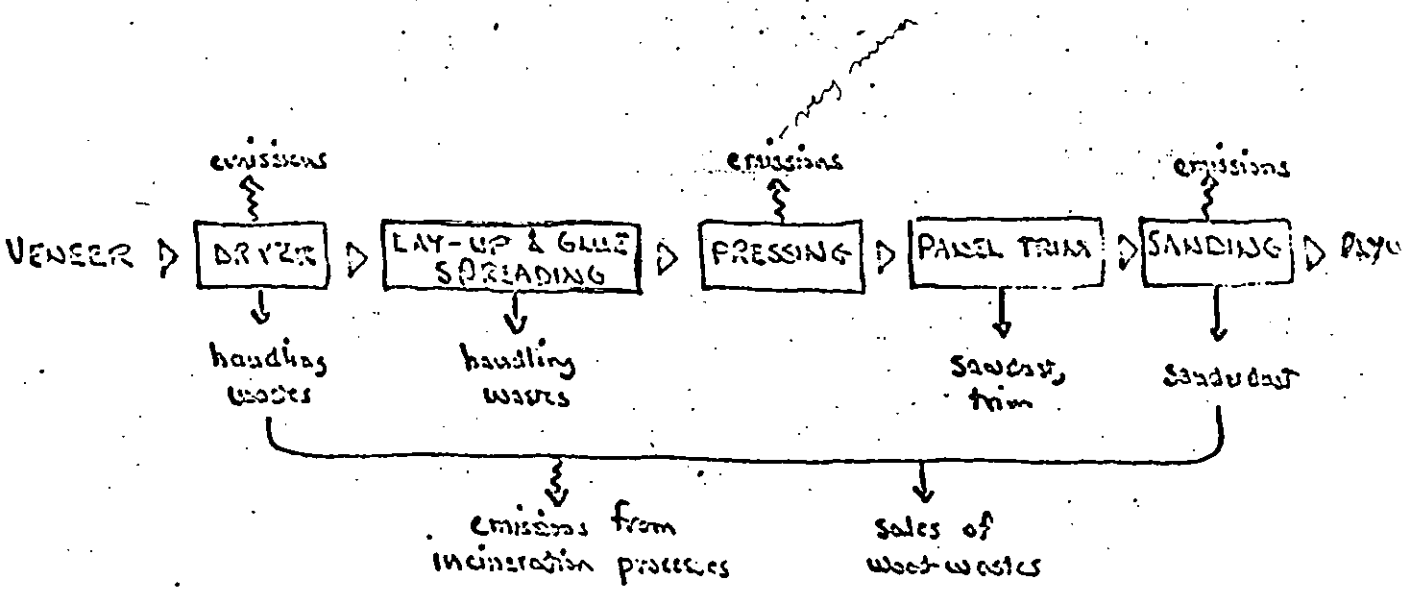

FIGURE 2. PROCESS FLOW-DIAGRAM FOR PLYWOOD LAYOUT PLANT

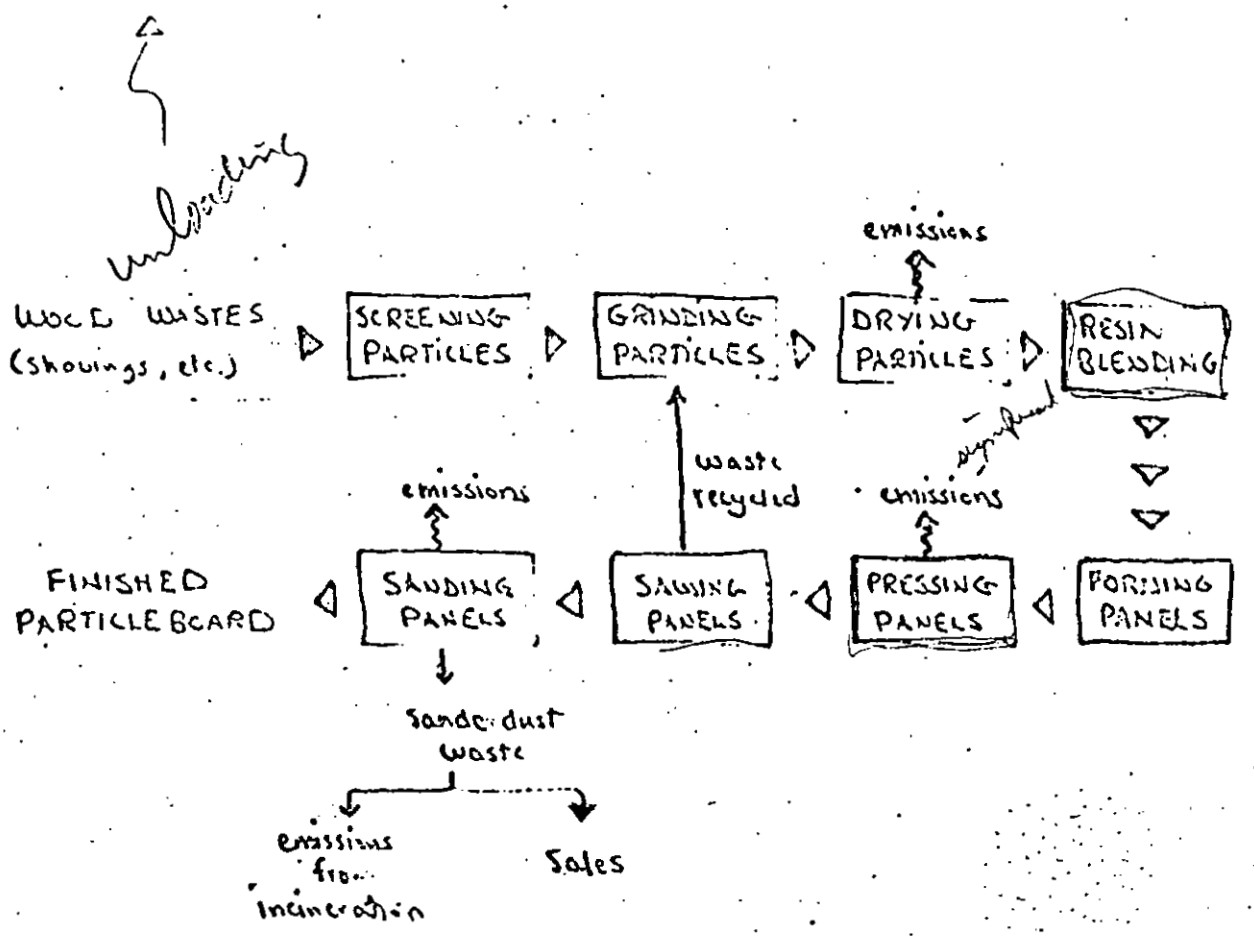

FIGURE 3. PROCESS FLOW - DIAGRAM FOR PARTICLE BOARD PLANT

plant production can be readily used for process weights and volumes.

To clarify this for the reader, Table I, below, contains the wood-waste survey factors. Appendix A contains additional information on the use of these factors. References are listed in superscript.

Table I Wood-Waste Survey Factors[1,2,3]

Type of Plant	Tons of Log Wastes Per Million BFLS	Tons of Production Wastes Per Million Ft.^{2} 3/8"
Plywood Veneer		
Bark	340 × 614 = 208,000	
Green Trim	590	
Core	290	
	1220	
	2000	
Plywood Layout		
Dry Veneer & Panel Trim		140.0
Sawdust		1.0
Sanderdust, One - .035"		46.5
Two - .050"		66.5
Particleboard & Hardboard		
Sanderdust		146.0

The search for emission factors led to many scattered references. Tables II, III, IV, and V bring these factors together. All factors have been adapted for use in a simple calculation to obtain total annual emissions.

Table II Emission Criteria for Wood-Waste Incineration[4,5,6,7]

Type Pollutant	Total Emission Lbs. Per Ton of Wood Wastes		
	Open Burning[4]	Wigwam[5,6] Waste Burner	Wood-Fired[7] Boilers
Hydrocarbons	15.0	11.0	22.2
Carbon Monoxide	60.0	130.0	0.5
Particulate	17.0	10.7	2.6
Nitrogen Oxides	2.0	1.3	1.3
Sulfur Dioxide	0.15	0.15	0.15

Any one of the three incineration processes in Table II can be selected for the determination of emissions. Total wood wastes are calculated by applying wood-wastes survey factors to annual log-scale or product production. (See Appendix B.)

Table III Emission Criteria for Veneer Dryers [8,4]

Type Pollutant	Total Emission Tons Per Million Ft.^{2} Production, (3/8" Basis)	
	lb pollt./ton wood dried @ density of 0.65	
Hydrocarbons	9	2.35
Particulate	0.5	0.125
Nitrogen Oxides	0.22	0.085
Sulfur Dioxide	0.01	0.0003
Carbon Monoxide	0.01	0.0003

To obtain total annual emission, the criteria in Table III are applied to annual product production. Further information is listed in Appendix B.

Table IV Emission Criteria Factors for Cyclone Collectors[11,12]

Type of Cyclone	Total Emission Percent of Sanderdust Wastes
Low Draft	13.7
Medium Efficiency	9.5
High Efficiency	3.6
Multiclone	2.6

The use of both Tables IV and V can be quite complicated and thorough explanations of their use is contained in the Appendix B.

The construction of these Tables was designed for time-saving calculation of total emissions. The Authority will update this as [illegible] emission inventory of these industries with a minimal effort.

— using 1.3 lb wood @ 5 density / ft^2 3/8"

Table IV — Emission Criteria Factors for Hot-Pressing Urea-Formaldehyde Resins[14]

Type Product	Tons of Resin Solid Emission Per Million Ft.^{2} (3/8" Basis)
Particleboard 10% resin, .65 S.G., 350°F.	0.96
Hardboard 6% resin, .80 S.G., 350°	0.88

RESULTS AND DISCUSSION

The field inspection of all production facilities resulted in the basic statistics shown in Table VI. This portion of the wood products industry employs 4,500 workers which makes it one of the major industrial activities of the Mid-Willamette Valley.

Table VI — Statistics, Mid-Willamette Wood Products Industry

Number of Plants*	Specialty	Annual Production
21	Plywood	2074 million sq. ft. 3/8" basis
21	Veneer	614 million board ft. log scale
2	Particleboard	280 million sq. ft. 3/8" basis
1	Hardboard (dry)	130 million sq. ft. 3/8" basis
1	Hardboard (wet)	95 million sq. ft. 1/8" basis

*number of individual firms totals 32.

Manufacture of these wood-products creates an enormous amount of wood-waste, not unlike the lumber industry. Utilization of wastes was found to be fairly good in veneer production plants and definitely poor in plywood production plants. The only waste at particleboard-hardboard plants was found to be sanderdust, as other "wastes" are recycled into the manufacturing process.

Utilization is the key to reducing air pollution problems in these industries, as utilization means reduced waste incineration. Table VII provides data on disposition of wood-wastes. Overall, 40% of total wastes are now marketed, 30% are burned in wigwams, and 30% are burned in boiler plants.

Table VII Annual Wastes and By-Products in Dry Tons in Mid-Willamette Area

Waste Material	Boiler	Wigwam Waste Burner	Chips (Sales)	Misc. (Sales)	Total
Bark	100,000	107,000			207,000
Green Trim	23,000	22,000	315,000		360,000
Sanderdust	59,000	25,000		1,000	85,000
Sawdust	1,000	1,000		1,000	3,000
Dry Trim	113,000	126,000		61,000	300,000
	296,000	281,000	315,000	63,000	955,000 dry

Three incineration processes and three production processes were found to be significant sources of air pollution. Table VIII summarizes the total annual contaminants.

Table VIII Annual Emission of Air Contaminants in Tons Per Year in Mid-Willamette Area

Sources	Emission* Part.	CO	HC	NO_x	SO_2
Combustion					
Wigwam Waste Burner	1,500	18,260	1,550	10	22
WWB Sanderdust Loss	(2,150)	n.a.	n.a.	n.a.	n.a.
Hog Boilers	385	70	3,290	190	22
NG Boilers	5	-	-	30	8
Open Burning	100	360	100	50	n.a.
Non Combustion					
Cyclone Collectors	7,470	-	-	-	-
Veneer Dryers	270	-	5,820	147	-
Particleboard press	-	-	280**	-	-
	10,680	18,690	11,040	427	52

10% of wonderdust, boilers

270 8

*Part. - Particulate
CO - Carbon Monoxide
HC - Hydrocarbons
NO_x - Nitrogen Oxides as NO_2
N.A. - Not Available
**Form - Formaldehyde

Nitrogen Oxides and hydrocarbons enter into photochemical smog reactions and the full effect of particulates is not known at this time. A comparison of these emission sources for these pollutants are made in Table IX.

Table IX A Comparison of Emission Sources in the Mid-Willamette Valley

Source	Annual Emission in Tons		
	Part.	HC	NO_x
Plywood Industry	10,680	11,040	427
Automobiles	510	13,690	4,560

Wigwam Waste Burners

The wigwam is the most serious source of year round visible emission in the Authority's jurisdiction. The plyboard manufacturers use 17 of the 61 burners used by the wood industry. However, the wastes incinerated (Table VII) consist of approximately one-half of the total wastes for the wood industry. As utilization progresses, all veneer plant wastes except bark should be out of the burners. Marketing trends for bark should and must develop in the next few years. Markets for wastes other than bark should provide complete utilization within three years. For example, Duraflake Corporation in Albany, is now expanding raw material pruchases by 8,000 tons per month. A projection for bark burners for 1970 will be 100,000 tons. Continued enforcement action on all burners is necessary to maintain compliance with the Authority's visible emission standards. Sander-dust disposed in a wigwam burner creates an additional particulate emission and the Authority conservatively estimates that 10% of this material directly leaves the wigwam in an unburned state but the actual figure could easily be two to three times greater.

Wood-Fired Boilers

The Authority area has several boilers which, because of inherently better combustion, create less emission than wigwam burners. Some marketable wastes go into boilers; a broad trend toward marketing these and purchasing hog-fuel has helped to reduce wastes in wigwams.

An analysis of the air pollution problems of boiler plants themselves was not included in this report, but their emissions are included in Table VIII.

Open Burning

This Authority has found nearly every mill in the wood-products industry to be guilty of open burning practices. Material burned includes log-deck and pond wastes, plant floor sweepings, office and lunchroom refuse, waste oil-rags-tires from shops, construction and demolition debris.

Emission criteria and estimated emissions are listed in this report (Tables II and VIII). Present rules and regulations are deemed sufficient to allow abatement of this air pollution problem.

Veneer Dryers

Available literature[8,10] indicated significant emissions of hydrocarbons from veneer dryers, so this process was examined closely.

Green veneer panels (50% moisture) are dried to less than 10% moisture in long enclosed heated chambers called ventilated veneer dryers. Two dryers are rarely ever alike. They emit a visible blue plume which is saturated with water vapor and loaded heavily with hydrocarbons. The average frequency of fires in these dryers is once per month. Frequent cleaning of dryers is effective in reducing the rate of these fires which may occur as often as four to five times

each week.[10]

Particleboard and hardboard plants process "green" raw material (shavings, sawdust, veneer wastes) through rotary kiln-like dryers. No specific written reference to these dryers and their emission could be found. With the goal of providing comprehensive coverage of the volatile hydrocarbon emission problem, veneer dryer emission criteria (Table III) were adapted for use on rotary dryers. (See Appendix B.)

Table X provides statistical data on the "wood dryers" in the Authority's area.

Table X Statistics on Wood Dryers in Mid-Willamette Area

Number of Dryers	Type of Dryer	Type of Heat
30	Veneer	Natural Gas
16	Veneer	Steam
6	Rotary	Natural Gas

The total annual emissions from these dryers include 5,863 tons of hydrocarbons, 345 tons of particulates, 153 tons of nitrogen oxides. The annual hydrocarbon emission level is much greater than wigwams (Table VIII) and probably as third as large as automobiles[15]. This is a serious source of air pollution and efforts toward abatement of present emission levels are necessary.

The Authority recognizes that considerable study is necessary before practical emission controls can be provided to reduce this high level of hydrocarbon and visible emissions and has urged the area mills to join in a cooperative effort in developing adequate controls through such organizations as the American Plywood Association.

January 1, 1971, has been set as a reasonable target date for completion of pilot plant studies. The American Plywood Association referred this problem to the Plywood Research Foundation for further study.

Cyclone Particle Collectors

Dust emitting processes are a particularly serious air pollution problem. The harmful influences of suspended particulate and the annoyances of particulate fallout are well documented.

A tremendous volume of sanderdust particulate is generated in most of the manufacturing plants considered in this report, except some plywood plants producing primarily unsanded panels.

The sanding process can be summarized as follows: After being sized in the trim saws, particleboard is sanded on two sides and the hardboard on one. Plywood is either produced as unsanded sheathing or it is sanded on either one or two sides. Quality control in producing the thickness of raw materials is the deciding factor which determines the oversize thickness necessary to produce an unblemished sanded surface. This oversize varies with the quality of logs, quality of veneer, and with the type of sanding equipment used. For instance, less oversize thickness is needed when belt sanders are used in place of the more common drum sanders.

The volume of sanderdust generated was found to vary from 46.5 tons to 146.0 tons per million square feet of sanded panels produced. (See Appendix A.) The total for all these manufacturers was determined to be 85,000 tons per year (Table II). Sanderdust emissions from cyclonic collectors were determined to be 7,465 tons per year (Table VIII).

A deeper examination of air transfer systems and cyclones and of

sanderdust can provide insight into this process and its problems. Air volumes of 40-60 thousand CFM are normally required to capture dust at the sanding machines and to convey it to the collectors. 30 CFM per pound of material is a figure often used to design air transfer systems for wood particles. The largest portion (99.8% by weight) of the particles are in the 10-80 micron size range with a mean particle size on a count basis of 22 microns (1 micron = 1/1000 millimeter = 0.00004 inches).

Table XI Physical Properties of Particleboard Sanderdust[11]

Particle Size	Weight Percent (Also in McGarger 1969)	Number of Particles %
0 - 10	0.1	16.0
10 - 20	2.7	30.0
20 - 30	8.3	20.0
30 - 40	13.2	14.0
40 - 50	16.7	6.0
50 - 60	18.5	5.0
60 - 70	21.2	2.0
70 - 80	19.2	1.5
80	0.1	5.5

Sawdust

Properly engineered medium efficiency cyclones, handling 50,000 CFM of air, are capable of 90.5 percent (weight) efficiencies, and a discharge grain loading of 0.2 gr./SCF or 80 pounds per hour. A high-efficiency multiple cyclone used as a secondary collector on this system would reduce particulate losses to approximately 4 pounds per hour. Some firms are now installing well-engineered cyclone systems for primary collection, followed by baghouses for final collection. Total dust emission then becomes negligible. The Authority's present particulate grain loading standards, when applied to a typical particleboard plant, could allow an atmospheric discharge of more than 8 tons

of dust per day. This is based upon a production rate of 100 million square feet per year with an air flow of 400,000 CFM through the dust removal system.

Process weight emission standards will be required for this type of operation to eliminate the nuisance problems caused.

Other wood-wastes observed to result in particulate emission included: (1) sawdust and hogged plywood wastes carried in air transfer systems and collected in cyclones, (2) hogged bark carried in air transfer systems and collected in cyclones or open air piles, (3) pulp-chip air transfer and collection in cyclones, bins, or transport vehicles. Dust emission from vehicle traffic over unpaved roads and yards can also be a problem in some urban areas. Emission tests may be required where air pollution problems are caused by these sources. Although the total volumes of wood-wastes handled is large, emission data on these specific problems is not available for inclusion in Table VIII. Tests taken on cyclones handling wood particles other than sanderdust, emissions ranging between 0.04 to 0.1 grains/SCF can be expected. In particleboard plants these losses can exceed sanderdust losses.

Particleboard plants purchase plywood trim, planer shavings, and sawdust, which includes small quantities of sanderdust, as raw materials. As the loaded trucks dump into receiving hoppers, considerable quantities of the fine particulate are carried into the atmosphere. One of our particleboard mills has submitted plans on hooding the truck dump station and installing a wet scrubber collection system on the evacuated air stream. This type of approach will be required on similar problems from other plants.

Pressing

Phenolic resin loss to the atmosphere during pressing of panels was examined as a potential air pollution problem. Dried softwood veneer is coated in glue-spreader machines with a phenolic based resin and then either cold or hot pressed into bonded laminated panels. This resin is mixed with a variety of additives in batch mixing areas, many of which were unventilated. The overall emission from this type of resin appeared to be very minor.

Formaldehyde-urea resin, on the other hand, has produced problems for the particleboard and hardboard industry, specifically in removing or masking the formaldehyde odor of the finished product. The bulk of formaldehyde emission occurs, however, during the high temperature (350°F.) press which cures and sets the resin. Haller[14] relates that a press temperature of 350°F., and with a 1.8:1 molecular weight ratio of formaldehyde urea resin, 3% of the total solids will be leached as free formaldehyde. One percent would be emitted at a 1.2:1 mole ratio. A resin manufacturer estimates that the mole ratios commonly used today range between 1.3-1.4:1.(See Figure IV.) The resin binder itself consists of approximately 10% of the total weight of particleboard and 6% in hardboard produced by the dry method.

In August 1966, the Oregon State Board of Health measured the formaldehyde emissions from the vent of a skyblast mounted over a particleboard press. Less than 10 ppm formaldehyde was detected in the exhaust rated at 50,000 CFM.

Formaldehyde emissions from press losses are included in Table VIII. However, more study is required on these emissions before drawing any conclusions as to the necessity for control.

CONCLUSIONS

These wood products industries, due to their size and their many emission processes, contribute a large quantity of contaminants to the atmosphere of the Mid-Willamette Valley. The following areas are of particular importance:

1. Utilization of incinerated wood wastes will result in the closure of most plyboard wigwam waste burners by 1972, with a corresponding reduction in emissions.
2. Wigwams cannot effectively incinerate the large quantities of sanderdust which are generated in the production of sanded plywood and hardboard panels. The burning of sanderdust in wigwams in the jurisdiction will cease in 1969.
3. Veneer dryers are a major source of gaseous hydrocarbon emissions, and studies for effective control programs must be made.
4. In air transfer systems, properly engineered cyclones can handle all wood wastes except sanderdust. Mills will have to modify poorly functioning systems, and for sanderdust collection, multiple cyclones, wet scrubbers or bag houses will be required for proper particulate emission control.
5. Additional studies will be necessary to determine press emissions from particleboard and hardboard plants.

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APPENDIX A.

Use of Wood-Waste Survey Factors

Plywood Veneer Plants

Survey factors include bark, green trim, and core. The factor for each waste was applied to total annual log-scale, in millions of board feet. (BFLS)

For peeler operations integrated into a full plywood plant, when log-scale was not readily available, apparent log-scale was calculated by converting finished plywood (ft^2 into equivalent veneer logs (board-feet) by using a 2.3:1 conversion (recovery was as high as 2.5:1 at some newer plants). If possible, adjustments were made for outside purchases or sales of veneer. No allowance was made for minor tree species (i.e., other than Douglas Fir).

These calculations result in a total process weight which is actually handled by several processes -- basically utilization or incineration of waste.

In order to allocate volumes of each waste to the various emission creating processes, the following questions were asked during the plant tour:

(1) How was the log trim (lilies) disposed?
Percent sold, chipped, burned?

(2) How was the green veneer disposed?
Percent chipped, burned?
(a) What general provisions for utilization?
Pickup of lathe, clipper, and floor, chip screening wastes?

(b) Any special conditions causing waste?
Any by-pass or loss due to poor operation or downtime of barker, chipper, conveyors, storage and transport?

(3) What disposal method for core?
Percent sold, chipped, burned?

(4) Any other wastes?
(a) Hog handling and storage (yard and pond)
Landfill, burned?

(b) Office, lunchroom, shop, plant floor refuse?
Haul-off, burned?

With this information available, a worksheet can be readily drawn up to indicate the volumes going to various processes.

Plywood Layout Plants and Particleboard-Hardboard Plants

For plywood, survey factors include dry veneer and panel trim, sawdust, and sanderdust. For Particleboard-Hardboard only a sanderdust survey factor was used (other wastes are recycled as raw material).

Except for sanderdust, factors were applied to total annual production, in millions of square feet, 3/8" basis.

Sanderdust required development of a whole table of survey factors:

Sanderdust survey factors by depth sanded and density.

(Table values in tons per million ft.^{2} sanded)

	Plywood - Particleboard - Hardboard				
Depth Sanded Densities:	0.51	0.65	0.70	0.75	0.80
Ratios:	1.00	1.27	1.37	1.47	1.57
0.025"	33.3	42.5	45.5	49.0	52.5
0.030"	40.0	51.0	54.8	58.8	63.0
0.035"	46.5	59.3	63.8	68.5	73.0
0.040"	53.3	68.0	73.0	78.5	84.0
0.045"	60.0	76.5	82.3	88.0	94.3
0.050"	66.5	85.0	91.0	97.8	104.5
0.055"	73.3	93.5	100.0	107.5	115.0
0.060"	80.0	102.0	109.5	117.5	125.5
0.065"	86.3	110.0	118.0	127.0	135.5
0.070"	92.8	118.0	127.0	136.5	145.3
0.075"	99.5	126.3	136.3	146.0	156.0

20% or 17% [illegible]

If on a [illegible] basis, density doesn't matter

To select an appropriate factor, firms provided information as to depth sanded and density of their product (always 0.51 for plywood). Three values were common and are underlined above and were used in Table 1. A more accurate, but more time consuming procedure is to request firms to weigh some sample panels before and after sanding.

For plywood, the factor was applied to rough percentage of the production that was sanded. For particleboard-hardboard, total plant production was used.

Again a worksheet was used to allocate these waste weights to various processes. Differences in process - sales process, or waste incineration process - were mainly between plants and not within plants.

APPENDIX A

Notes on Sources for Wood-Waste Survey Factors and Emission Factors

The sanderdust-waste table of factors was derived in the manner of this sample calculation for plywood sanded to 0.025 inch depth: (1,000,000 ft^2) (0.025 inch) (1 foot/12 inches) (0.51) (62.4 lb/ft^3) (1 ton/2000 lb) = 33.3 ton. Particleboard sanding depths vary between 75 to 125 thousandths, and 3/8 inch board weighs 14 pounds/ft^2.

All values in the first column (density 0.51) were similarly calculated. The other columns to the right were derived on a slide-rule by using ratios of density. These are "green basis densities" and not on a bone dry basis.

The sawdust waste factor was similarly derived. All other waste factors are adapted directly from the Pacific Power and Light Report (Reference 1).

The particleboard emission factor was derived in this manner: (1,000,000 ft^2) (.375 inch) (1 ft/12 inches) (.65) (62.4 lb/ft^3) (1 ton/2000 lb.) = 636.4 ton.

If 10% is resin and if 1 1/2% is lost in pressing:

(0.1) (636.4 ton) (0.015) = 0.96 ton.

APPENDIX B.

Use of emission criteria

Wood-Waste Incineration

The process weight (weight of wood-waste) in tons/year, was obtained as explained in Appendix A. Emission criteria were applied directly.

Veneer Dryers

Criteria were applied to total annual plywood production for dryers operating at 350°F. to 400°F. NO_x criteria were not used for steam-fired dryers. For particleboard-hardboard rotary particle dryers the criteria were used thusly:

$(.5)\ (\frac{.80}{.51})\ (100)\ (2.35) = 188$ tons/yr. hydrocarbons

(.5) = fraction of raw material that was green wastes rather than dry

$(\frac{.80}{.51})$ = ratio of average particleboard density to average plywood density

(100) - 100,000,000 ft^2/year production

(2.35) = hydrocarbon emission criteria

Cyclone Collectors

The process weight in tons/year, was obtained as explained in Appendix A. During plant inspection, the air transfer system was sketched out to note the efficiency of cyclone collectors, the number of cyclone passes, and the type of wastes in the system. Thus 600 tons/year passing through two medium efficiency cyclones would have this annual emission:

$(600)\ (.095) + (600 - (600)\ (.095)\ (.095) = 109$ tons/year

Particleboard Presses

The following table was compiled from data supplied by the Borden Chemical Company. Only two data points were available; therefore, emission losses were assumed to be a straight line function of mole ratios of formaldehyde: Urea.

Formaldehyde Emission From Hot Press of Particleboard

Mole Weight Ratio Formaldehyde: Urea		% (total resin weight) of Formaldehyde Vaporized at 350°F. Press Temperature
1.2		1.0
1.3		1.3
1.35	Industry Average	1.5
1.4		1.7
1.5		2.0
1.6		2.3
1.7		2.7
1.8		3.0

APPENDIX C.

Review of disposal methods for sanderdust

1. Sales - Agriculture uses sanderdust for mulches and fertilizer. The dust from particleboard has a high urea content. Sanderdust is also used as a resin extender.

2. Burned in Refractory-Lined Incinerators - the high temperatures generated in igniting sanderdust have been extremely corrosive to the incinerator linings. There are none in operation at this time.

3. Burned in a Flare (Gas Pilot) - The one which is in existence is used in an emergency only. The flare burns with a surprisingly clear plume with an unknown quantity of large particulate fallout. Presently limited to daylight operation only.

4. Injected into Dutch Oven Combustion Chamber - Acceptable practice only in boilers equipped with continuous chart monitoring smoke density indicators. To meet present emission standards, the Authority feels that over and under fire air controls a flyash collector (90% efficiency) and metered feed are essential.

5. Burned in Wigwam Waste Burner - 21,500 tons/year is being incinerated in four burners, none of which are able to comply with Section 15-010 of the Rules of the Authority. Particulate loss is casually estimated at 10% of the total sanderdust dumped into the wigwam waste burner, but losses could easily be two to three times this figure.

Owners have agreed to discontinue burning sanderdust in the four burners within a year.

6. Fired in Specifically Designed Steam Boilers - One 40 ton/day boiler is presently operated in a particleboard plant. Equipped with a multiclone cinder collector, flue gas is utilized in a rotary kiln. Three mills which presently use wigwam waste burners are considering the possibility of utilizing this heat in their veneer dryers. This type of boiler can handle wood waste up to one inch in diameter. The Authority plans on running stack tests on this unit to obtain additional data needed to review sanderdust boiler plans.