U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 72-121-242

MEDFORD VENEER & PLYWOOD CORP.
MEDFORD, OREGON

DECEMBER 1975

I. TOXICITY DETERMINATIONS

It has been determined that veneer dryer emissions, principally abietic and pimaric acids (condensed hydrocarbons) and α- and β- pinene (volatile hydrocarbons), present in the vicinity of the veneer dryer operations, under usual working conditions, may produce transient irritation of the mucous membranes of the eyes, nose and throat, as well as the upper respiratory tract, producing cough. Veneer dryer emissions as well as smoke from fires that occasionally break out in the dryers may transiently aggravate any underlying asthmatic or other chronic respiratory condition and may make hay fever symptomatically worse. On the day of the NIOSH visit two persons out of 19 interviewed noted transient irritation of the mucous membranes of the eyes. Baseline pulmonary function tests were within normal limits for all but three presons tested. Pulmonary function tests revealed small but statistically significant decrements in expiratory flow rates over the course of the usual work shift. The relationship between these acute changes and the subsequent development of chronic respiratory disease is not known at the present time; and only a long-term survey with periodic (annual) pulmonary function testing would evaluate this matter completely. There is no evidence from the present survey to suggest that veneer dryer emissions cause allergic pulmonary disease or hay fever. This determination is based upon a thorough inspection of the veneer dryer operations, environmental measurements, medical interviews, physical examinations, and pulmonary function tests.

Detailed information concerning the medical and environmental results of the determination are contained in the body of this report. Recommendations are included in this determination which are designed to keep employee exposure to veneer dryer emissions to a minimum.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202.

Copies have been sent to:

a. Medford Veneer & Plywood Corp., White City, Oregon
b. Authorized Representative of Employees
c. U.S. Department of Labor - Region X
d. NIOSH - Region X
e. Oregon State Accident Prevention Division

For the purposes of informing the approximately 35 workers, the employer shall promptly "post" the Determination Report in a prominent place(s) near where affected employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S. Code 669(a)(6) authorizes the Secretary of Health, Education, and Welfare, following a written request by any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received a Health Hazard Evaluation request from a representative of employees regarding exposure of the feeders, graders, and dryer tenders to veneer dryer emissions at the Medford Veneer and Plywood Corp., White City, Oregon.

IV. HEALTH HAZARD EVALUATION

A. Description of Plant Process

The Medford Veneer and Plywood Corp. manufactures plywood. The green veneer is trucked in from outlying plants and stored in the yard until needed. The veneer sheets are hand fed into continuous-feed, steam-heated veneer dryers which dry the veneer to a predetermined moisture content. As the veneer exists from the dryer, the veneer sheets are removed and sorted according to grade. The veneer is then jointed, patched, assembled into plywood panels, glued, pressed, trimmed, graded and sanded. This request involved only the veneer drying area.

Veneer dryers are usually equipped to carry the stock horizontally through the dryer by a series of rolls. The rolls comprise a line with the dryers usually containing from four to eight lines. The lines are enclosed in a shell of sheet metal which is divided into sections. The shell also contains fans, ducts and baffles for circulating and directing heat to the various lines. The temperatures used are usually less than 400°F. (Figure 1 is a diagram of a dryer.)

As the water is given up by the heated veneer, it is converted to steam and when mixed with air makes an excellent drying medium. The amount of moisture in the dryer is controlled by dampers in the venting stacks which allow excess steam to escape into the atmosphere. The air-steam mixture is kept in constant circulation by the large fans in the dryer.

Since there are large fans circulating the air in the dryers, a portion of the air in the dryer is under negative pressure and a portion is under positive pressure.

Air under positive pressure will seek out cracks and openings. Since a dryer has leaks around door seals and also is open on both the feeding and grading end of the dryer, the air escapes from the dryer into the room atmosphere.

The air that escapes from the dryer contains steam plus all the hydrocarbons that were volatilized from the wood. The hydrocarbons include alcohols, ketones, esters, aldehydes, terpenes, fatty acids, resin acids, and others. These can be put into two categories, those that condense at ambient temperatures and those that remain volatile at ambient temperatures.

Previous studies indicate that in Douglas Fir the largest portion of the volatile hydrocarbons consisted of α- and β- pinene and the majority of the condensed hydrocarbons were abietic and pimaric acids.

The contents of the emissions vary with the species of wood being dried, whether it is heartwood or sapwood, the percentage of redry veneer, operating temperatures, and operating speed.

B. Evaluation Progress

On 27 December 1972 a valid Health Hazard Evaluation request was received by the Hazard Evaluation Services Branch. On 17 March 1973 an initial environmental-medical survey of Medford Veneer and Plywood Corp. was conducted by Dr. Phillip Polakoff, NIOSH Medical Officer, and Arvin Apol, Regional Industrial Hygienist. A walk-through survey and medical interviews were conducted. It was subsequently decided that further in-depth environmental and medical investigations were necessary.

A literature search, contact with the plywood associations, a plywood manufacturer and Government regulator agencies revealed that sampling methods to characterize the veneer dryer emissions in the work room atmosphere were not available. Also, it was not known if the existing analytical procedures used for stack sampling were sensitive enough to detect the low levels of hydrocarbons expected in the work atmosphere.

Air samples were collected in the work area on April 25 and 26, 1973. The pinenes were collected on charcoal tubes and abietic and pimaric acids were collected on fiberglass filters. Analysis of the samples indicated that either the sampling methods were not adequate, the analytical methods were not sensitive enough or both. The University of Washington Industrial Hygiene group, under contract to NIOSH, embarked on a study to determine the optimum sampling and analytical methods. This period of research and development spanned two years, from 1973 to 1975.

It was determined that the total acids could be collected with an electrostatic precipitator (ESP) and the pinenes collected on charcoal tubes after the acids have been removed by the ESP unit.

It was determined that the pinenes could be desorbed from the charcoal using carbon disulfide and analyzed on a gas chromatograph. It was also determined that the total acids could be removed from the ESP tube with chloroform and analyzed using infrared techniques. (Difficulty was encountered in trying to analyze specifically for abietic and pimaric acids; however, it was possible to determine the total acids present. Since the bulk of the total acids [2,5] (no percentages given) are abietic and pimaric acids, it was decided to analyze for total acids and use the average molecular weights of these two acids in determining the concentration present.

C. Evaluation Methods

On April 14-15, 1975, a repeat environmental-medical survey was conducted by Dr. Robert A. Rostand, NIOSH Medical Officer, and Arvin Apol, Regional Industrial Hygienist.

1. Environmental Evaluation

The environmental evaluation consisted of measuring the concentrations of α- and β-pinenes and abietic and pimaric acids in the approximate area of the veneer dryer workers. The pinenes comprise 75 to 90% of the volatile material in Douglas Fir [2,5] and abietic and pimaric acids comprise the bulk of the condensible material [2,5]. This firm runs about 90% Douglas Fir and 10% White Fir.

On April 14 and 15, 1975, samples were collected in the general work area of the veneer feeders, graders, and dryer tenders. Area samples had to be collected because of the 110 V AC power requirement for the electrostatic precipitator units; however, it was felt that they would be representative since the persons involved generally work 25 to 40 feet from the dryer, and spend greater than 90% of their time in the immediate area. During the sampling period, Douglas Fir was being dried in dryers one and three and White Fir in dryer number two. The weather these two days was overcast, 45^{o} to 50^{o}F with intermittent showers and drizzle. The large traffic doors to these areas were closed approximately 50% of the time. Workers were asked to note how much time was spent out of the general areas of the veneer dryers.

a. Total Acids - Sixteen general area acid samples were collected using 4 Bendix Electrostatic Precipitator units at 12,000 volts DC and at a flow rate of from 4.65 cfm to 8.55 cfm (each unit had a different flow rate) (see Figure 2 for a diagram of the sampling train). The tubes were capped with polyethylene caps and sent to the University of Washington Industrial Hygiene Laboratory. The acids were removed from the tubes with chloroform and analyzed on a Beckman IR4 infrared spectrophotometer at a wavelength of 5.85 u. (See attachment 1 for a complete description of the analytical method used). The sample times varied from 3-1/2 hours to 4 hours each.

b. α- and β-pinenes - Sixteen general area samples were collected on charcoal tubes using MSA personal sampling pumps at a flow rate of 1.0 lpm. The samples were collected in the exhaust of the ESP units as the acids, if not removed, interfere with the adsorption of the pinenes on the charcoal. (See Figure 2 for a diagram of the sampling train). The charcoal tubes were capped with polyethylene caps and sent to the University of Washington Industrial Hygiene Laboratory. The pinenes were desorbed from the charcoal with carbon disulfide and analyzed using gas chromatographic techniques. (See attachment 2 for a complete description of the analytical methods used). The sample time varied from 3-1/2 hours to 4 hours.

2. Medical Evaluation

On April 14-15, 1975, concurrent medical and industrial hygiene evaluations were carried out. Since the Health Hazard Evaluation request specifically dealt with the veneer dryer emissions, only those persons who worked in the areas of the three dryers were evaluated. The persons selected included all pullers, feeders and dryer tender personnel on the first and second shifts. Nineteen (19) persons were evaluated. There were 6 female and 13 male persons.

A non-directed questionnaire was administered and focused on possible work-related illness, the acute and chronic symptoms of veneer dryer emissions inhalation, a short review of systems, a brief allergic history, a smoking history, an occupational history, and a review of past medical history. In addition, a short pre- and post-shift questionnaire was administered in order to evaluate the possible development of acute symptoms during the shift that were not present at the start of the shift. The pre- and post-shift questionnaires were given in conjunction with chest auscultation and pulmonary function test (PFT's). In addition, each person was asked to keep track of how much time was spent out of the area of the veneer dryers as well as how many cigarettes were consumed during the shift. The acute signs and/or symptoms of exposure to veneer dryer emissions that were sought included: irritation of mucous membranes of eyes, nose, and throat, headache, nausea and/or vomiting, shortness of breath, cough, wheezing, and chest discomfort. The chronic symptoms and/or signs that were sought included: development of a new allergy related to veneer dryer emissions, weakness, fatigue, weight loss, chronic cough, sputum production, chest discomfort, chronic shortness of breath. Physical examinations were limited to pre- and post-shift auscultations.

D. Evaluation Criteria

1. Environmental Standards

There are currently no occupational health standards or recommended levels at this time for α- or β- pinene or for abietic acid and pimaric acid.

2. Medical Standards

The medical criteria used to determine a toxic response to veneer dryer emissions under investigation consist of the signs and symptoms associated with exposure to the major substance found in the emissions of Douglas and White Fir. The intensity of veneer dryer emissions may vary with the variety of wood, whether it is heart or sap wood; the percentage of wood for redry, and the dryer temperature and speed.

The veneer dryer emissions consist basically of warm air, water vapor, and a small amount of solid particulate matter and hydrocarbons. The hydrocarbons are made up of two components--those that condense readily on contact with the ambient air and those that remain volatile. Those that remain volatile are similar to the hydrocarbons emitted naturally by growing vegetation and/or components of natural gas fuel. Those that condense are non-reactive in the context of photochemical smog reactions.[4]

The major substance found in veneer dryer emissions of Douglas and White Fir are: alpha-and beta-pinenes, abietic acid and pimaric acid. The literature on these compounds is scanty and incomplete.[6]

a. Pinenes: The pinenes are colorless to yellow liquids with the odor of turpentine. They are the major constituents of oil of turpentine. Pinenes have the following physical properties: mol. wt. 136.2, M.P. 55C., B.P. 155C., flashpoint 91°F, density 0.8585 at 20°C., vapor pressure 10mm at 37.3C, vapor density 4.7. The following information has been quoted from the Hygienic Guide Series on Turpentine. The toxic properties of the pinenes include:

(1). Inhalation: Among the effects observed in humans subjected to severe exposure were irritation of mucous membranes of nose and throat, cough, bronchial inflammation, salivation, headache, vertigo, and irritation of the kidneys and the bladder. It has been reported that continued inhalation of the vapor may cause chronic nephritis and predispose to pneumonia.[7] Albuminuria and hematuria have been reported in men exposed to turpentine vapor with subsequent recovery from such exposures.[8] There is little evidence to suggest that turpentine vapors at low levels are a chronic poison.[9] There is scanty evidence to suggest that some individuals may develop a hypersensitivity to turpentine after prolonged, repeated exposure.[10]

(2) Skin Contact: There is little doubt that turpentine is a skin irritant for normal persons if allowed to remain in contact with the skin for a sufficient length of time. Some persons are so sensitive that even moderate exposure to vapors will cause a skin reaction.[11] Most people do not develop a dermatitis from occasional contact.

(3) Eye Contact: A vapor concentration of 200 ppm is moderately irritating to the eyes.[12]

b. Abietic Acid: Abietic acid is a yellow powder with the following physical properties: Mol. wt. 302-44, metling point 137-166 C. There is scanty toxicological data available on this chemical. According to Patty, abietic acid has a low oral toxicity and is not a skin irritant. However, other sources claim that abietic acid is slightly toxic and slightly irritating to the skin and mucous membranes.

c. Pimaric Acid: No information is available on this agent either in the standard references or in Chemical Abstracts. It is not listed in the NIOSH Toxic Substance List. .

E. Evaluation Results

Environmental Results

Sixteen area samples were collected at four sampling locations for total acids and sixteen for pinenes. The samples were collected during the 4:00 p.m. to midnight shift on April 14 and the 8:00 a.m. to 4:00 p.m. shift on April 15. The individual sample results for the total acids and pinenes are listed in Table 1. The total acid concentrations ranged from 0.01 mg/M^3 to 0.60 mg/M^3 with an average of 0.21 mg/M^3 and a median of 0.17 mg/M^3. The pinene concentrations ranged from 0.02 parts of contaminant per million parts of air (ppm) to 0.90 ppm with an average of 0.13 ppm and a median of 0.05 ppm.

Employees were asked to note how much of their time they spent out of the general area of the dryers. Review of these records showed that employees spent on the average 30-45 minutes out of the dryer area; over 90% of their time was spent in the area of the dryers. Consequently, these area samples are representative of employee exposure to veneer dryer emissions over the course of the shift.

No correlation was found between the acid and pinene concentrations collected at the same time (e.g., they were not present in a fairly constant ratio, therefore, it cannot be predicted what the pinene concentrations would be by looking at the total acid concentrations or visa versa). In general, the levels were slightly higher during the swing shift of April 14 than the day shift on April 15. During the swing shift, the large traffic doors were closed a greater portion of the time as the weather was cold, rainy and included some snow.

Medical Results

The following table summarizes the epidemiologic data of the cohort studied:

Operation	No.	%	Average Age (Range)	Average Length of Employment at Medford Veneer & Plywood
Puller	11	(58%	30.8 yr. (18-45 yr.)	2.0 yr. (5 days - 4 yr.)
Feeder	6	(32%)	56.1 yr. (28-65 yr.)	6.4 yr. (0.25 - 21 yr.)
Tender	2	(10%)	50 yr. (43-56 yr.)	16.7 yr. (1.3 yr. - 22 yr.)
TOTAL	19	(100%)	41 yr.	9 yr.

As can be readily seen, the pullers, who make up over half of the cohort, are younger and have considerably fewer years of service than the other two groups.

Analysis of the questionnaires reveals no clustering of symptoms, signs, or medical illnesses to suggest that individuals working in any one operation or on any one dryer are affected to a greater extent than other individuals. Analysis of the questionnaires with regard to smoking and non-smoking revelas no clustering; however, three persons gave a history of chronic obstructive pulmonary disease. (The term chronic obstructive pulmonary disease, hereafter abbreviated COPD, includes the following diagnoses: chronic bronchitis, emphysema and asthma.)

The following table summarizes the results of the medical questionnaires:

Work Related Symptoms or Complaints Past or Present		Related To	Other Problems or Complaints		Allergic History	
Sneezing	- 1	Sawdust	COPD	- 3	Seasonal Pollinosis	- 3
Back Problems	- 2	Lifting	Bursitis	- 1	None	- 16
None	-16		Post traumatic Complications	- 2		
			None	-14		

TOTAL: 19 Persons

Seasonal pollinosis (hay fever) was noted by three persons, and dryer emissions were noted as the cause of the hay fever as were the emissions noted to aggravate their hay fever. The cases of post-traumatic epilepsy and neuropathy were not work-related. With regard to possible pulmonary allergy due to chronic exposure to veneer dryer emissions, no individual noted development of chest discomfort, soreness, wheezing or shortness of breath, while working around the dryers or after the shift upon returning home, either in the past or on the day of the NIOSH visit. Several individuals noted that when a fire broke out in a dryer, due to an accumulation of knots in the bottom of the dryer, they might occasionally develop chest discomfort, wheezing, as well as irritation of eyes and nose. A review of symptoms that workers have experienced in the past and relate to their job revealed: one individual with throat irritation due to sawdust; six persons with irritation of their eyes, of which three were related to sawdust; one person with cough due to sawdust; and no person noted nasal irritation. These data have been summarized and are found in the back of this report (Table II).

On the day of the NIOSH visit which was considered an average day by the employees, two persons out of 19 noted the following: one noted burning eyes due to a fire that developed in one of the dryers the night before and the other noted gritty eyes. Chest auscultation did not reveal the new development of rales or wheezing over the course of the shift. However, in the two persons with COPD, chest auscultation was abnormal at the beginning of the shift.

Pre- and post-shift pulmonary function tests were carried out employing a Vitalograph spirometer. Five forced expiratory maneuvers were carried out and the "best" curve was chosen and analyzed for forced vital capacity (FVC), forced expiratory volume in one second $FEV_{1.0}$), and maximal mid-expiratory flow rate (MMEF 25%-75%). These measurements were corrected to body temperature and standard barometric pressure of 760 mmHg (BTPS). The predicted values for each person were calculated according to the formulae of Morris, Koski and Johnson that were derived from data obtained from a large group of Mormons and Seventh Day Adventists who resided in Oregon and who had "negative" smoking, pulmonary and occupational histories.[8] The results of these pulmonary function tests along with the predicted values for each subject are at the back of this report (Table III). (Note that only 18 subjects are listed since one subject's tracings were technically poor and cannot be evaluated.)

The following criteria was used to determine if a medically significant acute change occurred over the course of the work shift; an acute decrease in MMEF and/or $FEV_{1.0}$ greater than 10% of the pre-shift value. There were no acute changes in $FEV_{1.0}$ over the course of the shift. There were four persons (subjects #1, 7, 12, and 18) whose tests showed an average drop in MMEF of 18% (range 12-25%) over the course of the shift. Of these persons #7 and #18 were active tobacco users; #1 was an ex-smoker with a history of COPD but with otherwise normal PFT's; and #12 was a non-smoker. There was no correlation between change in MMEF with number of cigarettes consumed, time in area, job location or concentration of α- or β- pinene and total acid as measured environmentally. There is evidence in the literature to suggest that nonspecific irritation may cause transient changes in peripheral airways which might conceivably account for these otherwise inexplicable changes in MMEF.

The following criteria was used to diagnose obstructive lung disease. $FEV_{1.0}$ less than 70% predicted value with a normal FVC; and/or MMEF 25-75% less than 75% predicted. Three subjects (#6, 14 and 16), all active tobacco users fulfilled these criteria. Of these cases, two (#6 and #14) were new cases; the third had been told he had lung disease. A fourth case of COPD (#7) involved a person with a history of asthma with normal PFT's. There were no cases of restrictive lung disease in this population.

Analysis of mean pre- and post-shift FVC, $FEV_{1.0}$, and MMEF 25-75% by work shift and smoking habit (Table IV) reveals small but statistically significant decrements in expiratory flow rates over the shift. The MMEF showed the most frequent statistically significant changes. There were significant changes in MMEF associated with near significant or significant changes in $FEV_{1.0}$

F. Summary of Investigation and Conclusion

A medical-environmental investigation to evaluate the possible relationship between illness and veneer dryer emissions was carried out. Analysis of questionnaires reveals that occupational exposure to veneer dryer emissions has been associated with the development of mucous membrane irritation as well as symptomatic exacerbation of hay fever. On the day of the NIOSH visit two persons out of 19 (10.5%) experienced transient mucous membrane irritation.

The degree of emission intensity in the area of the dryers is dependent on several environmental factors which include: (1) season of the year--the smoke is reported to be most intense from the end of November to the beginning of March; (2) daily weather condition--the smoke intensity is greater when the air is heavily ladened with moisture, little wind velocity present, or a temperature inversion; (3) time of day--the smoke intensity is greater in the evening than in the morning; (4) type of wood being dried--certain types of wood contain a lot of pitch, and (5) dryer operational procedures--dryer temperature, speed, damper settings, etc.

Medical histories and physical examinations revealed no symptomatic acute airway obstruction. Four individuals did show acute changes in MMEF 25-75% over the course of the shift, which were greater than 10%.

Analysis of the environmental data reveal that concentrations of total acids and α- and β- pinene were slightly higher during the swing shift than during the day shift.

Based on a thorough inspection of the veneer dryer operations, environmental measurements, medical interviews and physical examinations, and pulmonary function tests, it has been determined that veneer dryer emissions, under usual working conditions, may produce transient irritation of the mucous membranes of the eyes, nose, and throat, as well as the upper respiratory tract. Veneer dryer emissions as well as smoke from fires that occasionally break out in the dryers may transiently aggravate any underlying asthmatic or other chronic respiratory conditions and may make hay fever symptomatically worse. Baseline pulmonary function tests were within normal limits for all but three persons tested. Pulmonary function tests revealed small but statistically significant decrements in expiratory flow rates over the course of the usual work shift. The relationship between such acute changes and the subsequent development of chronic respiratory disease is now known at the present time; and only a long-term survey with periodic (annual) pulmonary function testing would evaluate this matter completely. There is no evidence from this survey to suggest that veneer dryer emissons cause pulmonary disease or hay fever.

V. RECOMMENDATIONS

1. It is strongly recommended that suitable ventilatory changes be carried out so that employee exposure to veneer dryer emissions be reduced to a level below that found by the NIOSH investigation.

2. The dryer tender is an important man in controlling the dryer emissions. An increased emphasis in this area should aid in keeping the dryer emissions to a minimum.

3. When leaks develop in the dryers, they should be repaired as soon as is practical.

4. When general ventilation is used as a control, large volumes of air have to be exhausted. Although total exhaust capacities were not measured, it is obvious that they are not adequate. Increasing the amount of general ventilation over the dryer would definitely aid in removing the emissions, however, the total effect is difficult to estimate.

5. The large fan behind the feeding end of the number two dryer exhausts out of the end of the building and under some weather conditions, the emissions will reenter the building through the traffic door by the number three dryer. If the air was directed upward and released above the building, the amount of reentry would be reduced.

6. It is recommended that a pre-employment history and physical examination be carried out on all new employees assigned to the veneer drying operations. In addition, it is recommended that pre-employment and subsequent periodic (annual) pulmonary function testing (to include FVC, $FEV_{1.0}$, and MMEF 25-75%) be carried out on all new employees assigned to the veneer dryer operations as well as on the current dryer feeders, off-bearers, and dryer tenders. Individuals with a history of asthma or other chronic respiratory condition may be made symptomatically worse by working in close proximity to the veneer dryers and may find the use of a respirator helpful.

7. Adequate house cleaning should be maintained at all times and every effort should be made to prevent fires from developing.

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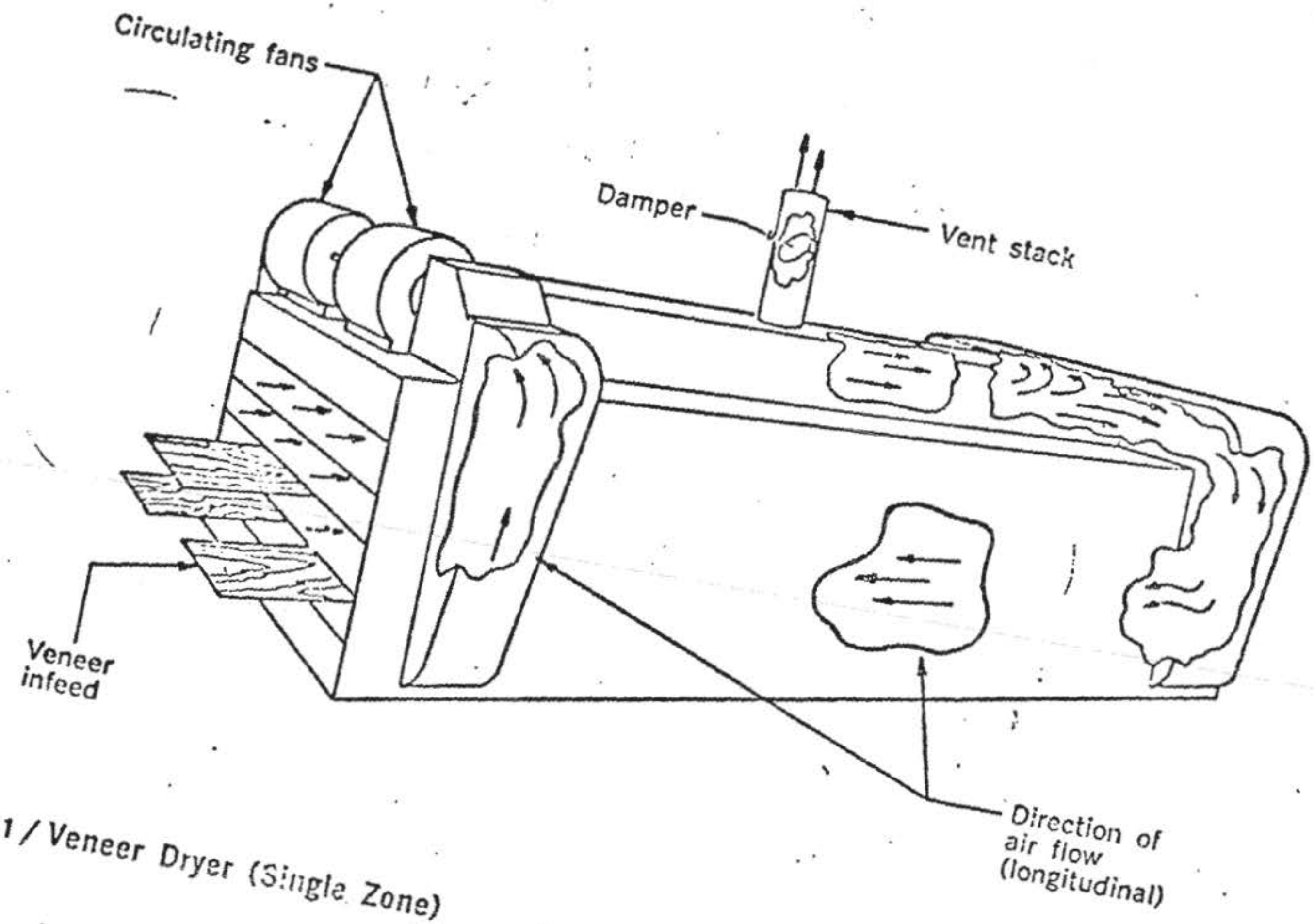

Figure 1 / Veneer Dryer (Single Zone)

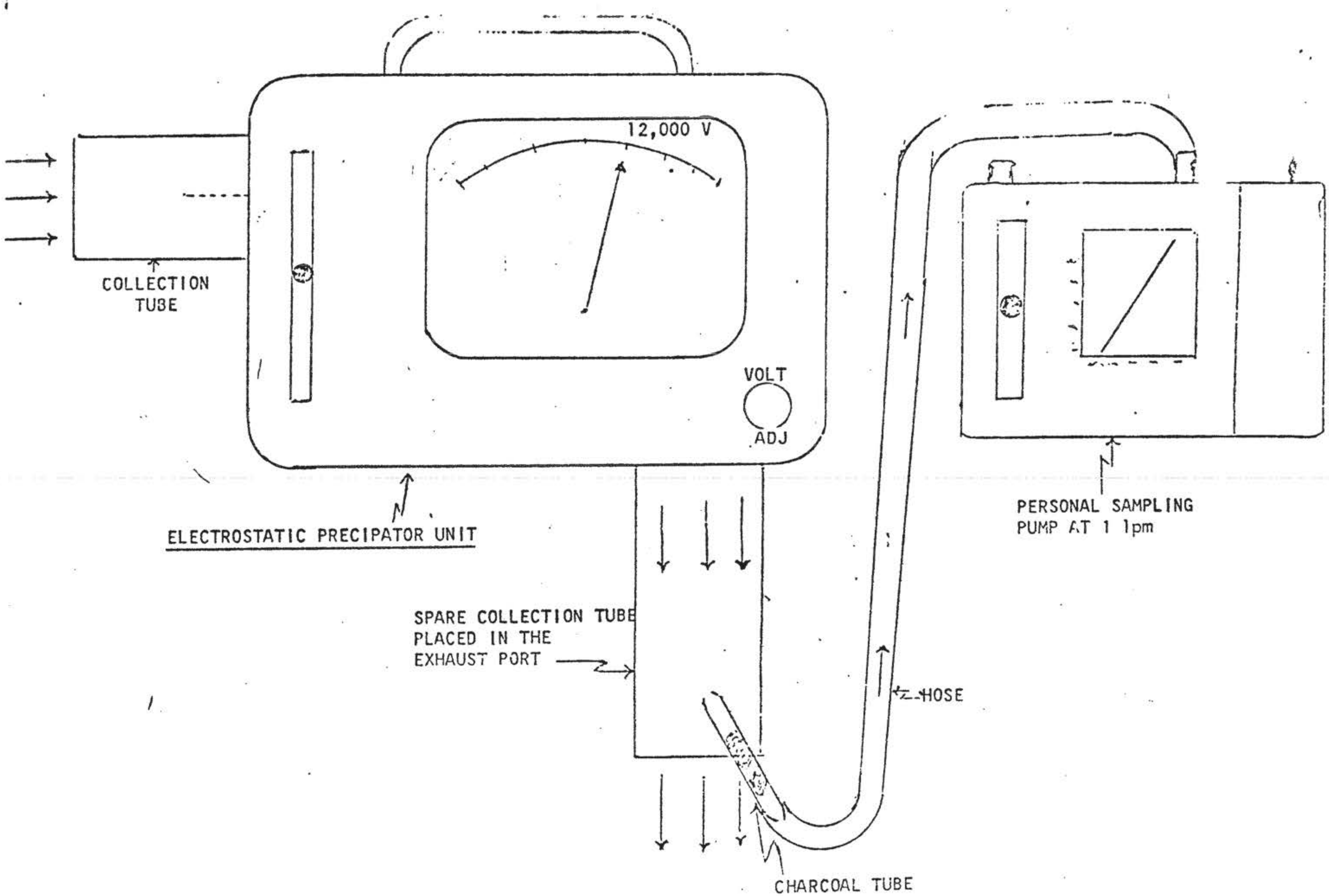

FIGURE 2. SAMPLING SCHEMATIC

TABLE I

α AND β PINENE AND TOTAL ACID CONCENTRATIONS

LOCATION	DATE	SAMPLE PERIOD	TOTAL SAMPLE TIME(MIN)	TOTAL ACIDS			α & β PINENE			TYPE OF WOOD DRIED
				SAMPLE #	SAMPLE VOL CUBIC METERS	mg/m³*	SAMPLE #	SAMPLE VOL LITERS	PPM **	
Grader End # 3 Dryer	4-14-75 4-14-75	4:25pm - 8:20pm 8:20pm - 11:55pm	235 215	1 7	47.2 43.2	0.31 0.60	1 7	235 215	0.04 0.06	Douglas Fir
	4-15-75 4-15-75	8:00am - 12:00 noon Noon - 3:45pm	240 225	11 16	48.3 45.2	0.12 0.20	11 16	240 225	0.03 0.04	" "
Feeder End # 3 Dryer	4-14-75 4-14-75	4:40pm - 8:25pm 8:25pm - 12:00 midnight	225 215	3 6	45.2 43.2	0.33 0.57	3 6	225 215	0.16 0.11	" "
	4-15-75 4-15-75	8:00am - 12:00 noon noon - 3:45 pm	240 225	12 15	48.3 45.2	0.09 0.17	12 15	240 225	0.07 0.10	" "
Grader End # 2 Dryer	4-14-75 4-14-75	4:20pm - 8:15pm 8:15pm - 11:55pm	235 220	2 5	56.9 53.3	0.11 0.24	2 5	235 220	0.03 0.03	White Fir
Feeder End # 2 Dryer	4-15-75 4-15-75	8:00am - 11:55pm 11:55am - 3:45pm	235 230	10 14	31.0 30.3	0.06 0.11	10 14	235 230	0.02 0.02	" "
Grader End # 1 Dryer	4-15-75 4-15-75	8:00am - 12:05pm 12:05pm - 3:45pm	245 220	9 13	59.3 53.3	0.01 0.02	9 13	245 220	0.02 0.13	Douglas Fir
Feeder End # 1 Dryer	4-14-75 4-14-75	4:45pm - 8:30pm 8:30pm - 12:00 midnight	225 210	4 8	29.6 27.6	0.17 0.30	4 8	225 210	0.35 0.90	" "

* mg/m³ - milligrams of substance per cubic meter of air

** ppm - parts of vapor or gas per million parts of air

TABLE II

PAST HISTORY OF SYMPTOMS

Related to Throat, Eyes, Nose, and Cough

	THROAT		EYES		NOSE		COUGH	
SMOKERS	0/10	(0%)	3/10	(30%)	0/10	(0%)	0/10	(0%)
NON-SMOKERS	1/9	(11%)	3/9	(33%)	0/9	(0%)	1/9	(11%)
TOTAL COMPLAINTS	1/19	(5%)	6/19	(32%)	0/19	(0%)	1/19	(5%)
NO COMPLAINTS	18/19	(95%)	13/19	(68%)	19/19	(100%)	18/19	(95%)

TABLE III

PULMONARY FUNCTION RESULTS

Medford Veneer and Plywood Co.

MEDPLY	PRE-SHIFT			POST-SHIFT			PREDICTED VALUES		
A.M. SHIFT NON-SMOKERS	FVC (% Pred.)	$FEV_{1.0}$ (% Pred.)	MMEF 25-75% (% Pred.)	FVC (% Pred.)	$FEV_{1.0}$ (% Pred.)	MMEF 25-75% (% Pred.)	Pred. FVC	Pred. $FEV_{1.0}$	Pred. MMEF 25-75
1	6.50 (126)	4.60 (129)	3.40 (106)	6.60 (128)	4.50 (126)	2.60 (81)	5.16	3.56	3.20
2	4.13 (87)	3.40 (94)	3.97 (105)	4.24 (89)	3.58 (99)	4.08 (108)	4.75	3.62	3.77
3	4.75 (116)	3.75 (127)	3.47 (115)	4.55 (112)	3.50 (118)	3.20 (106)	4.08	2.96	3.01
4	5.50 (183)	4.40 (182)	4.63 (149)	5.40 (179)	4.40 (182)	4.52 (146)	3.01	2.42	3.10
MEAN	5.22	4.04	3.87	5.20	4.00	3.60			
SMOKERS									
5	3.94 (113)	3.22 (118)	3.05 (96)	3.60 (103)	2.98 (109)	2.97 (93)	3.48	2.73	3.19
6	3.65 (81)	2.51 (80)	1.30 (45)	3.90 (86)	2.40 (77)	1.29 (44)	4.52	3.13	2.92
7	4.16 (73)	3.44 (82)	3.44 (86)	4.05 (71)	3.20 (76)	2.87 (72)	5.73	4.20	4.01
8	5.45 (104)	4.50 (108)	4.74 (104)	5.40 (104)	4.46 (107)	4.30 (95)	5.17	4.16	4.54
9	4.50 (103)	4.05 (115)	4.85 (124)	4.50 (103)	4.05 (115)	4.74 (121)	4.39	3.52	3.91
MEAN	4.34	3.54	3.48	5.29	3.42	3.23			

TABLE III (Cont'd)

PULMONARY FUNCTION RESULTS

Medford Veneer and Plywood Co.

MEDPLY	PRE-SHIFT			POST-SHIFT			PREDICTED VALUES		
SWING SHIFT NON-SMOKERS	FVC (% Pred.)	$FEV_{1.0}$ (% Pred.)	MMEF 25-75% (% Pred.)	FVC (% Pred.)	$FEV_{1.0}$ (% Pred.)	MMEF 25-75% (% Pred.)	Pred. FVC	Pred. $FEV_{1.0}$	Pred. MMEF 25-75
10	5.45 (123)	4.00 (125)	2.98 (93)	5.53 (125)	4.20 (131)	2.94 (92)	4.42	3.20	3.19
11	4.52 (108)	3.85 (116)	4.19 (112)	4.50 (107)	3.75 (113)	4.02 (108)	4.18	3.33	3.73
12	7.30 (122)	6.55 (137)	8.82 (173)	7.15 (120)	6.43 (134)	7.71 (151)	5.97	4.79	5.09
13	5.00 (96)	4.15 (98)	4.19 (90)	4.80 (92)	4.00 (95)	3.75 (81)	5.22	4.23	4.63
MEAN	5.57	4.64	5.05	5.50	4.60	4.61			
SMOKERS									
14	5.50 (117)	3.75 (105)	2.31 (63)	5.25 (112)	3.50 (98)	1.93 (53)	4.70	3.56	3.68
15	7.15 (124)	6.35 (147)		7.05 (122)	5.90 (136)	-	5.76	4.33	4.28
16	4.10 (109)	2.80 (106)	1.51 (57)	4.15 (111)	2.75 (104)	1.36 (51)	3.75	2.64	2.64
17	5.70 (143)	4.45 (140)	3.86 (106)	5.65 (142)	4.46 (140)	3.64 (100)	3.98	3.18	3.64
18	3.65 (81)	3.15 (88)	3.86 (98)	3.45 (77)	2.97 (83)	3.39 (86)	4.48	3.58	3.94
MEAN	5.22	4.10	2.89	5.11	3.92	2.58			

Table IV

MEDFORD VENEER & PLYWOOD CORP.

Category	Mean - Pre-Shift	Mean - Post-Shift	% Change Over Shift	p Value	Statistical Interpretation ($p < 0.05$ is significant)
A.M.					
Non-Smokers					
FVC	5.22	5.20	-0.38	0.7876	Not Significant (NS)
FEV_1	4.04	4.00	-0.99	0.6697	NS
MMEF	3.87	3.60	-6.9	0.2614	NS
Smokers					
FEV	4.34	4.29	-1.2	0.6262	NS
FEV_1	3.54	3.42	-3.4	0.0645	Near Significant
MMEF	3.48	3.23	-7.18	0.0937	Near Significant
A.M. TOTAL					
FVC	4.73	4.69	-0.85	0.5409	NS
FEV_1	3.76	3.67	-2.39	0.0984	Near Significant
MMEF	3.65	3.40	-6.85	0.0328	Significant
SWING					
Non-Smokers					
FVC	5.57	5.50	-1.26	0.3360	NS
FEV_1	4.64	4.60	-0.86	0.6380	NS
MMEF	5.05	4.61	-8.71	0.1621	NS
Smokers					
FVC	5.22	5.11	-2.11	0.1084	NS
FEV_1	4.10	3.92	-4.39	0.0852	Near Significant
MMEF	2.89	2.58	-10.73	0.0251	Significant
SWING TOTAL					
FVC	5.37	5.28	-1.68	0.0428	Significant
FEV_1	4.34	4.22	-2.76	0.0762	Near Significant
MMEF	3.97	3.59	-9.57	0.0161	Significant

Table IV (Cont'd)

MEDFORD VENEER & PLYWOOD CORP.

Category	Mean - Pre-Shift	Mean - Post-Shift	% Change Over Shift	p Value	Statistical Interpretation (p < 0.05 is significant
ALL SMOKERS					
FVC	4.78	4.70	-1.67	0.1605	Not Significant (NS)
FEV_1	3.82	3.67	-3.93	0.0081	Significant
MMEF	3.21	2.94	-8.41	0.0036	Significant
ALL NON-SMOKERS					
FVC	5.39	5.35	-0.74	0.3452	NS
FEV_1	4.34	4.30	-0.92	0.4748	NS
MMEF	4.46	4.10	-8.07	0.0458	Significant
GRAND TOTAL					
FVC	5.05	4.99	-1.19	0.0781	Near significant
FEV_1	4.05	3.95	-2.47	0.0116	Significant
MMEF	3.80	3.49	-8.16	0.0008	Significant

ATTACHMENT 1

SAMPLING AND ANALYTICAL PROCEDURE FOR TOTAL ORGANIC ACIDS

SAMPLING PROCEDURES

The samples were collected in Bendix Electrostatic Precipitator tubes, at a flow rate of from 4.85 cfm to 8.55 cfm (the flow rates on each unit varies) for a period of from 3 to 4 hours. The tube can be capped and stored until ready for analysis.

ANALYSIS

The collected sample was extracted from the ESP tube by a minimum volume of chloroform. Since the abietic acid is not volatile, the excess solvent is evaporated by a stream of dry air. The condensed extract is transferred to a one milliliter volumetric flask and diluted to volume.

A portion of the sample is then transferred to a clean dry infrared cell (0.2 mm thickness) and run against a solvent blank on a Beckman IR4 Infrared Spectrophotometer. Peaks at 2.95, 3.4, 5.85 and 7.2 microns were observed but the 5.85 μ peak was most sensitive and characteristic of the abietic and other organic acids. The slope of a standard curve for the commonly found acids was similar and the total acid is reported as the quantity of abietic acid. By gas chromatography of the esterified acid mixture, the abietic acid constitutes a major portion of the extracted acids. There are not significant amounts of other interferring substances.

ATTACHMENT 2

SAMPLING AND ANALYSIS FOR PINENE

SAMPLING PROCEDURES

The sample is collected on a NIOSH charcoal collection tube which is mounted in the exhaust flow of a Bendix Electrostatic Precipitator to remove interferring aerosals. The charcoal sample is taken at a rate of one liter per minute for a period of 3-4 hours. The tube can be capped and stored until ready for analysis.

ANALYSIS

The front section of the charcoal tube is desorbed with one milliliter of carbon disulfide. The backup portion of charcoal is run separately and if its content is greater than 20%, breakthrough would be indicated and would lead to questionable results. The charcoal was desorbed for a period of at least one hour. Standard solutions of α and β pinene in carbon disulfide are prepared and run along with the samples.

Microliter amounts of the samples were injected into a Model 1200 Varian gas chromatograph with a hydrogen flame ionization detector and a 1/8" x 6' Carbowax 20M on chromosorb G 60-80 mesh column. The column temperature for routine analysis was 85°C isothermal. For initial exploratory work, the column temperature was programmed from room to 200°C and the individual peaks were identified by mass spectrometry. Interferring compounds were not present. The concentration of pinene was determined from a ratio of peaks of samples to standards.

For the purposes of these samples, the α and β pinenes were both measured and the total pinene concentration was reported. The β pinene concentration did not exceed 10% of the total in any of the samples.