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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. 75-19-276

MASONITE CORPORATION
EVENDALE, OHIO

APRIL 1976

I. TOXICITY DETERMINATION

It has been determined that airborne concentrations of wood dust are toxic to helpers at the multi-blade rip and 1-man cutoff saws and operator of router number 63. Measured concentrations of total particulate ranged from 1.24 to 911.4 mg/M^3, and from 0.31 to 4.4 mg/M^3 for the respirable fraction. The questionnaire response and medical examinations of the interviewees provide evidence that the dust is causing irritation to conjunctiva and mucous membranes of the upper respiratory tract. Bronchial and deep lung irritation are difficult conditions to exclude; however, there is little in the questionnaire response, medical history, physical examination, pulmonary function or particle size data which indicates that such a condition exists. Also, there is no evidence to support that pulmonary allergic sensitization or nasopharyngeal cancer had occurred in any employees.

It also has been determined that the diehl rip saw helper appears to have a longstanding case of allergic contact dermatitis secondary to wood dust exposure. This is based on a query of a Masonite Corporation dermatologist and physical examination by a National Institute for Occupational Safety and Health (NIOSH) medical officer. Because NIOSH could not obtain employee cooperation, patch testing to determine which component of the dust was the etiologic agent was not performed.

Based on environmental measurements, employee interviews and medical examinations, and available literature on the toxicity of formaldehyde and phenol it also is concluded that these substances are not toxic in the concentrations found.

Recommendations have been offered in Section V of this report for (1) control of environmental exposure of employees to wood dust, and (2) employment of personal protective equipment until engineering controls can be instituted.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, Robert A. Taft Laboratories, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

a) Masonite Corporation, Evendale, Ohio
b) Authorized Representatives of Employees
c) U.S. Department of Labor - Region V
d) NIOSH - Region V

For purposes of informing the approximately 25 "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where exposed 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.C. 669 (a)(6) authorized the Secretary of Health, Education and Welfare, following receipt of a written request from 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 received such a request from an authorized representative of the International Association of Machinists Local Number 789. The request was directed at employee exposure to wood dust in the Saw-Sanding Department of the Masonite Corporation Fabrication Plant in Evendale, Ohio.

IV. HEALTH HAZARD EVALUATION

A. Description of Process-Conditions of Use

The Evendale facility has been in operation since 1962, and is involved in the fabrication of component wood parts for a variety of commercial products, including hutch and china back panels, clock faces, book case backs and television cabinets. Approximately 88 persons are employed in the plant, with 54 of those being classified as production workers; 25 employees are "directly affected" by the alleged hazard.

The component parts are principally fabricated from Masonite hardboard, although particleboard, fiberboard and flake board also are used. Ninety-five percent of the boards are supplied by three domestic mills, the remainder by two foreign mills. The bulk species of wood comprising the domestic boards are redwood, oak, elm and Douglas fir; secondary wood types include ash, cottonwood, hickory, magnolia, birch, beech, pecan, holly, maple, sweet gum, sycamore, walnut, willow and poplar. The imported boards contain South African black wattle and multiple species of the genus eucalyptus (blue gum).

Different adhesives are used in the bonding of the boards depending on the characteristics required of the finished product. The synthetic adhesives used by the suppliers to the Evendale facility are urea-formaldehyde and principally phenol-formaldehyde resin systems.

The fabrication process involves a multiplicity of different types of woodworking machinery common to the industry. The process begins in the saw-sanding department where the boards are cut to serviceable sizes. This involves a multi-blade rip saw used for cutting the boards into strips of different widths which are cut into a multiplicity of segments of various lengths by cross-cut saws. Belt, drum and pneumatic sanders are employed where needed for caliper control or surface smoothness. The boards proceed to the fabrication department where they are formed in the woodworking area and/or cut in the punch press area. The boards are formed by shapers, routers, planars, and other miscellaneous woodworking machinery. The punch presses are used to obtain precision cut hardboard parts.

The majority of the materials have been fabricated at this point, however, vinyl laminated strips are sent to the miter-fold department to be fabricated into television or speaker cabinets. The process involves a cross-cut groove saw which cuts a miter joint in a single piece of laminated wood allowing for a one piece folding, using the vinyl covering as the joint.

All machinery, except punch presses, are ventilated by a typical woodworking extract system. It consists of hoods for the pickup of wood dust and chips at the machines, ductwork, a collection device (cyclone), a storage bin, and a fan blower to supply air for conveying purposes.

B. Study Progress

During April 8-10, 1975 an initial environmental survey was conducted by a team of NIOSH industrial hygienists. An introductory conference was held with union and management representatives to obtain background information about processes, materials and employee profile. The entrance meeting was followed by a walk through survey of the fabrication process, relevant to the areas of the request.

Review of the fabrication process revealed that approximately 25 workers were exposed to a combination of particulate and gaseous air contaminants. Immediately identifiable was exposure to wood dust generated by the woodworking machinery. The gaseous contaminants included formaldehyde and phenolic vapours released during the sawing and sanding of the Masonite boards[1]. Consequently, the airborne levels of wood dust were measured at various woodworking operations located in the saw-sanding, fabrication and miter-fold departments, and during episodic operations such as blow down of the dust collection bins which occurred each day between 11:30-11:45 a.m. The airborne concentrations of formaldehyde and phenol were not measured due to the absence of necessary reagents and equipment. Medical questionnaires were completed on 18 of the 25 affected employees. Because of extremely high dust levels at several operations and the high incidence of complaints including rhinitis, conjunctivitis, dry or sore throat, cough with sputum, skin rash or irritation, bronchitis and asthma, an in-depth environmental/medical follow-up study was planned.

Subsequently, a detailed medical/environmental follow-up study was conducted on August 19 and 20, 1975. Employees from the above mentioned areas were interviewed individually and in private. A complete medical history was taken with regard to lung and skin problems, especially as any such problems might be related to wood dust, formaldehyde, or phenol exposure. A physical examination and pulmonary function test also were completed on each interviewee. Because two employees had skin rashes at the time of the examination, one of whom gave a history which was very suggestive of an occupationally-related contact dermatitis, samples of the boards and wash room soap were obtained for future patch testing. However, despite repeated attempts at contacting the dermatitis-affected employee for patch testing, no such testing was able to be performed due to lack of employee cooperation.

The environmental evaluation consisted of measuring the airborne levels of phenol, formaldehyde and wood dust. It also was considered important to obtain information on the size distribution of airborne dust produced at the rip saw to enable some estimation of its respirability to be made. The rip saw was selected because the environmental data of April 9 and 10, 1975 showed that the highest dust exposure was occurring at this operation. Secondly, the medical questionnaire response indicated that the particulate generated by this saw might be creating or contributing to an alleged pulmonary problem in one employee who worked at this saw. Thus, a more accurate characterization of the dust, beyond that supplied by a two stage cyclonic separator, was felt to be necessary to determine if the dust was of a size which could cause a pulmonary problem.

C. Methods

1. Environmental

a. Wood Dust

The total dust samples were collected on polyvinyl chloride (PVC) filters contained in 3-piece closed faced cassettes. The respirable fraction was collected on a PVC filter contained in a 2-piece cassette mounted in a 10 mm nylon cyclonic separator. The 1 and 2 stage samplers were attached to the workers garments as close to the breathing zone as possible; air was pulled through the sampler by means of a battery operated vacuum pump at a flow rate of 2.0 and 1.8 liters per minute, respectively. The filters were preweighed and the amount of dust collected was determined by weight increase.

A six stage Andersen cascade impactor was used to establish an aerodynamic particle size-mass distribution of the airborne dust produced by the rip saw. The air sampler was positioned on a one meter high pedestal which was placed adjacent to the normal work station of the saw helper. Three sets of data were obtained over the 8-hour shift in order to minimize or prevent particle re-intrainment[2]. An 81 mm diameter, 0.8 µm membrane filter was mounted on each metal impaction plate and was also mounted in a back-up filter assembly downstream of the sampler to retain all particles which were too small to be collected by the impactor. The flow through the impactor was regulated to 0.99 cfm by using a critical flow orifice. The filters were equilabrated in an environmentally controlled atmosphere for two days before initial and final weighing. When sampling was complete the filters were reweighed in order to determine the weight distribution.

The capture efficiency curves and aerodynamic effective cutoff diameter (ECD) values used were those of Flesch et. al., 1967, calibrated with methylene blue aerosol sized by electron microscope for stages 2-4 and with polystyrene latex aerosol for stages 5 and 6. Stage 1 was assumed to have an efficiency curve of shape similar to stage 2 but passing through the 50% point ECD of 9.2 um as reported by Andersen, 1966. The ECD values are summarized in Table I.

TABLE I

Andersen Sampler Aerodynamic Effective Cutoff Diameters

Stage No.	ECD Value (μm)
1	9.2
2	5.35
3	2.95
4	1.53
5	0.92
6	0.54

b. Total Phenol and Formaldehyde

The total phenol and formaldehyde samples were collected by drawing air at a rate of one liter per minute by means of a battery operated vacuum pump through a midget impinger containing 15 ml of an absorbing solution. The absorbing solutions were 0.01 N sodium hydroxide and 1% sodium bisulfite, respectively. A 3-piece closed faced cassette containing a PVC filter was placed upstream of the impinger to remove all particulate from the air stream prior to entering the impinger. The impinger was placed on a table adjacent to the normal work station of the employee.

2. Medical

During the April 8-10, 1975 field investigation medical questionnaires were completed on 18 of 25 employees affected by the alleged hazards. The interview was begun with a non-directed questionnaire in order to elicit any symptoms or medical problems of significant magnitude to come spontaneously to mind. A subsequent directed questionnaire was completed for each of the 18 interviewees. A physician elicited clarification of these questionnaires was performed via personal medical history and physical examination of the conjunctiva, nose, throat, skin and lungs on 17 of the 18 previously interviewed persons on August 19, 1975. Mid-shift pulmonary function testing using a vitalograph spirometer also was completed for each interviewee. The group consisted of one female (age 33) and 16 males (average age 36).

The pulmonary function test parameters evaluated were forced vital capacity (FVC), forced expiratory volume in one second ($FEV_{1.0}$) and the forced expiratory ratio ($FEV_{1.0}$)/FVC). The data were predicted on the basis of subjects sex, age and height and were compared with the actual test performance. For instance, FVC = 3.696 liters in this subject, which is 79.88% of the predicted value of 4.697 liters. Less than 80% of the predicted value was used as an index of obstructive difficulty. The predicted normal values for females and males are derived from the nomogram by Kamburoff and Woitowitz[11].

D. Evaluation Criteria

a. Environmental

The source of environmental evaluation criteria is the recommended and proposed threshold limit values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH) in 1975. These recommendations are based on the current state of knowledge concerning the toxicity of these substances and are designed to protect individuals occupationally exposed to these substances on an 8-hour per day, 40 hour per work week basis over a normal working lifetime. The TLV's are time-weighted averages for an 8-hour exposure, except when preceded by C, which indicates a ceiling value which should never be exceeded.

The present threshold limit value recommended by the ACGIH for phenol is 19 mg/M^3 (5 ppm) and an environmental limit of 3 mg/M^3 (2 ppm) expressed as a ceiling value is proposed for formaldehyde.

Review of the literature reveals that some of the wood types contained in the various boards are allergenic namely, ash, beech, birch, elm, oak, poplar, and eucalyptus[5,6], as well as, non-allergenic (refer to Part IV, Section A of this report). Thus, the wood aerosol generated consists of both allergenic and non-allergenic wood types. The ACGIH recommends a provisional limit of 5 mg/M^3 for non-allergenic wood dust (total). At the present time, a separate environmental criteria for allergenic wood dust does not exist. Even if one did exist, it is very doubtful that the technology needed to distinguish between wood types in a given sample exists. In view of the above, the 5 mg/M^3 (total dust) limit is used as the reference criteria for evaluating the environmental data.

b. Medical Criteria

1. Formaldehyde: Irritation of the eyes, nose, mouth and throat are the most common worker health effects from inhalation of the gas. Formaldehyde has a very pungent odor which is detectable at concentrations less than 1 ppm; discomfort noted at 2-3 ppm when a tingling sensation in the eyes, nose and throat may be felt; and burning of eyes, nose and throat with difficult breathing at 10-20 ppm[7]. Asthmatic symptoms, such as wheezing, may occur in persons with an allergic sensitivity to formaldehyde[8]. Individual susceptibility to formaldehyde gas is noticeable.

Some workers develop a physical tolerance to the irritant effects and work in concentrations intolerable to others, but others are markedly sensitive and may become more susceptible on repeated exposure[9,10]. Dermatitis may result from direct contact with either liquid solutions or solid materials or resins containing free formaldehyde. Skin sensitization seldom results from exposure in the vapor state. Individuals who already developed an eczematous skin sensitization may, however, show a flareup of the skin reaction upon encountering formaldehyde in the vapor state[7].

2. <u>Phenol</u>: Due to a relatively low volatility, phenol does not frequently constitute a serious respiratory hazard in industry[9]. Dizziness, headache, delirium, muscular weakness, and cold sweat are common symptoms in severe cases of poisoning, which usually occurs through ingestion. Liquid phenol is readily absorbed through the skin producing a tingling sensation followed by loss of feeling.

3. <u>Wood Dust</u>: The potential health problems relating to wood dust exposures embrace the toxic manifestations of cancer, dermatitis, respiratory disease and a variety of miscellaneous symptoms.

An increase incidence of adenocarcinoma of the nasal cavity and sinuses have been reported to occur among wookdworkers in the furniture industry in Great Britain[12] and among woodworkers in Sweden[20]. The types of wood implicated from the British studies of adenocarcinoma among woodworkers are oak, beech, mahogany, African walnut, Indian lamel, elm, chestnut, African cheery, cherry, walnut, deal, ash and plywood. In addition to carcinoma of the nasal sinuses, exposure to wood dust can produce pathological changes in the lungs[13]. This possible wood-cancer relationship was further studied by Milham[21] who conducted a mortality study of the AFL-CIO United Brotherhood of Carpenters and Joiners of America. This study supports the hypothesis that wood contains cancer causing agents. The cancer mortality patterns found were:

1. Excess lung cancer in acoustical tile applicators and insulators.
2. Excess gastrointestinal cancer in pile drivers.
3. Excess leukemia-lymphoma group cancers in millwrights, millmen, lumber and sawmill workers, and cabinet makers.
4. Excess lung and stomach cancer in construction workers with greater excesses seen in major urban areas.

Dermatitis due to contact with woods or their dusts is relatively common[14,15,1] Dermatitis may take the form of primary irritant dermatitis, either from mechanical or chemical irritation. Woods of tropical origin or woods not previously handed are most often incriminated. The toxic agents are commonly non-saturated resinous acids in a free state of alkaloids, but other types of chemicals are responsible in some cases. Respiratory conditions resulting from exposure to dusts from woods or diseased barks include bronchial asthma and pneumonia, allergic alveolitis and others[17]. Miscellaneous symptoms include nausea, epistaxis (nose bleed), headache, weakness, and others.

E. Evaluation Results and Discussions

1. Environmental

Personnel monitoring of the woodworking operations involved in the Masonite fabrication process and during episodic operations such as blow down of the dust collection bins was conducted during the first shifts of April 9-10 and August 19-20, 1975. The results of these measurements are summarized in Tables II through V. Twenty-seven personal air samples for total particulate were collected which ranged from a low of 0.31 mg/M^3 to a high of 911.4 mg/M^3, and eighteen for the respirable fraction which ranged from 0.07 to 4.4 mg/M^3.

Total dust concentrations experienced by workers at several operations exceeded the threshold limit value of 5 mg/M^3 recommended by the ACGIH on one or more days. The highest dust levels were measured in the breathing zone of the rip saw helper which ranged from 1.22 to 776.53 mg/M^3 with an average level of 272.14 mg/M^3 8-hour time-weighted average. The respirable fraction ranged from 0.33 to 3.75 mg/M^3 with an average concentration of 1.23 mg/M^3 8-hour T.W.A. The averages were computed from four days of sampling data.

Other excessive exposures included the cutoff saw helper and router operator. The respective concentrations, based on one day of sampling data, were 84.39 and 5.84 mg/M^3 8-hour T.W.A. No respirable fraction was obtained for the cutoff saw helper, however, the respirable fraction of the router operator was 0.72 mg/M^3 8-hour T.W.A. An employee during blow down of the dust collection bins also was exposed to elevated levels of total dust. The workers average exposure computed from four days of data was 48.20 mg/M^3 with a range of 11.18 to 117.5 mg/M^3. However, due to short exposure periods (range 0.17 to 0.33 hours), the measured exposure level expressed as an 8-hour T.W.A. (1.58 mg/M^3) is far below the TLV of 5 mg/M^3. The corresponding respirable fraction was 0.35 mg/M^3 8-hour T.W.A. A chemical cartridge-type respirator is worn by the employee during this activity.

The data on the particle size-weight distribution is summarized in Table VI. The cumulative weight percents were calculated assuming that the weight on each stage was larger than the effective cutoff diameters (ECD) for that stage, but less than that of the previous stage. For stage number 1 the mass collected on the sieve number 1 was added to weight of stage number 1 to account for wall losses[2]. A cumulative plot on log-probability paper of the measurements of total airborne dust is shown in Figure 1. The distribution of sample weights appears to approximate a log-normal distribution with a mass median diameter (MMD) greater than 10 µm. In all of the samples (3), greater than or equal to 62.8% (average 83.8%) of the weight of dust was found on the first stage of the impactor (equivalent diameter 9.2 um). Particles in this size range will be trapped very effectively in the nasal passages on inhalation. An average per cent of 6.88 of the total weight was collected on stage 2. The total particulate concentrations measured by the Andersen sampler are contained in Table VII. The sum total of the three sets of data resulted in a total dust level of 35.48 mg/M^3.

It is clear from the results that the dust concentrations vary over a wide range, and thus the level to which a particular worker is exposed may be quite different on consecutive days. Such differences are most apparent from the rip saw data. In part this may be attributed to daily variations in the types of boards being fabricated, i.e., observations indicated that higher dust levels were associated with flake board in contrast to hardboard. It is also apparent, that the particles produced are associated with a size range which is predominantly larger than the A.E.D. respirable size of 7 μm. Therefore, it seems likely that a relatively small proportion of the mass of airborne wood dust will penetrate to the alveolar region of the respiratory tract.

Work area concentrations of formaldehyde and total phenol vapours were measured at four woodworking operations during August 19-20, 1975. The evaluated operations and corresponding air sample results are summarized in Tables VIII and IX, respectively. The measured air concentrations of formaldehyde ranged from 0.09 to 0.17 mg/M^3, which is well below the selected environmental criteria of 3 mg/M^3. Systematic measurements were not made because low levels of formaldehyde were anticipated. The total phenol samples were all less than 0.53% ($<$ 0.1 mg/M^3) of the 19 mg/M^3 limit.

Subsequent to completion of NIOSH's field activities, the plant in question suffered an explosion in the dust collection system. Thus, the environmental conditions described may change significantly.

2. Medical Evaluation

a. Medical History

The medical history of the employees surveyed revealed the following: (1) Approximately half (10/17) of the workers complained of mucous membrane irritation (e.g. tearing, burning of the eyes and/or dry or sore throat); (2) none of the workers had a history consistent with pulmonary sensitization reaction to wood dust; (3) one of the workers had a history consistent with skin allergy to wood dust. The rash had been continually present for the past four years and was confined to areas where his skin contacted dust. It resolved when he was on vacation. Very careful avoidance of contact with dust and personal hygiene had been the most effective (although imcompletely effective) treatment; (4) all of the employees (7/17) who complained of symptoms of chronic bronchitis (e.g. bronchitis, cough with sputum) were long term heavy cigarette smokers, except one. This person has been a Masonite employee for approximately six years and had bronchitis symptoms prior to being employed; and (5) no employee was ever known to develop nasopharyngeal cancer.

b. Physical Examination

Physical examination of the chest was normal in all of the employees examined except two of the long-term heavy cigarette smokers who showed increased antero-posterior diameter and diminished chest excursion felt to be consistent with pulmonary emphysema. One employee (diehl rip saw helper) had a diffuse erythematous skin rash confined to the exposed areas of the hands and forearms which was felt to be consistent with allergic contact dermatitis. Despite the efforts described in Part IV, Section B of this report, the employee did not keep appointments to be patch tested. Examination of mucous membranes revealed no abnormalities except for four cases of moderate pharyngeal injection.

c. Lung Function Studies

The data for the 17 workers who completed pulmonary function maneuvers on August 19, 1975 are summarized in Table X. The average $FEV_{1.0}$/FVC was 86% and not less than 80% in any employee who had not been a long time cigarette smoker. The mean for cigarette smokers was 80%. The average $FEV_{1.0}$ and FVC for the 17 subjects studied was 103 and 106% of the predicted values, matched for sex, age and height.

The following conclusions are indicated from the medical evaluation data:

1. There is good evidence that the dust at the concentrations measured is causing irritation to conjunctiva and mucous membranes of the upper respiratory tract. This is especially true near the large rip saw, router number 63, and 1-man cutoff saw operations.

2. The diehl rip saw helper appears to have a longstanding case of allergic contact dermatitis secondary to wood dust exposure. Because NIOSH could not obtain employee cooperation, patch testing to determine which component(s) of the dust was the etiologic agent was not performed.

3. Bronchial and deep lung irritation are difficult conditions to exclude. However, there is little in the questionnaire response, medical history, physical examination, pulmonary function, or particle size data which indicates that such a problem exists. Also, there is no evidence to suggest that pulmonary allergic sensitization had occurred.

V. RECOMMENDATIONS

1. Environmental

Excessive wood dust levels at the multi-blade rip saw, router number 63 and 1-man cutoff saw indicate that the efficacy of the existing local exhaust ventilation systems on these machines is inadequate, thus further dust control measures are essential.

Even though a local exhaust hood completely encloses the dust producing areas of the rip saw, the saw helper is exposed to dust concentrations well in excess of the recommended environmental criteria. This may in part be attributed to improper positioning of two collection ducts located beneath the saw blades which permit large accumulations of saw dust. For example, as a board to be cut passes through the saw blades dust deposits on the board and are thrust into the breathing zone of the saw helper as the board strikes the floor. The two bottom ducts and hood should be so designed, located and placed that the wood particles and shavings generated will fall or be projected or drawn into the ducts in the direction of the air flow. Appropriate design performance data is contained in Appendix 1. Also the acoustical material which lines the inside of the upper exhaust hood should be removed. In all probability, it is creating turbulent air flow and increased static pressure with resultant decreased system collection efficiency.

The local exhaust system of router number 63 should be redesigned according to the criteria contained in Appendix 1. Locating the hood as close to the cutter head as possible is advisable due to the nature of the material generated which most likely includes inertials. Inertials are large particles with equivalent diameters exceeding 50 μm which may be projected from the cutting edge with such high speed and abundance that collection by an exhaust hood is more difficult. The use of compressed air to blow the particles and chippings away from the router table should be discouraged. Although the fine particles generated may not be inhaled by the operator of the machine, the use of compressed air may result in a general increase in the level of dust in the workshop environment. This should also apply to any other operations where this practice is employed.

The extract ventilation system of the 1-man cutoff (radial) saw should be modified to include a flexible exhaust duct at the inlet side of the saw. An illustration and design criteria for a typical radial saw is presented in Appendix II.

General ventilation system recommendations are:

1. A thorough inspection and evaluation of the entire ventilation system should be conducted to insure that conditions such as obstructions, leaking duct connections, torn flexible ducts, belt slippages, etc., are not preventing the attainment of maximum efficiency of the system.

2. When a machine is non-operational, consideration should be given to closing the dampers or gates of such machines, thereby affording greater collection efficiency by the hoods where wood machining is being conducted.

Until further dust controls are implemented or existing ones improved, the wood dust concentrations measured at the rip and cutoff saws and router number 63 indicate that a conscientious respirator program should be initiated. The program should meet the eleven criteria of a "minimal acceptable program" as outlined in 29 CFR Part 1910.134 (b) of the U. S. Department of Labor Occupational Safety and Health regulations.

Respiratory protective devices are tested and approved by the National Institute for Occupational Safety and Health for protection against various atmospheric contaminants. Pursuant to 29 CFR Part 1910.134 (b)(11), it is desirable to select NIOSH approved respiratory protective equipment.

A single-use respirator for respiratory protection against pneumoconiosis- and fibrosis-producing dusts may suffice for the exposures encountered by the multi-blade rip saw helper, 1-man cutoff saw helper and operator of router No. 63. A chemical cartridge type respirator with a pre-cartridge particulate filter is recommended for use by the employee responsible for blow down of the dust collection bins.

2. Medical

The diehl rip saw helper does appear to have a longstanding case of allergic contact dermatitis secondary to wood dust exposure. Skin contact should be avoided as far as possible. Personal cleanliness, protective clothing (gloves and long sleeve shirts) and barrier creams are effective prophylactic measures. Although it may be possible that employment of these measures will permit the allegedly sensitized worker to continue his present work, it is also possible that his dermatitis may be dosed by such small amounts of wood dust that he will be unable to tolerate any further skin contact with wood dust. If this occurs, provisions should be made to provide the worker with a job which does not require further exposure.

It might be noted that if it is planned to temporarily protect workers with cartridge-type respirators, that there might be individuals in this group for whom the wearing of a respirator carries certain specific dangers, i.e. highly increased resistance to airflow in an individual with compromised pulmonary function may be associated with acute respiratory insufficiency. Therefore, pulmonary function testing should be carried out prior to requiring any individual to wear a cartridge-type mask.

VI. AUTHORSHIP AND ACKNOWLEDGEMENTS

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TABLE II

Respirable and Total Airborne Particulate Sample Results

Masonite Corporation
Evendale, Ohio

April 9, 1975

Job Classification and Operation	(a) Type of Sample	Sampling Period	Sample Volume M^3	(b) Concentration mg/M^3
Helper: Multi-Blade Rip Saw	BZ-T	0749-1125	0.432	207.20
Helper: Multi-Blade Rip Saw	BZ-T	1205-1520	0.390	131.20
Operator: Multi-Blade Rip Saw	BZ-R	0720-1125 1210-1525	0.741	0.39
Operator: Large Porter Saw	BZ-R	0725-1125 1205-1525	0.748	0.36
1st Helper: Large Porter Saw	BZ-T	0750-1125 1205-1520	0.820	4.50
Operator: 1-Man Cutoff Saw	BZ-T	0751-1125 1205-1520	0.818	5.05
Helper: 1-Man Cutoff Saw	BZ-T	0754-1125 1205-1520	0.822	6.82
Operator: Blow Down of Dust Bins	BZ-T	1119-1137	0.042	117.50
Operator: RS28 Onsund	BZ-R	0735-1125 1205-1520	0.723	0.39
Operator: 60-34 Shaper	BZ-T	0759-1125 1205-1520	0.802	1.19
Operator: No. 1 Groover	BZ-T	0804-1125 1205-1520	0.792	1.35
Operator: Diehl Rip Saw	BZ-T	0815-1125 1205-1520	0.770	0.73

(a) BZ = Breathing Zone; T = Total Particulate; R = Respirable Particulate.

(b) mg/M^3 = Milligrams of particulate per cubic meter of air sampled.

TABLE III

Respirable and Total Airborne Particulate Sample Results

Masonite Corporation
Evendale, Ohio

April 10, 1975

Job Classification and Operation	(a) Type of Sample	Sampling Period	Sample Volume M3	(b) Concentration mg/M^3
Helper: Multi-Blade Rip Saw	BZ-T	0726-1125	0.478	223.20
Helper: Multi-Blade Rip Saw	BZ-T	1230-1520	0.340	688.20
Helper: Multi-Blade Rip Saw	BZ-R	0726-1125 1230-1520	0.695	4.40
Operator: Multi-Blade Rip Saw	BZ-T	0731-1125 1200-1525	0.878	0.98
Operator: Large Porter Saw	BZ-T	0740-1125 1200-1525	0.860	3.47
Helper: Large Porter Saw	BZ-R	0741-1125 1200-1525	0.766	0.48
Operator: 1-Man Cutoff Saw	BZ-R	0747-1125 1200-1520	0.710	0.58
Operator: Blow Down of Dust Bins	BZ-T	1130-1140	0.040	11.18
Operator: Router No. 64	BZ-T	0840-1125 1200-1520	0.730	1.67
Operator: Diehl Rip Saw	BZ-T	0749-1125 1200-1520	0.832	1.04

(a) BZ = Breathing Zone; T = Total Particulate: R = Respirable Particulate.

(b) mg/M^3 = Milligrams of particulate per cubic meter of air samples.

TABLE IV

Respirable and Total Airborne Particulate Sample Results

Masonite Corporation
Evendale, Ohio

August 19, 1975

Job Classification and Operation	(a) Type of Sample	Sampling Period	Sample Volume M^3	(b) Concentration mg/M^3
Helper: Multi-Blade Rip Saw	BZ-T	0740-1127 1212-1527	0.844	1.39
Helper: Multi-Blade Rip Saw	BZ-R	0740-1127 1212-1527	0.759	0.51
Operator: Large Porter Saw	BZ-T	0744-1127 1203-1518	0.836	0.83
Operator: Large Porter Saw	BZ-R	0744-1127 1203-1518	0.752	0.44
Operator: 1-Man Cutoff Saw	BZ-T	0753-1123 1210-1515	0.790	1.24
Operator: 1-Man Cutoff Saw	BZ-R	0753-1123 1210-1515	0.711	0.15
Operator: 2-Man Cutoff Saw	BZ-T	0759-1120 1208-1524	0.794	5.04
Operator: 2-Man Cutoff Saw	BZ-R	0759-1120 1208-1524	0.715	0.20
Operator: Router No. 63	BZ-T	1257-1520	0.286	9.65
Operator: Router No. 63	BZ-R	1257-1520	0.257	0.31
Operator: Blow Down of Dust Bins	BZ-T	1130-1140	0.020	47.78

(a) BZ = Breathing Zone; T = Total Particulate; R = Respirable Particulate

(b) mg/M^3 = Milligrams of particulate per cubic meter of air sampled.

TABLE V

Respirable and Total Airborne Particulate Sample Results

Masonite Corporation
Evendale, Ohio

August 20, 1975

Job Classification and Operation	(a) Type of Sample	Sampling Period	Sample Volume M^3	(b) Concentration mg/M^3
Helper: Multi-Blade Rip Saw	BZ-T	0748-1116 1205-1523	0.812	24.86
Helper: Multi-Blade Rip Saw	BZ-R	0748-1116 1205-1523	0.730	0.47
Operator: Large Porter Saw	BZ-T	0743-1119 1204-1512	0.808	1.74
Operator: Large Porter Saw	BZ-R	0743-1119 1204-1512	0.727	0.13
Operator: 1-Man Cutoff Saw	BZ-T	0735-1124 1206-1509	0.824	0.91
Operator: 1-Man Cutoff Saw	BZ-R	0735-1124 1206-1509	0.742	0.07
Operator: 2-Man Cutoff Saw	BZ-T	0736-1123 1208-1510	0.818	1.73
Operator: 2-Man Cutoff Saw	BZ-R	0736-1123 1208-1510	0.736	0.50
Operator: Router No. 63	BZ-T	0738-1044 1045-1123 1210-1525	0.372 0.468	45.40 51.04
Operator: Router No. 63	BZ-R	0738-1123 1210-1525	0.840	0.82
Operator: Blow Down of Dust Bins	BZ-T	1130-1145	0.030	16.33

(a) BZ = Breathing Zone; T = Total Particulate; R = Respirable Particulate

(b) mg/M^3 = Milligrams of particulate per cubic meter of air sampled.

TABLE VI

Data on the Aerodynamic Particle Size-Weight Distribution
of the
Particulate Generated by the Multi-Blade Rip Saw

Masonite Corporation
Evendale, Ohio

August 20, 1975

Data Set No. 1:

Andersen Section	Stage ECD, μm	Stage Weight mg	% of Sample Weight on Stage	Cumulative % Less Than ECD
Stage No. 1	9.2	8.19	62.81	37.18
Stage No. 2	5.35	2.44	18.71	18.47
Stage No. 3	2.95	0.87	6.67	11.80
Stage No. 4	1.53	0.51	3.91	7.89
Stage No. 5	0.92	0.42	3.22	4.67
Stage No. 6	0.54	0.41	3.14	1.53
Back-up-filter	--	0.20	1.53	--
Data Set No. 2:				
Stage No. 1	9.2	31.66	86.10	13.89
Stage No. 2	5.35	1.92	5.22	8.67
Stage No. 3	2.95	1.18	3.21	5.46
Stage No. 4	1.53	0.75	2.04	3.42
Stage No. 5	0.92	0.60	1.63	1.79
Stage No. 6	0.54	0.42	1.14	0.65
Back-up-filter	--	0.24	0.65	--
Data Set No. 3				
Stage No. 1	9.2	33.58	88.83	11.17
Stage No. 2	5.35	1.67	4.42	6.75
Stage No. 3	2.95	0.65	1.72	5.03
Stage No. 4	1.53	0.57	1.51	3.52
Stage No. 5	0.92	0.54	1.43	2.09
Stage No. 6	0.54	0.48	1.27	0.82
Back-up-filter	--	0.31	0.82	--
Cumulative Data:	9.2	73.43	83.81	16.19
	5.35	6.03	6.88	9.31
	2.95	2.70	3.08	6.23
	1.53	1.83	2.09	4.14
	0.92	1.56	1.78	2.36
	0.54	1.31	1.50	0.86
	--	0.75	0.86	--

TABLE VII

Total Particulate Concentration as Measured by an Andersen Impactor Positioned Adjacent to the Multi-Blade Rip Saw

Masonite Corporation
Evendale, Ohio

August 20, 1975

Data Set No.	Sampling Period	Sample Volume M^3	Concentration[(a)] mg/M^3
1	0810-1020	3.63	3.59
2	1108-1125 1205-1330	3.97	9.26
3	1430-1530	1.67	22.63

(a) mg/M^3 = Milligrams of particulate per cubic meter of air sampled.

TABLE VIII

Work Area Concentrations of Airborne Formaldehyde

Masonite Corporation
Evendale, Ohio

August 19-20, 1975

Date of Sample	Sampling Location	Sampling Period	Sample Volume m^3	Concentration (a) mg/M^3
8-19-75	Table: Large Porter Saw	0920-1129 1205-1526	0.330	0.13
8-19-75	Table: 1-Man Cutoff Saw	0915-1525	0.430	0.12
8-19-75	Table: Multi-Blade Rip Saw	0907-1531	0.444	0.17
8-20-75	Table: Large Porter Saw	0810-1528	0.426	0.09
8-20-75	Table: 2-Man Cutoff Saw	0810-1516	0.438	0.09
8-20-75	Table: Multi-Blade Rip Saw	0810-1119 1204-1518	0.383	0.16

(a) mg/M^3 = Milligrams of substance per cubic meter of air sampled.

TABLE IX

Work Area Concentrations of Total Phenol's

Masonite Corporation
Evendale, Ohio

August 19-20, 1975

Date of Sample	Sampling Location	Sampling Period	Sample Volume m^3	(a) Concentration mg/M^3
8-19-75	Table: 1-Man Cutoff Saw	0915-1525	0.430	<0.1
8-19-75	Table: 2-Man Cutoff Saw	0924-1524	0.430	<0.1
8-19-75	Table: Large Porter Saw	0920-1129 1205-1526	0.330	<0.1
8-20-75	Table: Multi-Blade Rip Saw	0907-1531	0.444	<0.1

(a) mg/M^3 = Milligrams of substance per cubic meter of air sampled.

TABLE X

FORCED EXPIRATORY VOLUMES

Masonite Corporation
Evendale, Ohio

August 19, 1975

TEST	PREDICTED	OBSERVED	% PREDICTED	% FEV(1)/FVC
CODE NO. 100 AGE 34 SEX MALE HT(IN) 66 WT(LBS) 135				
FVC	4.37	4.75	108.71	
FEV(1)	3.66	4.50	122.93	94.74
CODE NO. 101 AGE 33 SEX MALE HT(IN) 70 WT(LBS) 175				
FVC	4.92	5.50	111.80	
FEV(1)	4.06	4.45	109.48	80.91
CODE NO. 102 AGE 33 SEX MALE HT(IN) 69 WT(LBS) 165				
FVC	4.79	5.40	112.79	
FEV(1)	3.97	4.40	110.81	81.48
CODE NO. 103 AGE 30 SEX MALE HT(IN) 67 WT(LBS) 175				
FVC	4.59	4.60	100.23	
FEV(1)	3.87	4.00	103.45	86.96
CODE NO. 104 AGE 21 SEX MALE HT(IN) 55 WT(LBS) 155				
FVC	3.20	3.85	120.22	
FEV(1)	2.99	3.40	113.68	88.31
CODE NO. 105 AGE 30 SEX MALE HT(IN) 60 WT(LBS) 145				
FVC	3.66	3.60	98.23	
FEV(1)	3.21	3.50	109.08	97.22
CODE NO. 106 AGE 25 SEX MALE HT(IN) 69 WT(LBS) 190				
FVC	4.96	5.70	114.84	
FEV(1)	4.19	4.65	110.86	81.58
CODE NO. 107 AGE 31 SEX MALE HT(IN) 69 WT(LBS) 160				
FVC	4.83	4.65	96.24	
FEV(1)	4.03	3.75	93.13	80.65

TABLE X (cont'd)
FORCED EXPIRATORY VOLUMES
Masonite Corporation
Evendale, Ohio

TEST	PREDICTED	OBSERVED	% PREDICTED	% FEV(1)/FVC
CODE NO. 109 AGE 22 SEX MALE HT(IN) 67 WT(LBS) 130				
FVC	4.77	3.90	81.84	
FEV(1)	4.09	3.80	92.89	97.44
CODE NO. 110 AGE 33 SEX FEMALE HT(IN) 64 WT(LBS) 134				
FVC	3.38	3.30	97.58	
FEV(1)	2.99	2.65	88.58	80.30
CODE NO. 111 AGE 28 SEX MALE HT(IN) 72 WT(LBS) 145				
FVC	5.29	7.25	136.95	
FEV(1)	4.39	5.60	127.49	77.24
CODE NO. 112 AGE 41 SEX MALE HT(IN) 66 WT(LBS) 150				
FVC	4.22	4.45	105.57	
FEV(1)	3.46	3.40	98.13	76.40
CODE NO. 113 AGE 43 SEX MALE HT(IN) 71 WT(LBS) 165				
FVC	5.10	5.10	100.00	
FEV(1)	4.18	3.75	95.00	73.53
CODE NO. 114 AGE 50 SEX MALE HT(IN) 76 WT(LBS) 260				
FVC	5.34	5.50	103.03	
FEV(1)	4.15	4.00	96.33	72.73
CODE NO. 115 AGE 62 SEX MALE HT(IN) 67 WT(LBS) 172				
FVC	3.89	3.35	86.22	
FEV(1)	2.97	2.55	85.84	76.12
CODE NO. 116 AGE 43 SEX MALE HT(IN) 67 WT(LBS) 175				
FVC	4.30	4.85	112.70	
FEV(1)	3.50	3.30	94.21	68.04
CODE NO 117 AGE 48 SEX MALE HT(IN) 60 WT(LBS) 140				
FVC	3.27	4.15	126.96	
FEV(1)	2.70	2.60	96.13	62.65

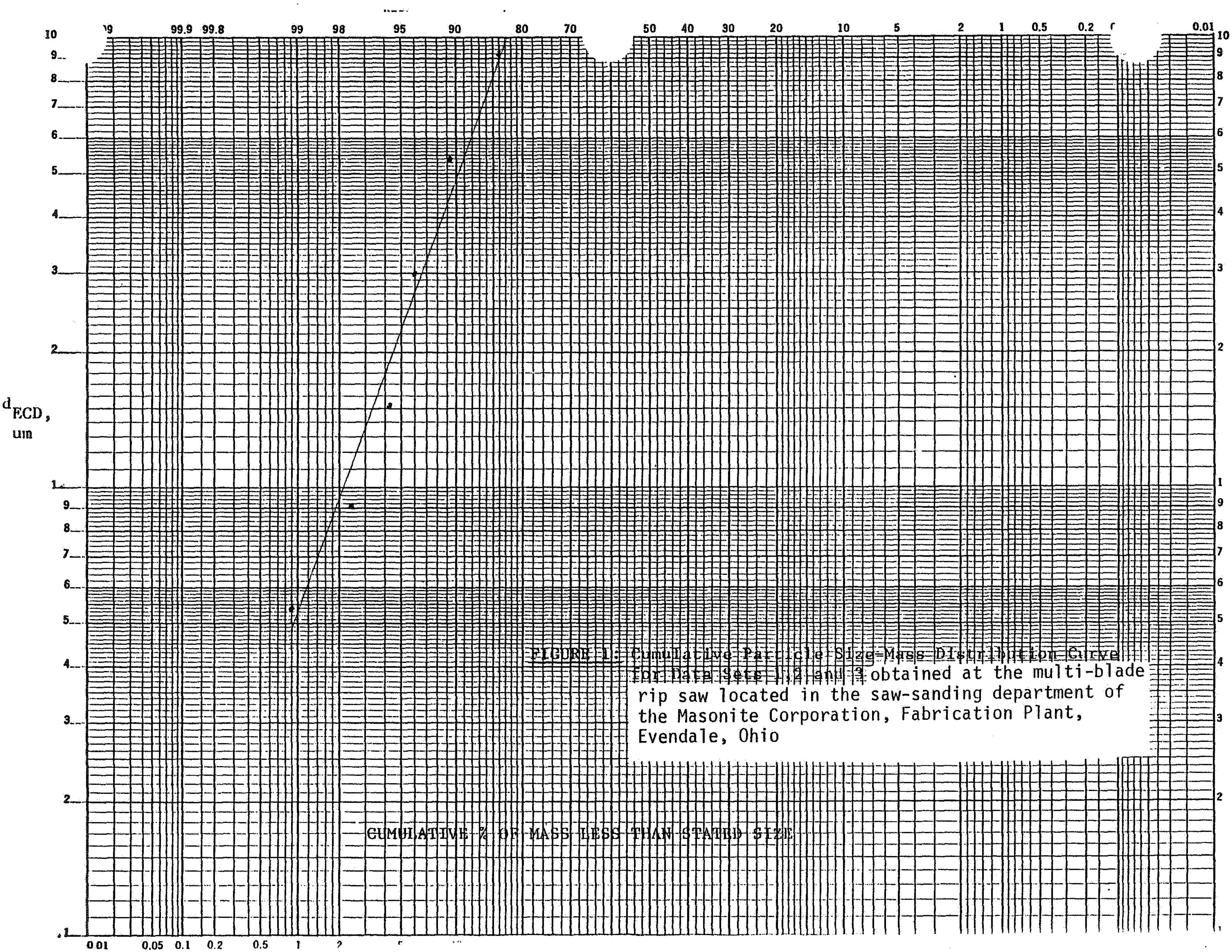


FIGURE 1: Cumulative Particle Size-Mass Distribution Curve for Data Sets 1, 2 and 3 obtained at the multi-blade rip saw located in the saw-sanding department of the Masonite Corporation, Fabrication Plant, Evendale, Ohio

APPENDIX 1

RECOMMENDED EXHAUST VOLUMES FOR A ROUTER

and

SELF-FEED TABLE RIP SAW[19]

Masonite Corporation
Evendale, Ohio

	Exhaust volume, cfm			Duct diameter, in.		
	Bottom Hood	Top Hood	Range	Bottom Hood	Top Hood	Range
Self-feed table ripsaw						
Saw diameter, in.						
Up to 16	440	350		4 1/2	4	
Over 16	550	350		5	4	
Self-feed, not on table	800	550		6	5	
Router			350-800			4 to 6

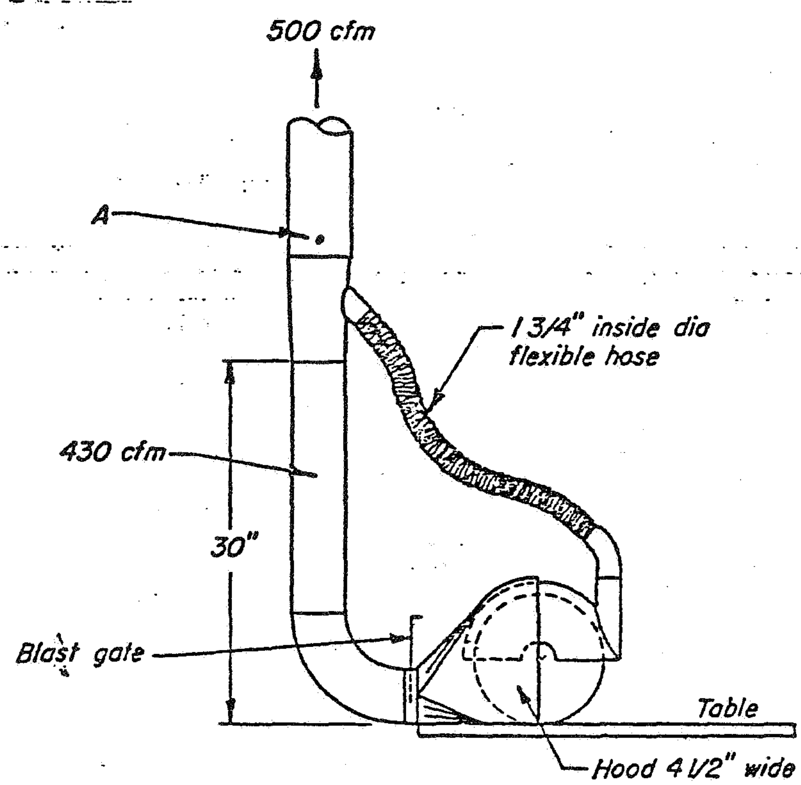
APPENDIX 11

Illustration and Design Criteria

for a

Radial Saw [18]

Masonite Corporation
Evendale, Ohio



Duct velocity = 3500 fpm
Entry loss = 3.5 VP in duct riser (Point A)