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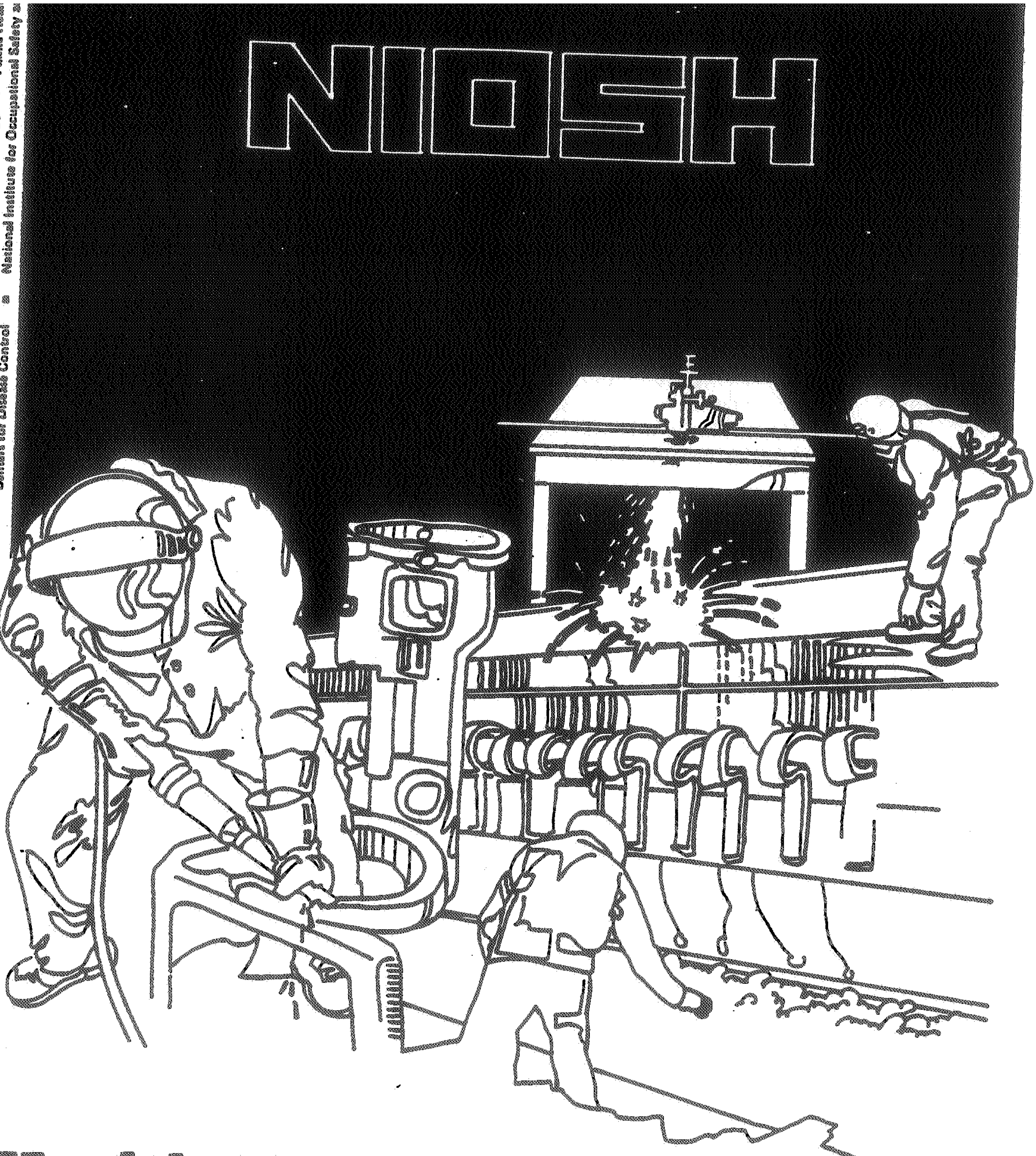

Health Hazard Evaluation Report

HETA 85-105-1689
FIBRE-GLAST DEVELOPMENT CORPORATION
DAYTON, OHIO

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following 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 Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 85-105-1689
MAY 1986
FIBRE-GLAST DEVELOPMENT CORPORATION
DAYTON, OHIO

NIOSH INVESTIGATORS:
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I. SUMMARY

In December 1984 the National Institute for Occupational Safety and Health (NIOSH) received a request from Fibre-Glast Development Corporation, Dayton, Ohio, to assess employee exposures to various chemicals used during production of fibrous glass kits. NIOSH conducted environmental surveys at the facility in January, March, and June 1985.

The environmental assessment included collecting air samples for methylene chloride, styrene, butyl cellosolve, and other organic vapors and total and respirable particulates. Assistance was also provided to the company in the form of recommendations for a ventilation system which they planned to install.

Two methylene chloride samples collected for 80 minutes had concentrations of 443 and 460 ppm. These values are approximately 90% of the previous short-term exposure criteria of NIOSH and the current ACGIH TLV of 500 ppm. Additionally, these two sample values equal 74.8 and 79.5 ppm when calculated as 8-hour time-weighted averages. Prior to April 1986 the NIOSH full-shift exposure criteria was 75 ppm. A recent National Toxicology Program (NTP) laboratory study found methylene chloride to be carcinogenic in rats and mice. In April 1986 NIOSH, in Current Intelligence Bulletin No. 46, stated that exposures to methylene chloride should be reduced to the lowest feasible level. All other materials were well below existing exposure criteria on all samples. Styrene concentrations ranged from below the laboratory limit of detection to 1.63 ppm on all personal samples. The lowest exposure criteria is 100 ppm for a short-term sample (NIOSH, ACGIH). Two samples of butyl cellosolve have time-weighted average values of 0.16 and 0.4 ppm. The lowest TWA exposure criteria for butyl cellosolve is 25 ppm for the ACGIH.

Based on these results the NIOSH investigators believe that a health hazard existed due to methylene chloride exposure for the employees in the production area. Recent findings in an NTP study that methylene chloride is carcinogenic in laboratory animals emphasizes the need for reducing airborne concentrations. Recommendations are made in Section VIII to reduce exposure to this material through either substitution of a less toxic solvent or engineering controls.

KEYWORDS: SIC 3079 (Miscellaneous Plastic Products) fibrous glass, methylene chloride, butyl cellosolve, styrene, toluene.

II. INTRODUCTION

On December 17, 1984 the National Institute for Occupational Safety and Health (NIOSH) received a request from Fibre-Glast Development Corporation for a health hazard evaluation at their Dayton, Ohio plant. The request concerned potential exposures to 1-2 employees involved in the production of fibrous glass repair kits.

NIOSH investigators visited the plant on January 24, 1985, March 11-12, 1985, and June 13, 1985. During the visits air samples were collected to assess exposures to methylene chloride, butyl cellosolve, styrene, general organics, total and respirable particulates and carbon dioxide. Additionally, the investigators provided recommendations regarding an engineering control system the company planned to install.

Progress reports with results and recommendations were forwarded to interested parties by letter on January 28, March 18, May 9, June 27, July 22, and August 15, 1985.

III. BACKGROUND

The Fibre-Glast Development Corporation is a small plant (figure 1) with a total of six people including the office personnel. One to two employees work in the production area where fibrous glass kits are assembled. Principal operations are repackaging and compounding.

Repackaging

This operation consists of filling smaller containers from 55-gallon drums. For liquids the bulk container is raised, via a forklift, to the appropriate height and then transferred into the smaller containers using a manual valve system. Powders are transferred via scoops from bulk bags into smaller containers.

Compounding

Four different specialty epoxy systems are compounded with production for each averaging less than 5000 lbs. per year. These systems consist of an epoxy component and a cure component which are mixed separately and transferred to separate containers, and sold.

The liquid component is mixed in a 30 gallon mixer. While the mixer runs, powdered material is added through an opening in the top. The resulting combination is mixed for 1/4 to 1 hour, then the remaining liquid portion is added. The mix is blended for another 15 minutes and then dispensed through the bottom of the mixer into appropriate containers. The mixer is then cleaned using methylene chloride.

Fourteen materials constitute the bulk of the chemical raw materials used per year. This includes less than 1000 lbs of silica, microballons, styrene monomer, and epoxy curing agents, 1000 to 5000 lbs of methylene chloride, poly vinyl alcohol, MEKP (methyl ethyl ketone peroxide), epoxy cure, and talc, and from 5000 to 2000 lbs acetone, polyester resin, and epoxy resin.

Safety/Health Practices

At the time of the NIOSH investigation company safety and health requirements included no smoking or eating in the production areas. Eye protection was required when working with low viscosity liquids, and a nuisance dust mask was required when working with some materials. Chemical aprons, gloves, and eye protection were required when transferring methyl ethyl ketone peroxide. Flammable and volatile materials were transferred outside. Latex gloves are also recommended but generally not required.

IV. EVALUATION DESIGN AND METHODS

The environmental assessment was designed to determine the potential for hazardous exposure to the employee conducting repacking and compounding. Specific materials to be sampled were selected based on discussions with the plant owner, the quantity of specific materials used on an annual basis, and the corresponding toxicity of these materials.

During the initial discussions, the plant owner expressed his intentions to install an engineering control system, and asked for assistance in determining what type of system would be effective. It was decided that the NIOSH investigators would supply suggestions for a ventilation system based on results of the air monitoring and the physical layout of the facility.

Air samples were collected by passing air through the media of choice for the contaminant being evaluated. The collection media was attached via flexible tubing to a battery operated pump calibrated at a known flow rate.

Due to the fact that only one employee routinely worked with the various chemicals used in the production area, NIOSH investigators decided to wear samples to gather additional information on air contaminant concentration.

Bulk samples were collected in 25 ml glass vials. Sampling and analysis were performed according to standarized NIOSH methods where applicable. Additional information on sampling and analytical methods is listed in Table I.

V. EVALUATION CRITERIA

A. General

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

B. Specific Compounds

1. Methylene Chloride

Methylene chloride is a nonflammable, liquid which does form flammable mixtures with air. It is used as a solvent for cellulose acetate and as a cleaning and degreasing fluid.

Methylene chloride is a narcotic. Effects of exposure include headache, irritability, and numbness. Higher exposures cause irritation of the eyes and respiratory system. Very high concentrations may cause pulmonary edema, coma, and death. It is also reported to cause elevated levels of carboxyhemoglobin.[2]

In the 1940s methylene chloride was considered the least toxic of the chlorinated hydrocarbons and was assigned a TLV of 500 parts methylene chloride per million parts of air (ppm) by ACGIH.[3] Subsequent reports of its toxicity resulted in ACGIH reducing its TLV to its current level of 100 ppm in the absence of exposure to carbon monoxide (CO).[4] The OSHA PEL which is based on the 1968 TLV is 500 ppm. Until April 1986, the NIOSH recommended standard had been 75 ppm as a TWA with a ceiling limit of 500 ppm.[5-6] The values are to be lowered in the presence of CO.

A recent study conducted by the National Toxicology Program found that methylene chloride was carcinogenic in male and female mice and male rats.[7] In general NIOSH believes that no safe level of exposure has been demonstrated for carcinogens. In accordance with this policy NIOSH completed a Current Intelligence Bulletin on methylene chloride in March 1986 in which NIOSH states..."As prudent public health policy, employees should voluntarily assess the conditions under which workers may be exposed to methylene chloride and take all reasonable precautions to reduce exposures to the lowest feasible limit."[8]

2. Styrene Monomer

Styrene is a colorless, oily liquid that can form explosive mixtures in air. It readily undergoes polymerization if exposed to light.[9] It is used in the manufacture of resins, polyesters, insulators, copolymers elastomers, styrene butadiene rubber, and acrylonitrile styrene butadiene.[2]

The liquid and vapor are irritating to mucous membranes, the eyes, and skin. Repeated contact may lead to dermatitis. Acute exposure to high concentrations may produce irritation of the mucous membranes, narcosis, cramps, and death from respiratory center paralysis.[2]

Exposure at 376 ppm resulted in objective signs of neurologic impairment. Styrene sickness including symptoms of drowsiness, nausea, headache, fatigue, and dizziness has been reported for workers exposed from 200 to 700 ppm.[3] In the NIOSH criteria document for styrene, studies are cited that report health effects to employees at exposures at and below 100 ppm.[8] The current ACGIH TLV is 50 ppm as a time weighted average (TWA) with a short-term exposure limit (STEL) of 100 ppm.[4] The OSHA permissible exposure limit (PEL) is 100 ppm as a TWA with a ceiling value of 200 ppm.[5] NIOSH recommends a limit of 50 ppm TWA with a ceiling value of 100 ppm.[9]

3. Butyl Cellosolve

Butyl cellosolve (2-butoxyethanol) is one of a group of ethylene glycol ethers used as solvents for surface coatings cleaning compounds, cosmetics, and the drycleaning industry.[2,3]

Ethylene glycol ethers are mild skin irritants. Exposure to the vapor may cause eye and upper respiratory tract irritation. Acute exposure may result in narcosis, pulmonary edema, and severe liver and kidney damage. Long-term exposures may result in fatigue, headache, nausea and tremors.[2]

Experiments with laboratory animals indicate that exposure to butyl cellosolve increases the asmotic fragility of red blood cells in rats which results in the development of hemoglobinuria at higher exposure levels.[3] The current OSHA PEL for butyl cellosolve is 50 ppm as an 8 hour TWA.[6] The ACGIH TLV is 25 ppm with an STEL of 75 ppm.[4] NIOSH currently has no recommended standard for butyl cellosolve.

4. Toluene

Toluene is a colorless liquid with an aromatic odor similar to benzene.[10] Short-term exposure may cause irritation in the eyes, respiratory tract, or skin. Other adverse health effects include headaches, weakness, fatigue, and drowsiness. Very high concentrations may cause unconsciousness or death. Long-term exposure may cause drying or cracking of the skin.[10]

The current OSHA PEL for toluene is 200 ppm as an 8 hour TWA with a 10 minute peak exposure of 500 ppm.[5] NIOSH recommends an 8 hour TWA of 100 ppm with a ceiling level of 200 ppm.[11] ACGIH recommends a TWA of 100 ppm with an STEL of 150 ppm.[4]

VI. RESULTS

A. Air Monitoring

Results of air monitoring for methylene chloride, styrene, butyl cellosolve, and toluene are presented in Table 2. Methylene chloride air concentrations of 443 and 460 ppm were measured on the employee and a NIOSH investigator respectively. These samples were taken for 1 hour and 20 minutes while the employee was cleaning the mixer using methylene chloride; he was also repackaging and mixing different materials. These values are about 90% of the NIOSH and ACGIH short-term exposure criteria for a 15 minute period. When calculated as a time weighted average they equal 74.8 and 79.5 ppm respectively, which essentially equal the previous NIOSH recommended standard for a full-shift exposure. The NIOSH recommendation now is for employers to voluntarily reduce employee exposures to methylene chloride to the lowest feasible level.[8] Concentrations for styrene, butyl cellosolve, and toluene were all well below the corresponding exposure criteria on the 2 to 6 samples collected for each material.

Table 3 presents the results of one set of triplicate samples for respirable and total particulate. The mean values were 0.061 milligrams per cubic meter of air (mg/m^3) for respirable dust and 0.103 mg/m^3 for total dust samples. These values indicate that both respirable and total particulate levels were well below the current ACGIH occupational exposure criteria of 5 mg/m^3 and 10 mg/m^3 respectively.

Bulk material samples of talc contained no asbestos material and bulk material samples of microballons contained no detectable quantities of crystalline silica.

B. General Observations

The repacking/kit assembly operation has five sources of organic vapor emissions and one source of particulate emissions which may require local controls. These are:

1. The mixing operation which produces relatively high levels of methylene chloride when the mixer is cleaned with the solvent and amorphous silica emissions when the powder is added to mix with resin. These dust emissions continue to persist for a short time after the beginning of mixing. The top of the mixer is misshaped so that a tight fit is not possible.

2. The packaging operation which involves filling various sized containers with the fibrous glass resin mixture from 55-gallon drums.

3. The "aeration" of liquid resin in 55-gallon drums.

4. Packaging of methyl ethyl ketone peroxide in small containers.

5. Miscellaneous spills and diffusion of styrene through the walls of polyethylene warehoused plastic bottles containing the fibrous glass mixture.

VII. DISCUSSION AND CONCLUSION

Based on these results the NIOSH investigators believe that a health hazard existed for the employees from exposure to methylene chloride. The recent finding (NTP study) that methylene chloride is carcinogenic in rats and mice make it imperative that employee exposures to it be reduced through either replacement of methylene chloride with a less toxic solvent or the use of engineering controls. Air sampling results and odors detected in the office area suggest that organic vapors including methylene chloride were migrating into the office from the production area.

Based on the environmental sampling results, discussions with plant personnel, and observation of plant activities, methylene chloride is the primary agent of concern when considering implementation of engineering controls at this plant. The ventilation system the company plans to install must be selected carefully. The size of the facility and the logistics of some of the operations reduce the potential effectiveness of some types of ventilation systems. A system the investigators believe would work well is presented in Appendix I. It should be noted that other systems or components may work as well as the one indicated.

According to the plant owner there are approximately 25 similar facilities in the United States. Most are very small operations with staffs of five or less. The NIOSH investigators were unable to find any other published reports of environmental investigations in these types of facilities. The environmental air monitoring data and recommendations for the ventilation system presented here may be beneficial to management and employees of similar facilities.

The literature includes reports of studies in fibrous glass manufacturing plants. The types of exposures are similar including methylene chloride, styrene, etc., but exposures are generally higher and/or for longer durations.[3,6,9-11]

NIOSH has conducted studies in plants producing fibrous glass products. Some of these were in plants making fibrous glass raw material (i.e., fiberous glass fiber and cloth). Others however have been in plants producing reinforced plastic products.[12] In one such study of the reinforced plastic boat making industry, exposures to styrene were much higher with 86% of 397 sample values in excess of 25 ppm.[12] The highest air concentration of styrene in this HHE was 1.63 ppm. The other studies were HHEs, during which air concentrations were generally higher than those measured in our HHE.

VIII. RECOMMENDATIONS

1. Personal exposures to methylene chloride should be reduced through either substitution with a different solvent or engineering controls. Substitution with a less hazardous organic solvent is the preferred choice but care must be exercised in the selection to insure that the substitute solvent is indeed safe.

2. Airborne concentrations of methylene chloride in the compounding, repacking, and office areas should be reduced. The most effective technique is via engineering controls. One such potential system is included in Appendix I.

3. Until personal exposures to methylene chloride have been reduced through implementation of recommendations 1 and 2, employees should wear respiratory protection while working with methylene chloride. Single use dust respirators are not adequate for organic vapors. At a minimum, respirators should be equipped with organic vapor cartridges suitable for methylene chloride environments.

4. The air compressor located in the mixing room should be equipped with a muffler to reduce its noise output. While no noise measurements were taken, the compressor sounded loud and made communications difficult. Such a muffler would involve a minimal expenditure.

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

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1. Fibre-Glast Development Corporation
2. NIOSH, Region V
3. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1

Fibre-Glast Development Corporation
Dayton, Ohio
HETA 85-105

March 12, 1985

Contaminant	Sample Type	Flow Rate	Collection Media or Device	Analytical Technique
Asbestos	Material Bulk	-	25 mm vial	Polarized light microscopy with dispersing staining techniques.
Crystalline Silica	Material Bulk	-	25 mm vial	X-ray diffraction according to NIOSH Method 7500 with modifications.[19]
Organic Solvents-Screening Samples	Air Bulks	0.5	charcoal tube	Samples desorbed with 1 ml of CS_2 and screened using a gas chromatograph equipped with a flame ionization detector
Butyl Cellosolve	Personal and Area	0.05	charcoal tube	Samples desorbed in 1 ml of methylene chloride and analyzed using a gas chromatograph equipped with a flame ionization detector; according to NIOSH Method 1403 (modified).[19]
Methylene Chloride and Styrene	Personal and Area	0.05-0.1	charcoal tube	Samples desorbed in CS_2 and analyzed using a gas chromatograph equipped with flame ionization detector, according to NIOSH Method 1501 and 1003 (modified).[19]
Methylene Chloride, Styrene, Toluene	Personal and Area	0.1	charcoal tube	Samples desorbed with CS_2 and analyzed using a gas chromatograph equipped with a flame ionization detector.
Respirable Dust	Area	1.7	37 mm PVC filters loaded into plastic cassettes. Cassettes preceeded by 10 mm nylon cyclone.	Sample plus filter weighed using electro-balance. Previously determined weight of filter was subtracted from the final weight to determine the overall weight change.
Total Dust	Area	2.0	37 mm PVC filters loaded into plastic cassettes	Sample plus filter weighed on electro-balance. Previously determined weight of filter was subtracted.

Table 2

Airborne Concentrations for Solvent Vapors

Fibre-Glast Development Corporation
Dayton, Ohio
HETA 85-105
March 11-12, 1985

Sample Number	Job/Location	Date	Volume (liters)	Sample Time	Sample Type	Analyte	Concentration (ppm) For Sample Duration	8-Hour TWA
0-4	Employee Mixing 85-E	3/11	21.5	1235-1605	P	MC STY	13.1 0.43	5.73 0.19
M-1	Employee cleaning mixer with methylene chloride and mixing and repacking various materials	3/12	4.39	908-1029	P	MC STY	443 1.59	74.8 0.27
0-1	NIOSH Invest.	3/11	30.6	951-1101 1154-1545	P	MC STY	5.23 0.38	3.28 0.24
M-2	NIOSH Invest.	3/12	4.22	909-1032	P	MC STY	460 1.10	79.5 0.19
BC-1	Employee Mixing and Repacking	3/12	9.47	1030-1112 1214-1425	P	BC	0.44	0.16
BC-2	NIOSH Invest.	3/12	14.3	1034-1113 1214-1609	P	BC	0.70	0.40
0-10	Employee cleaning mixer with methylene chloride mixing. mixing and repacking	3/12	36.1	908-1112 1214-1605	P	MC* T STY	29.5 0.22 1.63	21.8 0.16 1.21
0-14	Mixing and Repacking	3/12	9.8	1352-1605	P	MC T STY	4.11 ND (<0.27) ND (<0.48)	1.14 - -
0-3	Office Area, top of file cabinet	3/11	29	1052-1547	A	MC T STY	1.39 1.19 ND (<0.16)	1.39** 1.19** ND (<0.16)**
0-12	Office Area, top of file cabinet	3/12	37.9	914-1539	A	MC T STY	6.07 0.56 0.12	6.07** 0.56** 0.12**

* = Methylene chloride on back section of charcoal tube indicates there may have been break through and actual air concentration may have been higher.
** = Used values obtained with 5-6 hour samples for 8 hour TWA. The values represent gases/vapors entering office from production area. NIOSH investigators believe concentrations would not vary significantly for the rest of the shift.
*** = NIOSH criteria up to April 1986
Note: NIOSH investigator in production area for the entire period of sampling.
LFL = Lowest Feasible Limit, NIOSH criteria per CIB #46

	Short-Term (15 minutes or less) Occupational Exposure Criteria (ppm)			Full Shift TWA Exposure Criteria (ppm)		
	NIOSH	OSHA	ACGIH	NIOSH	OSHA	ACGIH
MC = Methylene Chloride	500*** LFL	1000 -	500 -	75*** LFL	500 -	100 -
STY = Styrene	100	600	100	50	100	50
BC = Butyl Cellosolve	none	none	75	none	50	25
T = Toluene	200	500	150	100	200	100

Table 3

Total and Respirable Particulate Samples

Fibre-Glast Development Corporation
Dayton, Ohio
HETA 85-105

March 12, 1985

Sample Number	Description	Sample Time	Volume (liters)	Air Concentration (mg/m^3) Ind. Sample	Air Concentration (mg/m^3) Mean for the Set (s = standard deviation)
4464	Triplicate set of respirable	900-1600	714	0.056	
4454	samples on shelf 4' from mixer	900-1600	714	0.028	0.061
4459		900-1600	714	0.098	(s=0.035)
4463	Triplicate set of total dust	901-1601	840	0.083	
4471	samples, on shelf 6' from mixer	901-1601	840	0.119	0.103
4468		901-1601	840	0.107	(s=0.018)

Table 4

Heat Transfer Coefficients for Fibre Glast Development

Fibre-Glast Development Corporation
Dayton, Ohio
HETA 85-105

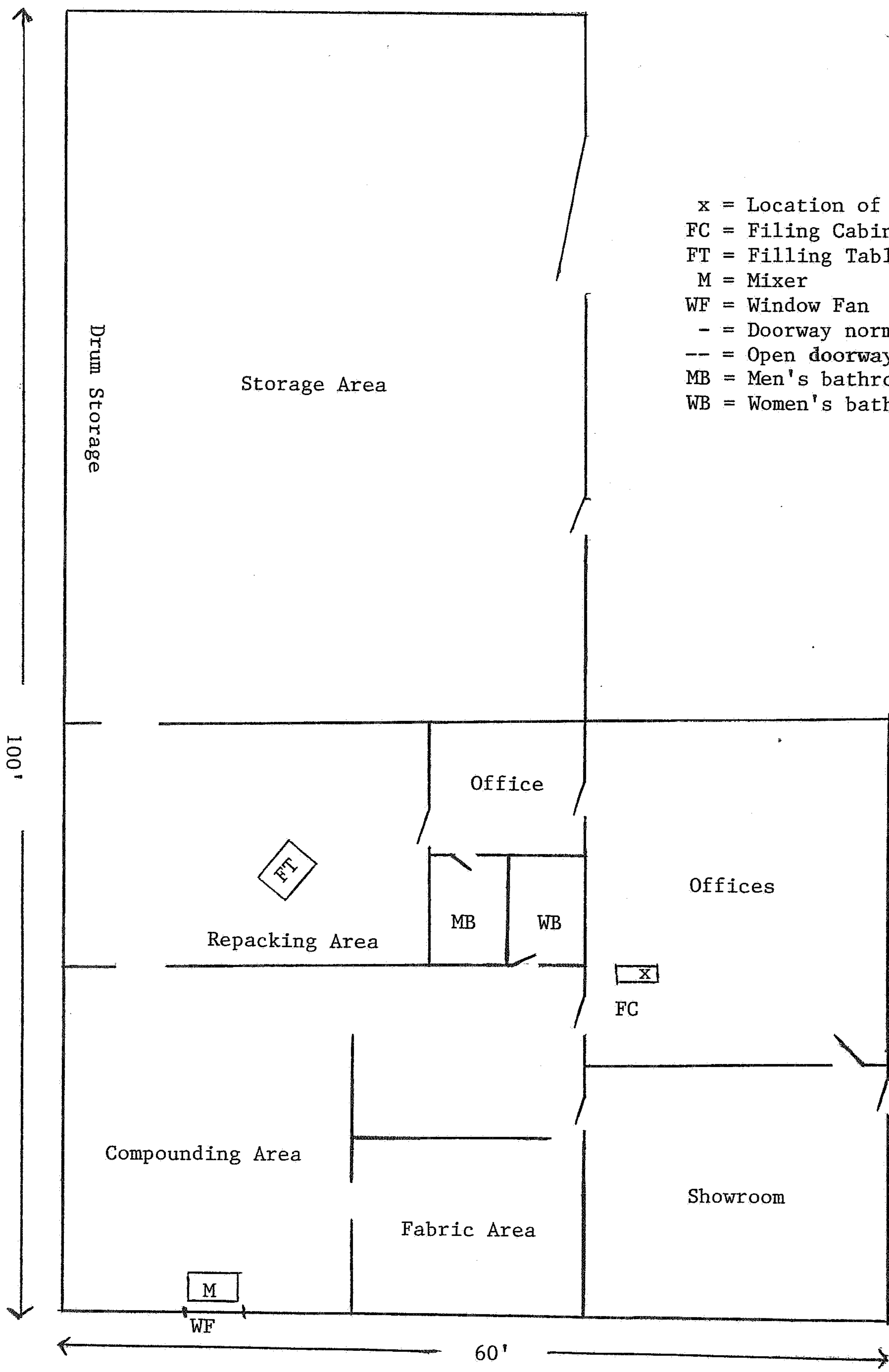
Component	Construction Details	Sq. Ft.	Heat Transfer Coefficient, Btu/hr-sq. ft. - F
Sidewalls	12 inch three-oval concrete blocks	2780	0.39
Ceiling	Ceiling is made of 1/2 inch fiberboard 2x6 inch joists or 16 inch centers, mineral fiber insulation between joists. Attic consists of 2x6 inch rafters on 24 inch centers, plywood deck and asphalt shingles.*	900	0.05
Area Without Attic	Consists of metal deck 1 inch wood fiber insulation, 0.375 inch built up roof.	2000	0.26

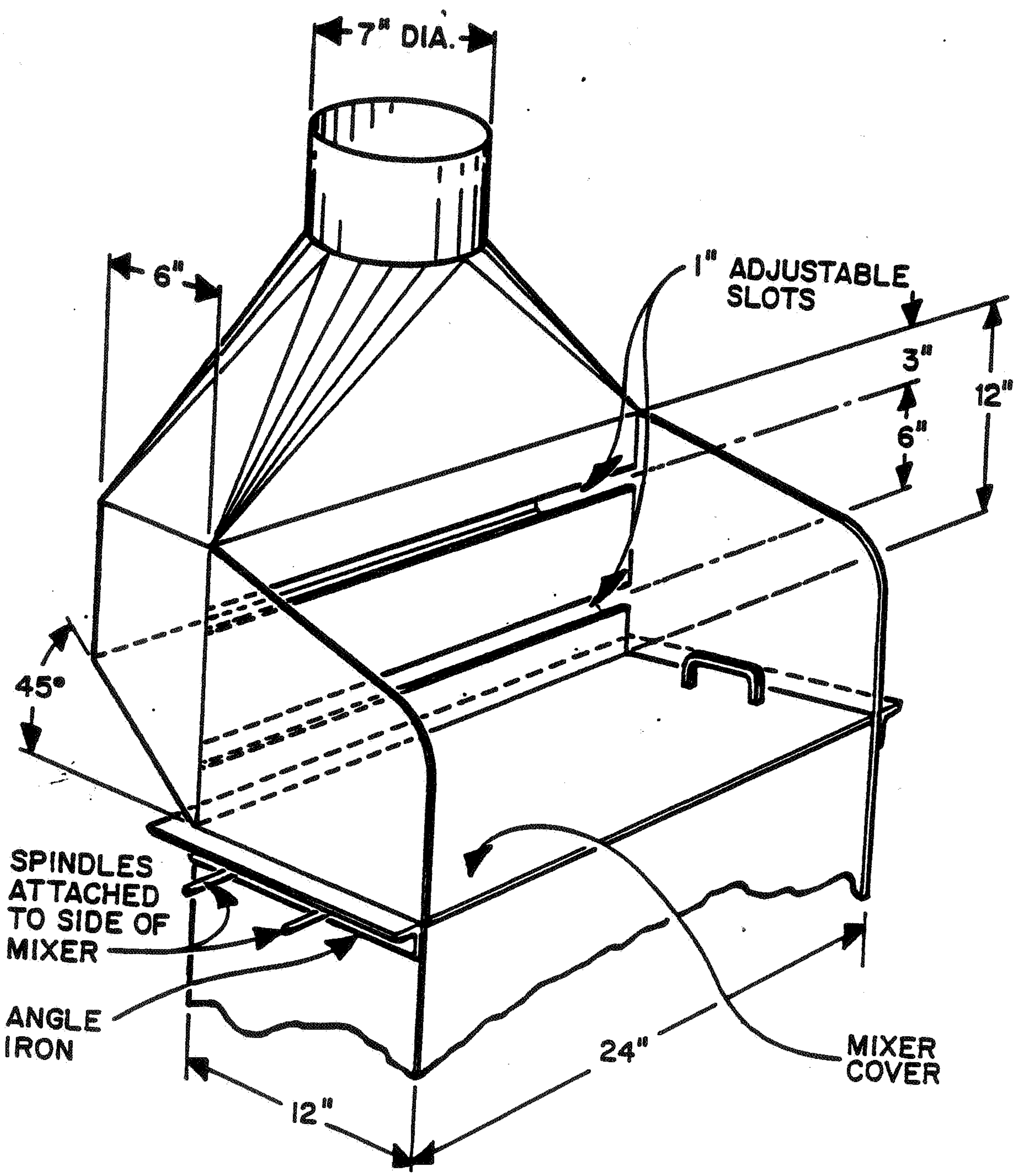
* This only approximates actual construction.

Figure I

Fibre Glast Development Corporation
Dayton, Ohio

HETA 85-105





AIR FLOW = 1040 cfm (Divided between the two slots).
STATIC PRESSURE = 2.20 in H_2O

Figure 2. Hood for Control of Fumes and Dust from Top of Mixer.

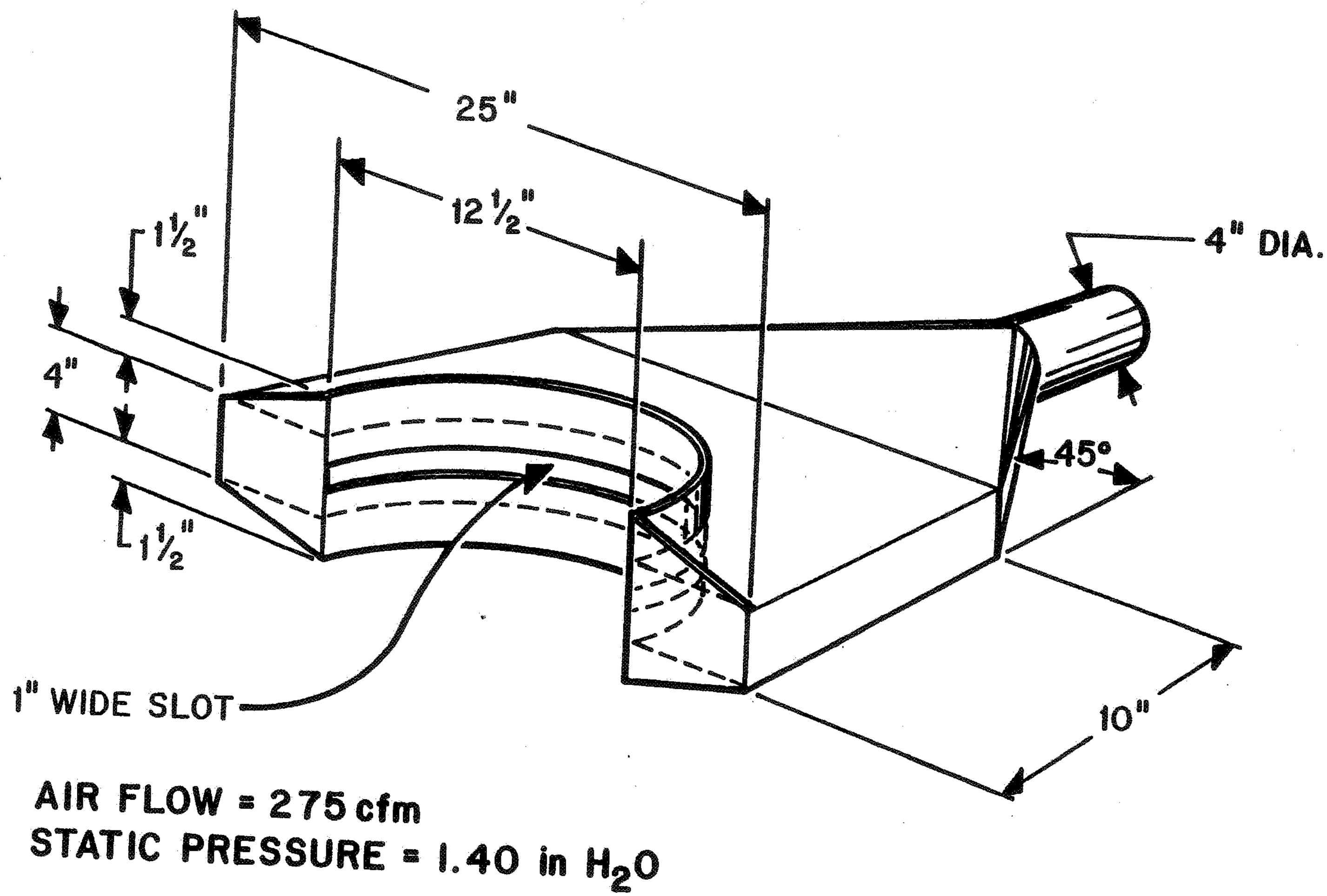


Figure 3. Semicircular Slot Hood for Control of Vapor from Mixer Discharge.

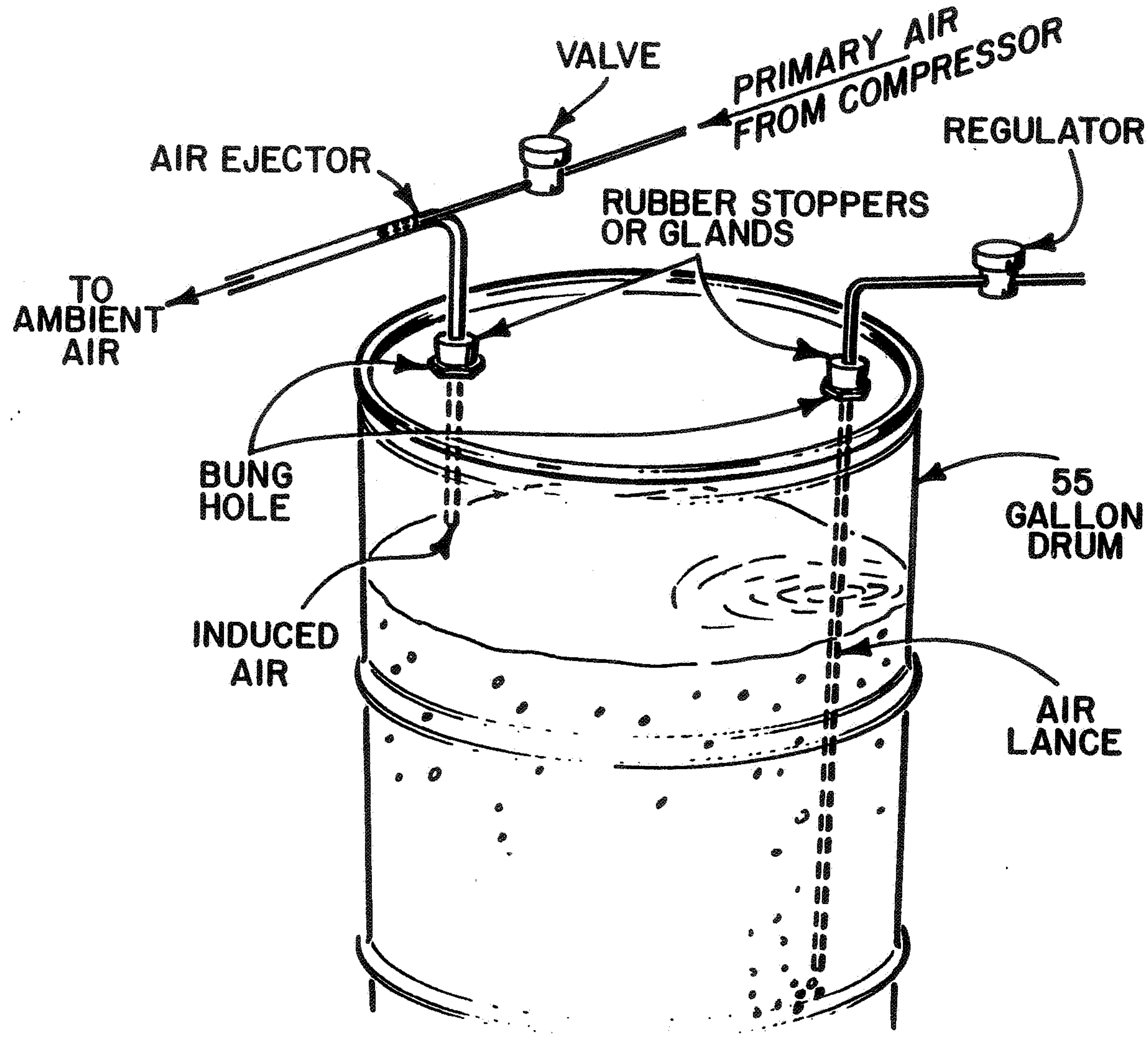
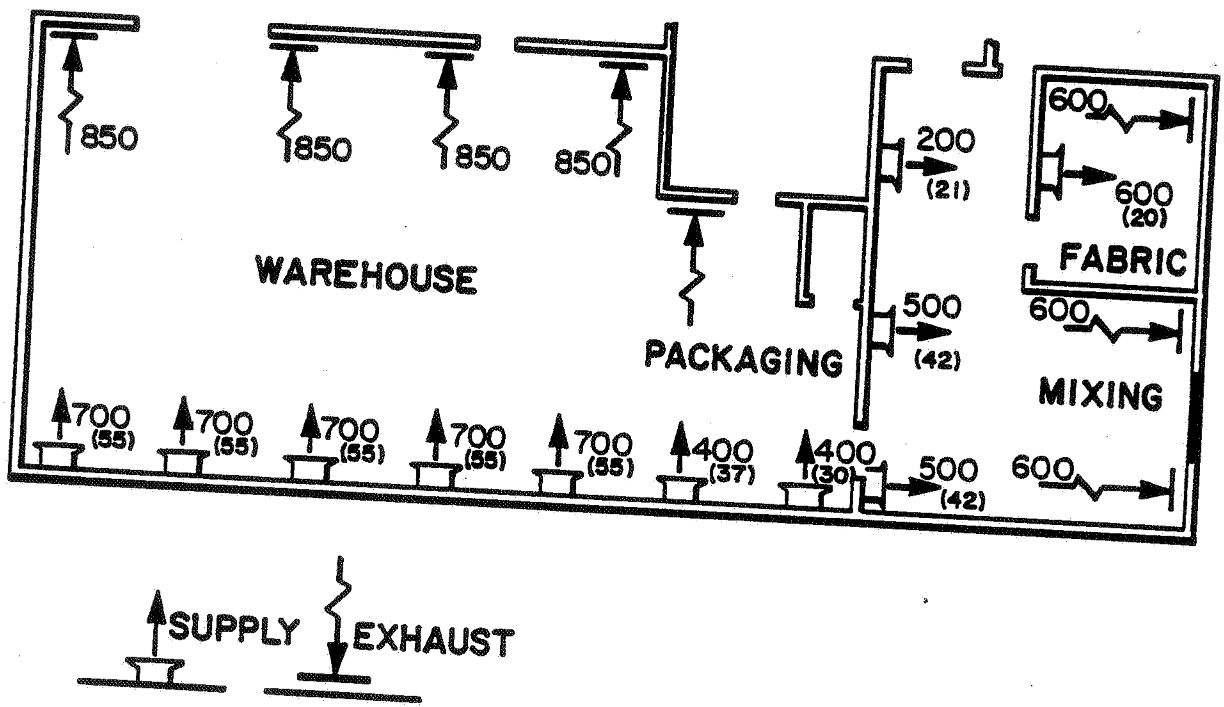


Figure 4. Controls for Aeration Operation.



NOTE: NUMBERS IN PARENTHESIS REPRESENT THROW, IN FEET, FOR SUPPLY GRILLES. OTHER NUMBERS ARE FOR AIR FLOW IN cfm.

Figure 5. Distribution of Supply and Exhaust Air.

APPENDIX I

ENGINEERING CONTROLS

There are a number of sources of organic vapor emissions and one source of amorphous silica at this plant. In the following paragraphs a number of local and general ventilation controls will be recommended which, in the opinion of the NIOSH investigators, have a high probability of succeeding in reducing methylene chloride and unpleasant odor levels in the office area to acceptable values. There are a number of factors which tend to create uncertainties about the performance of ventilation control systems:

1. The mathematical descriptions of particle motion and molecular dispersion in the usually - turbulent work environment are complex and, except for relatively simple situations, are difficult to predict analytically.

2. The intensity with which a contaminant is injected into the workplace and the path(s) that it takes are in many cases difficult to predict.

LOCAL EXHAUST CONTROLS

Mixing

The mixer is in operation about 10 percent of the time. In addition to organic vapors, amorphous silica dust emissions are generated while adding the material to the liquid resin and for a short period after addition through cracks in the mixer cover. A double slot backdraft hood was selected to simultaneously control both emissions from this source.[21] The hood is also expected to capture methylene chloride solvent emissions when the mixer is cleaned between batches. The configuration of this hood is shown in Figure 2. The design is for a mixer cover approximately 12" x 24" and a capture velocity of 100 fpm at the rim. Angle iron is used to provide rigidity for the baffles and to secure the hood assembly to spindles attached to the side of the mixer. A close clearance (about 1/16 inch) between the angle iron and the mixer cover should be maintained in order to preserve the capture capability of the hood. The flow in each slot was calculated from the equation for a flanged slot hood $Q = 2.6\ LVX$.[21] Assuming a slot velocity of 3000 fpm and a 1000 fpm velocity (one-half slot velocity or less is recommended) in the plenum, a 1 inch slot and a 6 inch wide plenum are obtained. In order to prevent the accumulation of dust in the ductwork a duct velocity of 4000 fpm is recommended resulting in a duct that is 7 inches in diameter.[20]

Methylene chloride and other organic vapor emissions which may occur when the mixer is emptied may be controlled by the flanged semicircular slot shown in Figure 3. The design was adapted from a local ventilation control reported in Ref. 21, p. 5-35. In addition to the basic design, a 1.5 inch flange was added on both sides of the slot to increase the capture velocities at the critical points and exhaust flow was increased to 350 cfm per sq. ft. of barrel top to overcome any maldistribution problems that may be inherent in the basic design. This value was arrived at by conducting measurements of capture velocity for a similar situation. The hood can accommodate a container 12.5 inches in diameter. The configuration design criteria given in Ref. 21 should be followed for larger-sized containers. For smaller sized containers the hood may also be used by attaching semicircular horizontal flanges.

Packaging of Resin

Liquid resin containing styrene is dispensed from 55-gallon drums into smaller containers. The 55-gallon drum which is laid on its side between the forks of a fork-lift truck, is hoisted a few feet above a 2 3/4 ft. x 4 1/4 ft. bench. The resin flows from the drum to the receptacle through a manually - operated spigot. Inspection of the exposure data seems to indicate that exposures from this are below applicable standards and as such it is only a source of unpleasant odors. If in the future solvents which are more volatile and toxic than styrene are used, an 18" x 18" side - draft hood placed 12 inches away from the centerline of the container may be considered for this application. A suction rate of 1350 cfm would be necessary to obtain a capture velocity of 75 fpm at critical points around the container that is being filled. However, for resin liquids packaged during the survey, general ventilation, as described later, would be adequate to contain odors from this source.

Aeration

The styrene vapor-laden air generated in the course of mixing resin in 55-gallon drums by aeration may be controlled as shown in Figure 4. An air ejector may be used to produce a slight vacuum in the air space above the liquid.[21] This air would be entrained by the primary air which is at a higher pressure and velocity than the secondary air. Mathematical prediction of the performance would require knowledge of the thermodynamic properties and velocities of the primary, secondary, and mixed streams.[22] It would be easier in this case to construct and experiment with the relatively simple device by slowly increasing the primary air flow until a slight vacuum is obtained in the air space above the liquid.

Packaging of Methyl Ethyl Ketone Peroxide

In the absence of data on the chronic health effects from this substance no safeguards beyond those already in use are deemed necessary.

Miscellaneous Sources

Organic vapor emissions from small leaks and spills may be controlled by general dilution ventilation as described in the following section.

GENERAL VENTILATION

General ventilation is recommended to accomplish the following:

1. Effect the dispersion and dilution of organic vapors emitted from liquid resin and solvent dispensing operations and from miscellaneous sources.

2. Provide supply air for local exhaust systems.

3. Bring odors due to styrene and butyl cellosolve to acceptable levels.

RECOMMENDED AIR REQUIREMENTS

Since styrene vapor has a lower threshold value for odor than butyl cellosolve the following analysis of air requirements will be based on styrene (Ref. 23).

Industrial hygiene sampling conducted in March 1985 showed that employee exposures to styrene ranged between 0.43 ppm (21.5 liter sample) and 1.59 ppm (4.39 liter sample). This yields a volume-average of 0.63 ppm which is of the order of 1 ppm. From a knowledge of the geometry of the workplace and an estimate of outside air infiltration rate into the building of about 1 air change per hour a generation rate of 4 gms per hour with respect to styrene was estimated by performing a material balance.[24] To reduce the 1 ppm level to a level below the odor threshold value of 0.1 ppm about 6000 cfm of fresh outdoor air are needed assuming a uniform concentration in the workplace.[23] This volumetric flow rate coincides with the requirement of 8 to 10 air changes per hour to prevent the occurrence of "stagnant regions" in the environment.[24]

In view of the difficulty of estimating the generation rate of various odor-producing chemicals, which may also depend on the frequency and magnitude of spills, the degree of recirculation of exhaust air cannot be estimated a priori. Rather it should be determined on the basis of supplying (and also exhausting) enough outdoor air to maintain styrene concentrations below the 0.1 ppm level. As will be explained later, once-through operation should be practiced whenever the mixer is in operation, (about 10 percent of the time).

DISTRIBUTION OF SUPPLY AND EXHAUST AIR

The distribution of the supply and exhaust air will be based on winter conditions as these represent the most severe from the point of view of contaminant dispersion. Under these conditions doors and windows would be kept closed to prevent the infiltration of outside cold air. In arriving at the air distribution pattern the following design basis was employed:

1. High side wall diffusers would be selected to distributed supply air even though floor diffusers would be more appropriate in applications other than manufacturing. Floor diffusers would be inappropriate here because of the potential for duct work contamination by leaks.

2. Return air grilles would be placed close to floor level and against walls. This placement results in exhausting the coolest air as required by good practice.

3. To the extent possible the comfort criteria prescribed in Ref. 24 and 25 will be adhered to in specifying the throw length of supply air diffusers.

In order to apply the comfort criteria in the selection of the grilles (specifically to estimate the appropriate throw for each grille) the heating load for the building had to be calculated. This in turn would be obtained on the basis of overall heat transfer coefficients for the side walls, ceiling, and concrete floor. A summary of the estimates for the heat transfer coefficients and the areas appears in Table 4. Using the data in Table 4 and a design dry bulb temperature of $-1^{o}F$ for Dayton, Ohio, the building heat load is estimated to be about 2200 Btu per minute or 45.5 Btu/hr sq. ft. of which about 11 percent is attributable to the concrete floor.[25]

The distribution of supply and exhaust air is shown in Figure 5. The supply air diffusers are of the high, side wall type. They were selected with respect to throw in accordance with a procedure specified in Ref. 24, pg. 345. A noise criteria (NC) level between 20 and 25 is recommended.

OPERATION OF VENTILATION SYSTEM

When the mixer is in operation the return air grilles in that room should be closed so that air is exhausted through the local exhaust hoods. No recirculation (or a once-through operation) of exhaust air should be practiced under those conditions. Recirculation of exhaust air may be practiced at other times and the degree of such circulation should be determined on the basis of no build-up of hydrocarbon levels and no detectable odors of styrene or other gases/vapors.

The heating requirement for fresh air in once - through operations are about 3.5 to 4 times the heating load of 2200 Btu per min.