WALK-THROUGH SURVEY REPORT:

CONTROL OF METHYLENE CHLORIDE IN FURNITURE STRIPPING

AT

Jet Strip
Boulder, Colorado

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Public Health Service
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PLANT SURVEYED:	Jet Strip 1949 33rd Street Boulder, Colorado 80301
SIC CODE:	7641
SURVEY DATE:	August 1, 1991
SURVEY CONDUCTED BY:	Ronald M. Hall John W. Sheehy
EMPLOYER REPRESENTATIVES CONTACTED:	John P. Bertrand, owner Linda Bertrand, co-owner
EMPLOYEE REPRESENTATIVES CONTACTED:	None (nonunion)

DISCLAIMER

Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention.

INTRODUCTION

Under the authority of the Occupational Safety and Health Act of 1970 (Public Law 91-596), the National Institute for Occupational Safety and Health (NIOSH), Centers for Disease Control and Prevention (CDC), located in the Department of Health and Human Services (formerly DHEW), conducts research to prevent occupational safety and health problems. This legislation mandated NIOSH to conduct a number of research and education programs separate from the standard setting and enforcement functions carried out by the Occupational Safety and Health Administration (OSHA) in the Department of Labor. An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards. The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study the engineering aspects of health hazard prevention and control.

Since 1976, ECTB has conducted a number of assessments of health hazard control technology on the basis of industry, common industrial process, or specific control techniques. The objective of each of these studies has been to document and evaluate effective control techniques for potential health hazards in the industry or process of interest, and to create a more general awareness of the need for or availability of an effective system of hazard control measures.

These studies involve a number of steps or phases. Initially, a series of walk-through surveys is conducted to select plants or processes with effective and potentially transferable control concepts or techniques. Next, in-depth surveys are conducted to determine both the control parameters and the effectiveness of these controls. The reports from these in-depth surveys are then used as a basis for preparing technical reports and journal articles on effective hazard control measures. Ultimately, the information from these research activities builds the database of publicly available information on hazard control techniques for use by health professionals who are responsible for preventing occupational illness and injury.

This particular research effort was prompted by the growing concern of the hazards of methylene chloride and the need for technical advice to furniture strippers. For years, methylene chloride and methanol have been the primary constituents in paint stripping solutions. Methylene chloride provides the furniture stripper with an effective and efficient paint remover. This project will evaluate the technology available for the control of hazardous substances in furniture stripping applications, particularly methylene chloride vapors.

This report discusses results from the walk-through survey of furniture stripping operations at Jet Strip. This shop was selected for a walk-through survey because of the unique automated furniture stripping enclosed spray system which featured a gasket sealed lid that is in place while furniture is being stripped. The object of the survey was to ascertain the potential effectiveness of the control.

PLANT AND PROCESS DESCRIPTION

PLANT DESCRIPTION

Jet Strip opened for business in 1976 and moved into the present building in 1981. The building shown in Figure 1 occupies 2200 square feet. The stripping and rinsing areas are located in the back section of the shop (see Figure 1 for shop diagram). This facility is currently operated by the co-owners of the shop. At the time of the survey there were no employees. One of the co-owners strips furniture on a daily basis. Refinishing is done if requested by a customer.

PROCESS DESCRIPTION

Paint stripping is done on a continuous basis throughout the workday. The enclosed spray system tank was 6 ft wide by 10 ft long and 4.5 ft deep with refrigerated water filled cooling pipes around the tank perimeter. Pieces of furniture to be stripped are carried to the area of the enclosed spray system and placed on a metal grid that is hung from the lid (or top) of the enclosed spray system. Once the grid (or rack) is loaded with furniture it is mechanically lowered into the tank. The lid which is interconnected to the metal grid is simultaneously lowered. The lid then drops down to form the cover of the enclosed spray system. There is a hole located in the lid which is connected to a water bed mattress which lays on top of the lid.

Stripping solution is turned on and applied to the furniture through an automated spray system. While the stripper is applied the mattress expands as it fills up with vapors. When the stripping process inside the tank is completed the vapors slowly dissipate back into the tank leaving the mattress in its original form. After the mattress returns to its original form the lid is mechanically opened and the furniture is removed.

STRIPPING SOLUTION

The stripping solution used at Jet Strip is a pre-formulated solution that is transferred to the process equipment by pumping. Raw materials are purchased in bulk quantities and mixed on site for use at this facility. The stripping solution consists of methylene chloride as the major ingredient with methanol, ammonia, sodium hydroxide, and paraffin. The temperature of the stripping solution is maintained at 60 to 70 degrees Fahrenheit. The methylene chloride in the stripping solution is reclaimed through distillation and sometimes sold to other businesses for degreasing purposes. The solid waste is disposed of by a private solid waste removal contractor.

POTENTIAL HAZARDS

Potential chemical exposures in the furniture stripping industry are found primarily during the handling and stripping of the furniture. Other exposure sources may include the rinsing of the furniture after stripping; the mixing or transferring of stripping solution; the evaporation of solution; or the evaporation of solution off furniture after stripping.

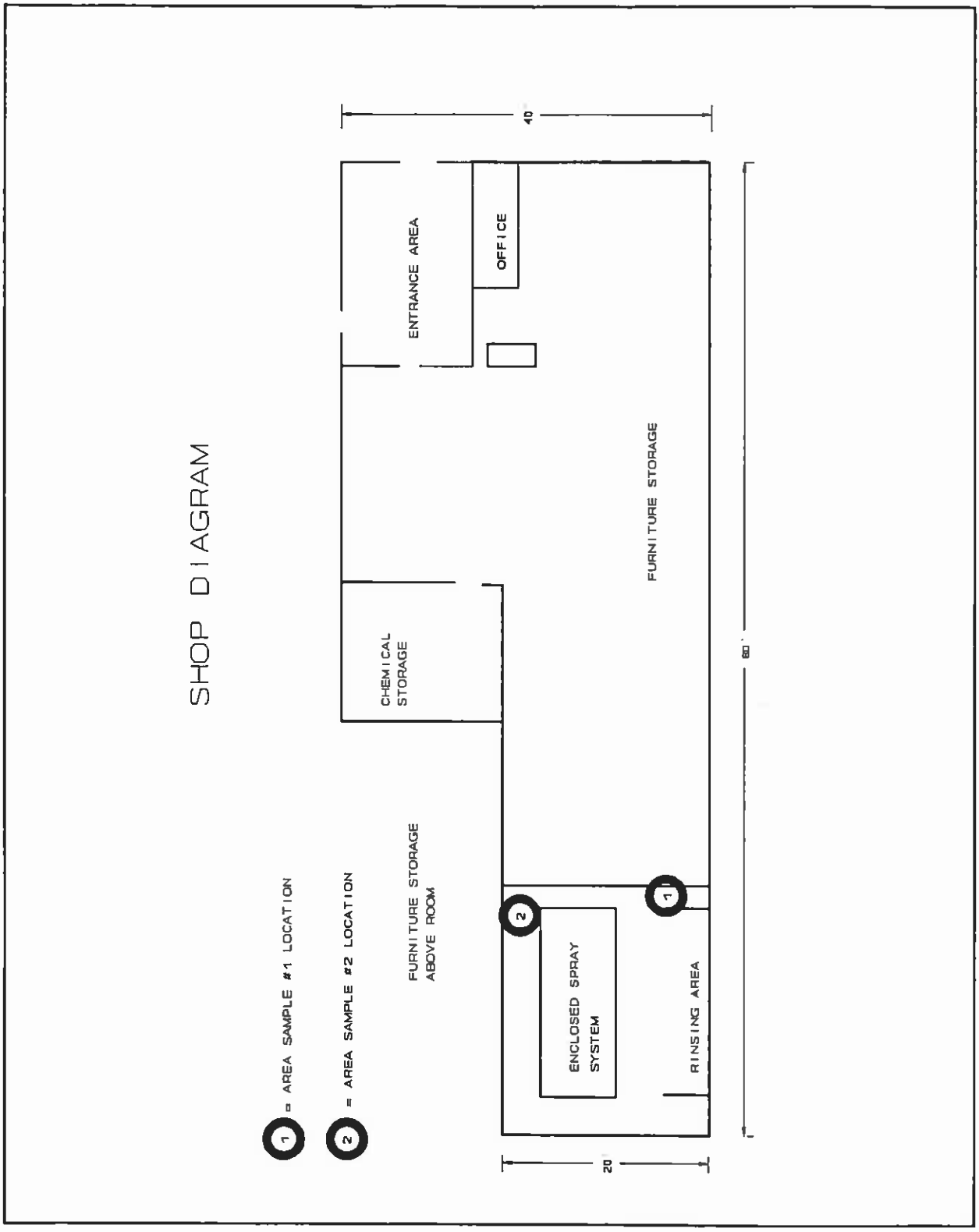

Figure 1: Shop diagram with area sample locations.

The major routes of entry of methylene chloride and other solvents into the body include inhalation and absorption of the liquid through the skin. The severity of the hazard depends on the formulation of the stripping solution, type of operation (i.e., dip tank, flow-over system, hand stripping), work practices, duration of exposure, temperature, ventilation (i.e., type of system, location relative to worker, air patterns, and flow rates), and general workstation design.

Methylene chloride has been classified as a potential occupational carcinogen based on animal studies conducted by the National Toxicology Program (NTP). These studies have shown exposure to methylene chloride levels can produce lung and liver tumors in mice, and benign mammary tumors in rats.[1] The Environmental Protection Agency (EPA), the Consumer Product Safety Commission (CPSC), the Food and Drug Administration (FDA) and NIOSH [1986] have classified methylene chloride as a potential occupational carcinogen. However, the current exposure limits were set by OSHA to prevent neurological damage. Recent research findings suggest that methylene chloride can be toxic to the central nervous system (CNS) at concentrations much lower than previously suspected.[2-3] Research has identified carbon monoxide (CO) as a human metabolite of methylene chloride, which has led to concern regarding cardiovascular effects of methylene chloride exposures.

ENVIRONMENTAL CRITERIA

As a guide to the evaluation of the hazards resulting in 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 criteria. 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 in the United States that can be used for the workplace are: NIOSH Recommended Exposure Limits (REL's) and the U.S. Department of Labor (OSHA) Permissible Exposure Limits (PEL's). The OSHA PEL's are required to consider the feasibility of controlling exposures in various industries where the agents are used; the NIOSH REL's, by contrast, are based primarily on concerns relating to the prevention of occupational disease. It should be noted that industry is legally required to meet only those levels specified by an OSHA PEL's.

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.

The current OSHA PEL for methylene chloride (29 CFR 1910.1000 Table Z-2) is an 8-hour TWA concentration of 500 parts per million (ppm), with a ceiling concentration of 1000 ppm, and a maximum peak concentration of 2000 ppm for no more than 5 minutes within any 2 hours. This PEL was derived from a standard recommended by the American National Standards Institute (ANSI) and adopted in 1971 without rulemaking.[4] The Federal Register dated Thursday, November 7, 1991, published an OSHA Proposed Rule of 25 ppm with a action level of 12.5 ppm for the occupational exposure to Methylene Chloride.[5]

In 1976, the NIOSH REL for methylene chloride was 75 ppm, as a TWA for up to 10 hours per day, 40 hours per week, with a 500 ppm peak exposure as determined over any 15-minute sampling period during the workday. This REL was based on the need to prevent significant reduction in the oxygen carrying capacity of the blood which affects the central nervous system.[6] Then in 1986, NIOSH recommended that methylene chloride be regarded as a "potential occupational carcinogen." NIOSH further recommended that occupational exposure to methylene chloride be controlled to the lowest feasible limit.[7] This new recommendation was based on the observation of cancers and tumors in both rats and mice exposed to methylene chloride in air.[8] In 1992 NIOSH testimony presented at the OSHA informal public hearing on the proposed rule for occupational exposure to methylene chloride reaffirmed the recommendation that methylene chloride exposures be controlled to the lowest feasible limit.[9]

CONTROLS

PRINCIPLES OF CONTROL

Occupational exposure can be controlled by the application of a number of well-known principles, including engineering measures, work practices, personal protection, and monitoring. These principles may be applied at or near the hazard source, to the general workplace environment, or at the point of occupational exposure to individuals. Controls applied at the source of the hazard, including material substitution, process or equipment modification, isolation or automation, local ventilation, and work practices are generally the preferred and most effective in terms of both occupational and environmental concerns. Controls which may be applied to hazards that have escaped into the workplace environment include dilution ventilation, dust suppression, and housekeeping. Control measures may also be applied near individual workers, including the use of ventilated control rooms, isolation booths, supplied-air cabs, work practices, and personal protective equipment.

In general, a system comprised of the above control measures is required to provide worker protection under normal operating conditions as well as under conditions of process upset, failure, and/or maintenance. Process and workplace monitoring devices, personal exposure monitoring, and medical

monitoring are important mechanisms for providing feedback concerning effectiveness of the controls in use. Ongoing monitoring and maintenance of controls to insure proper use and operating conditions, and the education and commitment of workers and management to occupational health are also important ingredients of a complete, effective, and durable control system.

These principles of control apply to all situations, but their optimum application varies from case to case. The application of these principles is discussed below.

ENGINEERING CONTROLS

The control system used at Jet Strip consisted of an enclosed furniture stripping tank with a water-bed mattress (to collect methylene chloride vapors) and auxiliary ventilation. Figure 2 shows the automated furniture stripping enclosed spray system. A mechanical lift raises the lid of the tank and a metal grid (or rack) for loading the furniture and after the furniture is loaded, lowers the metal grid into the tank, closing the lid. An automated nozzle spray system is used to apply the stripping solution to the furniture in the closed tank. The stripper solution is delivered from a 85 gallon external sump, through an opening into the tank. The used stripping solution drains from the tank into the enclosed 85 gallon external sump where it can be distilled (disposing of the solid waste) and reclaiming the methylene chloride.

A slot hood with a series of openings that measured 8 in long by 3/16 in wide is located around the top edge of the tank. Smoke tube test indicated no draw from the openings until the smoke was within a half inch from the slots. The slot hood has a very low exhaust rate and was only on the top sides of the tank. In addition, a exhaust hood with a 25 in by 13 in opening connected to a 10 in diameter duct was positioned by the ramp leading up to the tank. When one fan was in operation the average velocity at the face of the 10 in duct was 1100 fpm and the average velocity at the 25 in by 13 in opening was 386 fpm with a volume of 867 cfm. When both fans were operating the average velocity at the 10 in duct was 617 fpm and the 23 in by 13 in opening the average velocity was 845 fpm with a volume of 1898 cfm. The cost of the automated furniture stripping enclosed spray system excluding the exhaust system was approximately 10,000 dollars in 1982.

PERSONAL PROTECTIVE EQUIPMENT

During stripping and rinsing operations, the worker wore a rubber apron, neoprene gloves, and safety glasses.

ENVIRONMENTAL MONITORING

Methodology

See Figure 1 (shop diagram) for sample locations. A personal air sample for methylene chloride was collected in the breathing zone of the worker for the duration of the stripping and rinsing operations. In addition area samples for methylene chloride were collected. One area sample was located on the

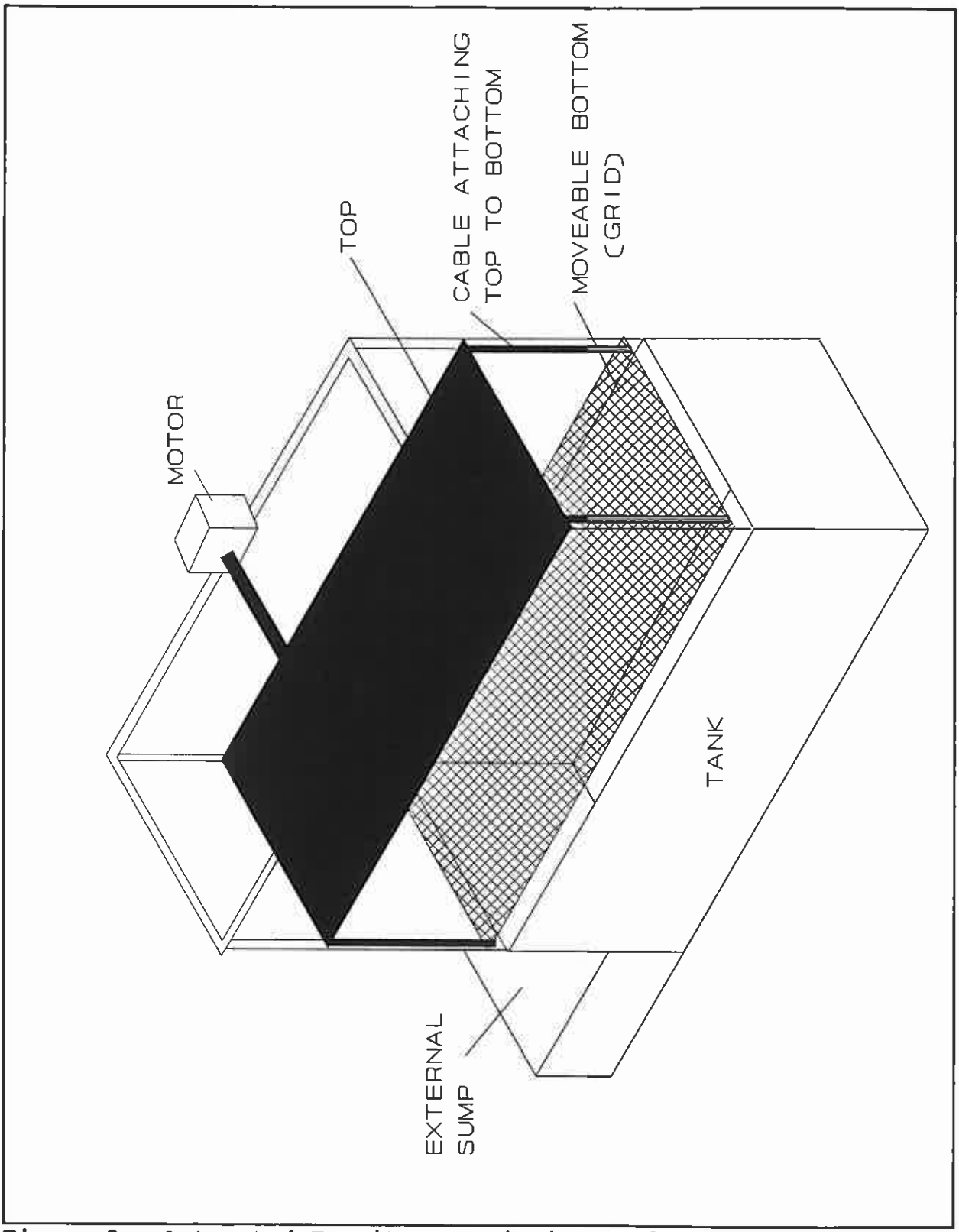

Figure 2: Automated Furniture Stripping Enclosed Spray System

cabinet next to the rinse area, and a second area sample was located behind the enclosed spray system along the wall. Samples were collected on 50/100 mg charcoal sorbent sample tubes (SKC 226-01, SKC, Inc., Eighty-four, PA). Sampling was conducted at a flow rate of 0.02 liters per minute (lpm) using a personal sampling pump (P200A, E.I. DuPont DeNemours & Co., Inc., Wilmington, Delaware).

The samples were analyzed using method 1005 for methylene chloride, from the NIOSH Manual of Analytical Methods, at DataChem (Salt Lake City, Utah).[10]

RESULTS AND DISCUSSION

METHYLENE CHLORIDE

The single personal sample collected during stripping and rinsing operations showed a methylene chloride concentration of 68 ppm. This indicates that the automated furniture stripping enclosed spray system control may have the potential to control methylene chloride fumes below 25 ppm provided the rinse area also were controlled.

Area samples for methylene chloride also were collected during stripping and rinsing operations. The rinse area was located behind the furniture stripping automated enclosed spray system (see Figure 3). Area 1 was located on the cabinet next to the rinse area. Area 2 was located behind the enclosed spray system along the wall. Area 1 had a concentration of 25 ppm methylene chloride and area 2 had a concentration of 39 ppm methylene chloride. Table 1 summarizes air sampling results.

Table 1. Air Sampling Results

Sample location	Methylene Chloride Concentration (ppm)
Personal Sample	68
Area 1	25
Area 2	39

CONCLUSIONS AND RECOMMENDATIONS

The automated furniture stripping enclosed spray system was a homemade system that is not commercially available. Extensive development and work is necessary to improve the efficiency of the system and making it commercially available. Although the enclosed spray system has the potential to control methylene chloride levels to below 25 ppm in its present configuration it is a complex and expensive option and is not recommended for further evaluation at this time.

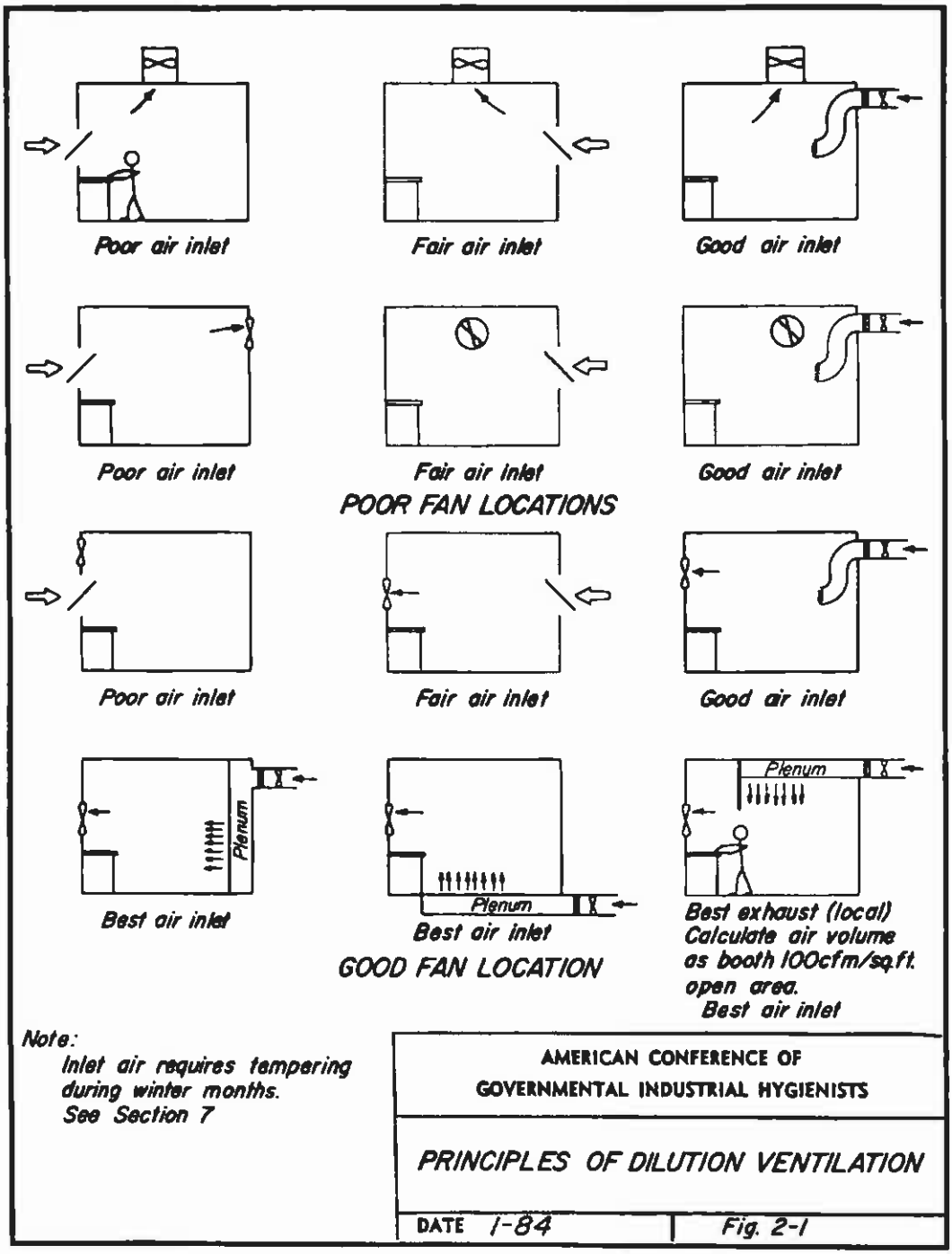

Figure 3. Dilution Ventilation

It is recommended that the owners apply an effective control to the rinse area in order to reduce methylene chloride concentrations. For example, a simple design enclosure could be placed around the rinse area with a fan located inside the enclosure and then ducted to the outside. There should be a velocity of 100 feet per minute (fpm) at the face of the booth. A booth 6 ft wide and 7 ft high at the face with a total face opening of 42 square feet would require a total exhaust air volume of 4200 cubic feet per minute (cfm). The fan selected should have the capacity to pull 4200 cfm.

When rinsing with this type of system, the operator should always keep the furniture between himself and the wall fan so the air flow is directed out the fan and not across the operator's breathing zone. This type of system also could be designed with fire proof curtains that could be movable in order to rinse large pieces of furniture. Good work practices can significantly reduce worker exposure. Keeping the worker's head as far as possible from the stripping solution and the furniture will lower the exposure.

General room ventilation also must be considered as a necessary secondary control method. Figure 3 depicts principles of dilution ventilation and shows the importance of fan location.[11]

Keep all soiled cloths, brushes or tools in a ventilated area or in an airtight container. Paint scrapings contain substantial amounts of methylene chloride and other organics and should be stored in airtight containers until properly disposed. Any clothing that becomes soaked with stripping solution should be immediately removed and the exposure area thoroughly washed. Soiled clothing should not be taken home and washed with other clothes. Eating or smoking in the shop area also can contribute to exposures. Hands should be thoroughly washed before eating or smoking. Eating or smoking should not be done in the shop area. Also, some of the chemicals used in the furniture stripping and refinishing industry are flammable and therefore, there should be no smoking in the shop or near flammable storage areas.

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