U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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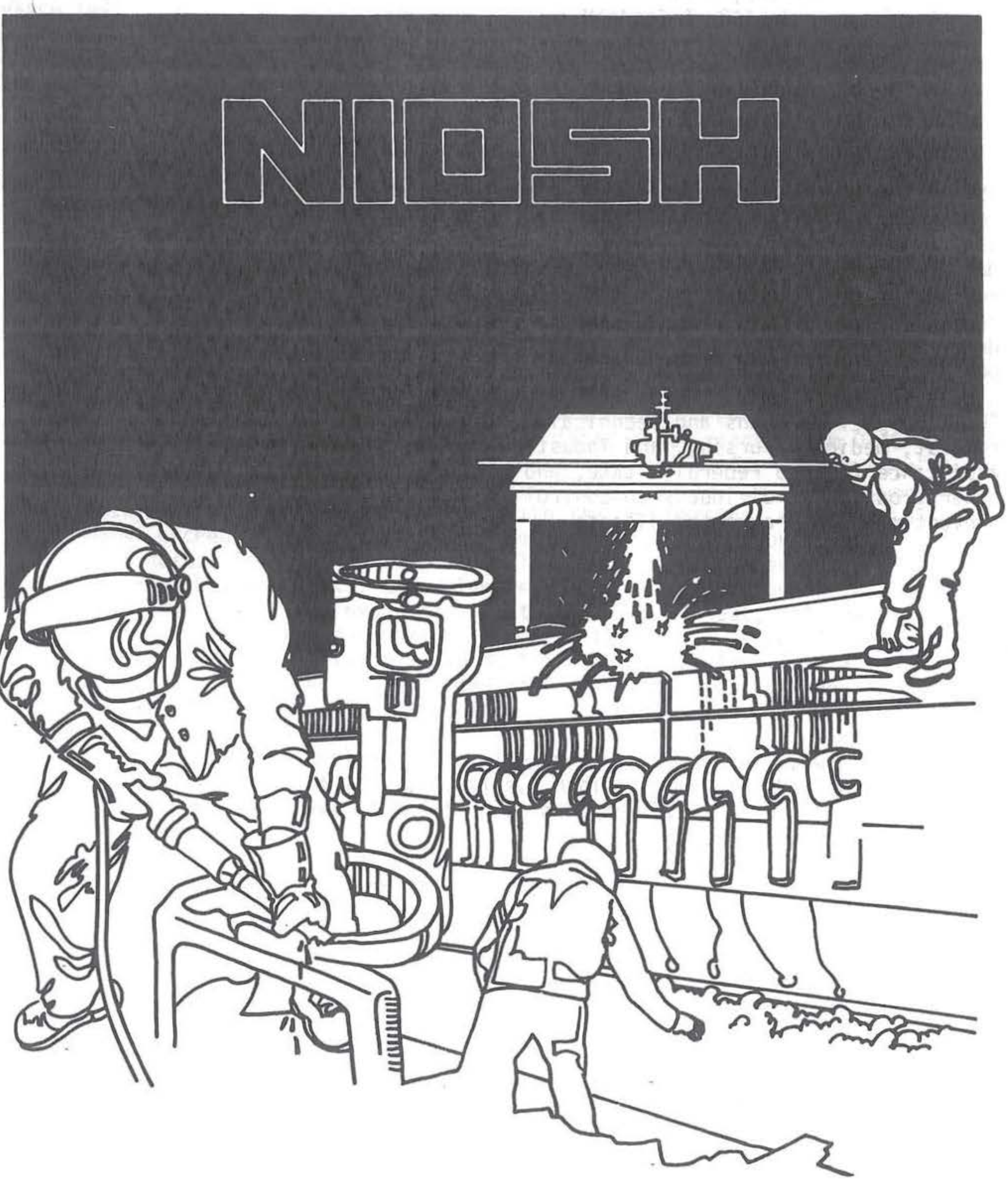


# Health Hazard Evaluation Report

HETA 82-044-1284
SETH THOMAS DIVISION
GENERAL TIME CORPORATION
BOSCAWEN, NEW HAMPSHIRE

## 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.

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SETH THOMAS DIVISION
GENERAL TIME CORPORATION
BOSCAWEN, NEW HAMPSHIRE

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## I. SUMMARY

In November 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a Health Hazard Evaluation at the Seth Thomas Division of General Time Corporation --- makers of grandfather clocks. Workers reported symptoms of eye irritation, nausea, dizziness, and light-headedness, possibly associated with wood dust and solvent exposures.

On April 28, 1982, investigators from Harvard University conducted environmental sampling and medical interviews. Three personal air samples for "respirable particulates" (wood dust) ranged from 0.48 to 0.88 mg/m$^3$ (no recommended or legal standard exists for "respirable" wood dust). Four area and one personal air samples for "total" wood dust ranged from 0.15 to 36 mg/m$^3$ with the one personal sample of 36 mg/m$^3$ exceeding the evaluation criterion of 5.0 mg/m$^3$ for total wood dust. Seven personal air samples for hexane, toluene, methyl isobutyl ketone (MIBK), and xylene exposure determinations were all less than 14% of the evaluation criteria. The highest, toluene (14 ppm) was 14% of the evaluation criterion (100 ppm). A composite exposure index, combining individual solvent vapor levels as a fraction of evaluation criteria, indicated the seven exposures to range from 1 to 22% of the evaluation criteria.

A ventilation evaluation of the five spray paint booths showed inadequate hood face air velocities. Modifications to the booths may increase the face velocities to desirable levels.

Workers involved in gluing operations reported dry skin, and workers involved in varnishing operations reported nausea, dizziness, and feeling "high".

Based on the environmental data collected in this study, it is concluded that there are potential overexposures to wood dust in this plant. Although the solvent air concentrations were not excessive, the symptoms reported by the varnishing operation workers suggest that exposures at the varnishing operation may have exceeded those at other operations. Skin absorption may also contribute to exposures. Recommendations for improved environmental controls are included in the text of this report.

KEYWORDS: SIC 3873 (Watches, Clocks, Clockwork Operated Devices, and Parts), wood dust, hexane, toluene, methyl isobutyl ketone, MIBK, xylene, local exhaust ventilation, solvents.

## II. INTRODUCTION

In November 1981, NIOSH received a request for a Health Hazard Evaluation from five employees of the Seth Thomas Division of the General Time Corporation, makers of grandfather clocks, Boscawen, New Hampshire. Employees in both the finishing area and the mill area reported eye infections and irritation. Employees in the finishing area also reported nausea, headaches, dizziness, and light-headedness. The eye problems were thought to be caused by exposure to airborne wood dust. The severity of symptoms seemed related to the type of wood being used. The neurological symptoms were thought to be associated with the application of spray lacquers and wipe stains. To determine whether these symptoms were work-related, an industrial hygiene survey and medical interviews were conducted on April 28, 1982, by the Harvard University School of Public Health (under cooperative agreement with NIOSH).

## III. BACKGROUND

This grandfather clock factory is located in a large, single-story building. Clock cases are constructed, sanded, finished, and the clock mechanisms installed. Principal areas of the plant are the rough mill, located in the middle of the building; the finish mill, located to the south of the rough mill; the assembly area, located to the south of the finish mill; and the finishing area, located to the northern end of the plant. The plant has a model shop, grinding room, offices, parts storage area, clock mechanism area, and shipping area.

The rough mill area contains three circular saws used to cut wood to size; all are supplied with local exhaust ventilation (LEV). The finish mill has a large number of machines used to cut, shape, and sand pieces of wood. Most are attached to one large LEV system servicing the mill area.

The assembly area contains facilities for gluing together the clock bodies and an area for hand-sanding the assembled bodies to prepare surfaces for finishing. Most of the hand-sanding is done with small electric sanders, while some is done with hand-held sandpaper. No LEV systems are used in this area. Some workers were observed wearing disposable face masks while sanding.

Stains and lacquers or other finishes are applied and sanded smooth in the finish area. The clock bodies are moved along a conveyor system from one station to the next, where a variety of materials are sprayed or wiped onto the wood. The standard sequence is stain preparation, staining, sealing, sanding, and lacquer application. All of these operations, with the exception of sanding, are performed with compressed-air spray guns in ventilated spray booths. Stains are also rubbed down and wiped off by hand, causing considerable skin contact for some workers.

Investigation of Material Safety Data Sheets revealed the presence of toluene, xylene, hexane, and methyl isobutyl ketone (MIBK) in the lacquer and lacquer sealer being used during the survey.

## IV. METHODS

### A. Environmental

All sampling was conducted on April 28, 1982. Sampling pumps were worn by company employees from two to five hours to obtain representative personal (breathing zone) samples. Area sampling was accomplished by placing the sampling pumps in various areas of the woodworking unit for about five hours in an effort to obtain samples which would indicate ambient levels and possible exposures to wood dust. Filters and charcoal tubes were capped immediately after the sampling period and stored until analysis.

Respirable particulate samples - Medium flow personal sampling pumps were calibrated with a spirometer to deliver 1.7 lpm with a two stage respirable dust sampler connected in line. The dust sampler consisted of a 10 mm diameter cyclone and a 37 mm diameter fibrous glass filter with a backing pad. The filter cassette was used closed face.

Total particulate samples - Medium flow personal sampling pumps were calibrated with a spirometer to deliver 1.7 lpm with an open face 37 mm diameter fibrous glass filter and cassette in line.

Solvent vapor samples - Medium flow personal sampling pumps were calibrated with a spirometer to deliver about 1.0 lpm with the sample collection system in line. The sample was collected on an open face 37 mm diameter polyvinylchloride filter and cassette followed by a charcoal tube. The filter was used to collect any paint mist which may have been present; it was presumed that any solvents collected on the filter would subsequently evaporate and be collected in the charcoal tube.

Analyses - A Cahn 21 Automatic Electrobalance was used to determine filter weights. Pre-sampling weights were determined on April 26, 1982; the relative humidity was 49.5% and the temperature was 81°F at the time of weighing. The post-sampling weights were determined on May 6, 1982; the relative humidity was 46% and the temperature was 80°F at the time of weighing. The charcoal tubes were analyzed for hexane, toluene, MIBK, and xylene by gas chromatography.

### B. Medical

No formal medical survey of the workers in this plant was undertaken. A number of individuals were interviewed at their work stations to see if they reported symptoms associated with exposure to wood dust, wood chips, and the solvents contained in the varnish and stain preparations.

## V. EVALUATION CRITERIA

### A. Environmental Criteria

To evaluate workplace exposure hazards, occupational health professionals often use environmental evaluation criteria for chemical and physical agents. These criteria 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 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, pre-existing medical condition, and/or hypersensitivity (allergy). Evaluation criteria may change as new information on the toxic effects of an agent becomes 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 since they usually are based on more recent information. The OSHA standards may also consider the feasibility of controlling exposures in various industries. 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 only those levels specified by an OSHA standard.

The evaluation criteria and sources considered most appropriate for this study are as follows:

| Substance | Evaluation Criteria 8-hr TWA* | OSHA Standard 8-hr TWA* |
|---|---|---|
| Soft Wood Dust (nonallergenic) | 5.0 $mg/m^3$, (ACGIH) | none |
| Hexane | 100 ppm (NIOSH) | 500 ppm |
| Toluene | 100 ppm (NIOSH) | 200 ppm |
| MIBK | 50 ppm (NIOSH) | 100 ppm |
| Xylene | 100 ppm (NIOSH) | 100 ppm |

*8-hour time weighted average (TWA)

A combined exposure index or a calculation for mixtures is relevant when two or more hazardous substances, which may result in similar health effects, are present in the same environment. The calculation is performed according to the method published by the American Conference of Governmental Industrial Hygienists. If the sum of the following fractions,

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \frac{C_3}{T_3} + \ldots$$

exceeds unity, then the recommended environmental limit for the mixture is considered as being exceeded. $C_1$ is the observed air level and $T_1$ is the corresponding environmental limit, etc. Calculations of solvent vapor mixture fractions were performed for each solvent sample of this study.

B. Toxicology

Wood Dust (hard woods and non-allergenic soft woods) presents three major health effects; dermatitis, respiratory disease, and cancer. Contact dermatitis may result from handling a variety of domestic and imported or exotic woods and may be induced by irritation (mechanical or chemical) or sensitization. However, much of this dermatitis may be caused by additives and not the wood itself.

Among diseases of the respiratory system that have been attributed to wood dust are: asthma from inhalation of several African wood dusts; bronchial asthma from cork dust; granulomatous pneumonitis (Sequoiosis) from redwood dust; airway obstruction from abiruana wood dust; asthma and rhinitis from Canadian red cedar; and allergic disorders of the upper respiratory tract from dust of arbor-vitae[1].

An increased incidence of adenocarcinoma of the nasal cavity and ethmoid sinus has been demonstrated in furniture wood workers in England, with similar cases reported from Belgium, France, and Denmark. The periods of latency ranged from 28 to 57 years. An impaired mucociliary function may be important because of prolonged retention of wood dust in the nasal cavity. There is no evidence that the conditions which caused the nasal cancers still exist. However, the air dust concentrations must have been uniquely high during the period 1920 to 1939 when the peak of mechanization occurred without corresponding improvement in hygienic controls[1].

Hexane is a colorless, flammable, aliphatic hydrocarbon whose properties appear similar in many ways to the chlorinated hydrocarbons. Aliphatic hydrocarbons are asphyxiants, narcotics, and general central nervous system (CNS) depressants. Route of entry is through inhalation and to a lesser degree through skin absorption. CNS symptoms of over-exposure may include lightheadedness, giddiness, nausea, headache, and dizziness. Greater exposure can result in unconsciousness and death.

Hexane is a respiratory, skin, and mucous membrane irritant affecting eyes, nose and upper respiratory tract. Prolonged and repeated skin exposure causes defatting which can lead to dermatitis and infection. Due to the low viscosity of hexane, aspiration may result in chemical pneumonitis and pulmonary edema.

Recent research into the exposure of glue sniffers and Japanese sandal makers has shown n-hexane to be associated with the development of peripheral neuropathy, which may develop from several months to a year following beginning of exposure. A delayed progression of the disorder may continue for up to three months following cessation of exposure. Initial symptoms often have been sensory with numbness and paresthesias of distal extremities. Sensory loss usually involves hands and feet. Generally the result is a subacute, progressive sensorimotor polyneuropathy which in most cases is thought to be reversible.

Toluene is a clear, colorless, non-corrosive liquid with a sweet, pungent odor. Exposure is predominantly through inhalation although some skin absorption does occur. Although toluene is much less toxic than benzene, it can cause central nervous system depression and narcosis. Symptoms include weakness, confusion, euphoria, dizziness, headache, dilated pupils, nervousness, numbness and tingling in the limbs, and muscular fatigue.

Toluene may also cause a drying, cracking type of dermatitis. Blood related abnormalities are uncommon and no serious abnormalities have been reported which were independent of those caused by benzene as a contaminant.

Methyl Isobutyl Ketone (MIBK) is a colorless liquid with a characteristic camphor-like odor detectable at 100 ppm and objectionable at 200 ppm. Exposure occurs essentially by the inhalation route. MIBK is an irritant of the eyes, mucous membranes and skin, and can produce a dry scaly and cracking dermatitis after repeated exposure. Mucous membrane irritation can result in eye and throat symptoms.

In high concentrations, CNS depression occurs with narcosis, headache, nausea, light headedness, vomiting, dizziness, lack of coordination, and, if exposures are high enough, unconsciousness. In one study workers exposed to about 100 ppm complained of nausea and headache, but tolerance developed during the work week.[2]

A peripheral neuropathy has been reported in mixed exposures that might include methyl isobutyl ketone, but a well-documented neuropathy has not been described. Peripheral neuropathy after exposure to MIBK in spray paint has been documented.[3]

Xylene is a colorless, flammable liquid. Exposure occurs predominantly through inhalation and to some extent through skin absorption. Xylene vapor is an irritant of the eyes and mucous membranes and skin and may cause a drying and cracking dermatitis. Repeated exposure of the eyes to high concentrations of xylene vapor may cause reversible eye damage.

At high concentrations, xylene vapor may cause CNS depression and minor reversible effects upon liver and kidneys. The symptoms associated with these are dizziness, staggering, drowsiness, and unconsciousness. In one study, three painters who were overcome, developed pulmonary edema and one died. Those who recovered had temporary liver and kidney impairment but this resolved over time. Workers exposed to over 200 ppm complained of loss of appetite, nausea, vomiting, and abdominal pain[2].

## VI. RESULTS

### A. Environmental Monitoring

The results of the respirable and total particulate air samples are summarized in Tables 1 and 2, respectively. The respirable dust concentrations ranged from 0.48 to 0.53 mg/m$^3$. Although there is not a recommended or legal standard for "respirable" wood dust, these air concentrations are judged to be quite low.

The measured total particulate concentrations showed more variability than did the respirable samples, ranging from 0.15 to 36 mg/m$^3$. The personal sample of 36 mg/m$^3$ was collected from a router and exceeded the evaluation criteria of 5 mg/m$^3$ by a factor of seven. The router who was sampled was working on a ventilated machine, but the ventilation did not appear to be effective at collecting larger wood particles. One other total particulate sample approached the criteria for soft wood dust. This area sample, collected in the vicinity of the hand sanders, measured a concentration of 4.6 mg/m$^3$. This result is consistent with the observed level of general or local exhaust ventilation in this area on the day of sampling.

The results of the seven personal solvent vapor samples are summarized in Tabel 3. All measured concentrations of hexane, toluene, MIBK, and xylene were well below evaluation criteria and OSHA legal standards. Hexane levels ranged from <0.003 to 1.6 ppm (evaluation criterion: 100 ppm); toluene levels ranged from 0.1 to 14.2 ppm (evaluation criterion: 100 ppm); MIBK levels ranged from 0.3 to 2.5 ppm (evaluation criterion: 50 ppm); and xylene levels ranged from 0.03 to 3.8 ppm (evaluation criterion: 100 ppm). The highest exposure was to the lacquer sealer, who was exposed to 14 ppm of toluene by one air sample. This exposure was 14% of the evaluation criteria or 7% of the OSHA standard.

If we assume that the health effects of all four solvents are additive, then the lacquer sealer had the highest overall exposure being 12% of that allowed by OSHA and 22% of the stricter exposure limits recommended by NIOSH.

B. Ventilation Evaluation

The local exhaust ventilation systems in the woodworking area appeared to be in good operating condition, and many of the hoods appeared to be effectively collecting wood chips and sawdust. Housekeeping was generally good.

During the clock finishing operation, clocks are hand-pushed along a system of rollers through several spray booths, where various finishing coats are applied. A rough sketch of the finishing area is shown in Figure 1. A detailed side view of the booths is shown in Figure 2. The clocks pass in front of the booth itself along the rollers and can be stopped in the center of the face of each booth at a rotating platform where they can be rotated for spraying. The actual spraying thus takes place at the face of each booth, rather than inside the booth. The depths of the five booths vary slightly. The air from each booth is exhausted through a bank of paper filters, 6 feet high and the width of the booth, located 6 inches off the floor.

Face velocity measurements were made by traversing each hood face with a rotating vane anemometer. These measurements allowed the calculation of the average face velocity in front of the conveyer for each of the five booths. Average face velocities were also measured at the filter banks, which allowed the total air flow through each booth to be calculated. These data are summarized in Table 4, along with the recommended air flow rates as given in the ACGIH Ventilation Manual.[4] The recommended air flow rates are selected to give average face velocities of 100-150 cfm per square foot of opening at the face of the booth. Since the spraying is done in front of the conveyor openings, the open area must include the 32 $ft^2$ for these openings. If proper air flow rates are maintained, velocities at the face of each hood should average 100-150 fpm.

Table 4 reveals that the air flow rate through each hood is insufficient to maintain the desired velocity at the hood face. Four of the hoods were exhausting 7,200 cfm of air, while the fifth was exhausting 4,800 cfm. These air flow rates were sufficient to generate face velocities of 45-60 fpm at the booth openings. The air flow rate recommended for booths of this size ranges from 11,000 to 16,500 cfm (creating face velocities of 100 to 150 fpm).

C. Medical

A number of employees in the woodworking area were interviewed. One reported a nose bleed that was possibly associated with sawing operations, but the employee was not convinced of this. All five sanders were interviewed and none reported any symptoms of mucous membrane, upper or lower respiratory tract irritation. The only complaints associated with using the router were loud noise and occasional cough. Those involved in the gluing operations reported that their skin was dry, but they did not have a rash nor cracking or bleeding of the skin. No hypersensitivity reactions were described.

Those involved in the staining and varnishing operations were also interviewed. The three workers who operated the staining processes reported no symptoms related at all to their work. The three workers involved in the varnishing operations did report symptoms which included nausea, dizziness, and the feeling of being "high" when operating the varnishing equipment on a regular basis. One of these individuals reported headache, and one reported a rash which was observable on exposed areas as erythematous.

The skin dryness reported by the workers involved in gluing operations was compatible with skin contact with organic solvents. The central nervous system effects reported by all three workers involved in varnishing operations, however, did not seem consistent with the relatively low solvent inhalation exposures measured at other operations. This suggests that these workers' solvent exposures may have been greater than the exposures measured at other operations. Skin absorption may also have played a role.

## VII. RECOMMENDATIONS

### A. Woodworking Area

The local exhaust ventilation system was not effective at the router location sampled during this survey. Complete exhaust system evaluations should be made of the routers used at this plant.

One area sample collected in the hand-sanding room indicated a relatively high concentration of total dust (9.6 mg/m$^3$), even though little sanding was taking place on the day of the survey. Although local exhaust ventilation would be difficult to utilize in the hand sanding area, exposure could be decreased by improving the general exhaust supplied to that portion of the plant. NIOSH approved respirators for wood dust should be made readily available to all workers in this area.

Workers were observed using compressed air to assist in cleaning machines at the end of the work shift. Such practices should be discouraged, since they increase dust dispersion. Flexible connections to the local exhaust ventilation system could be used instead to remove the material by vacuum.

### B. Clock Finishing Area

Even though all of the solvent air concentrations were acceptable on the day we sampled, an evaluation of the spray booths found several areas where the ventilation system could be improved to further reduce worker exposure. Since other types of clock cases and spray materials may result in greater work exposures, it is recommended that these ventilation modifications be incorporated.

Several steps should be taken to improve the performance of these spray booths. First, the booths could be made narrower. The present design is far too wide for the clock bodies being finished, with the result that much of the exhaust air is being wasted by passing through unused areas of the booth face. For this type of operation, the ACGIH Ventilation Manual[4] recommends that the booth face be 2 feet wider than the work size; thus, a booth width of 4 feet would be sufficient for each of the five booths used here. This change would reduce the required air flow rate for each booth to the range of 6400-9600 cfm, into which four of the booths currently fall.

As an alternative to narrowing the booths, the conveyor system could be modified so that spraying occurs inside the booth, rather than at the face. The present setup allows air to be drawn in through the conveyor openings without contributing to the ventilation of the clock bodies; moving the bodies slightly forward into the booth would force the air being drawn in through the openings to pass over the clock bodies and thus contribute to the exhaust efficiency. If this change were made, the required air flow rate would be reduced to 8,000 cfm, approaching the capabilities of the present exhaust fans.

A third modification concerns the make-up air ducts used on Booths 4 and 5 in Figure 1. These ducts are designed to draw unheated outside air into the booths, thus decreasing the amount of heated air which is exhausted to the outside. This design is ineffective, since the duct locations on the side walls of the booths causes the air which is drawn in to bypass completely the location where spraying occurs.

If make-up air ducts of this type are to be used, they should be located as slots along the edge of the hood face and the air should be supplied to the hood face by a forced-draft fan. If these conditions are met, the make-up air may interact with the contaminants given off during spraying and may help to reduce exposure. The success of using such supplied air is dependent on the specific configuration used, however; we recommend that the make-up air ducts simply be eliminated from Booths 4 and 5.

These modifications would result in a ventilation system which would exhaust about the same amount of air as the current system but would do a much better job of capturing the contaminants given off during spraying. Although the solvent air concentrations measured during this survey were not excessive, the changes recommended here represent good industrial hygiene engineering practices and thus are highly recommended.

C. Medical

Periodic skin examinations should be made available to workers in operations that involve skin contact with solvents.

## VIII. REFERENCES


1. Documentation of the Threshold Limit Values for Substances in the Workroom Air, 4th edition, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1980.

2. Proctor NH & Hughes JP. Chemical Hazards of the Workplace. JP Lippincott, Philadelphia, 1978.

3. Johnson BL, Setzer JV, Lewis TR, Anger, WK. Effects of methyl n-butyl ketone on behavior and the nervous system. American Industrial Hygiene Association Journal. 38:567-579, 1977.

4. Industrial Ventilation - A Manual of Recommended Practice, 16th ed, American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation, P.O. Box 16153, Lansing, MI, 48901. 1980.


## IX. AUTHORSHIP AND ACKNOWLEDGEMENTS


| | |
|---|---|
| Study Conducted by (under cooperative agreement with NIOSH): | Occupational Health Program<br>Harvard School of Public Health<br>Boston, Massachusetts 02115 |
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| Report Typed By: | Cheri Nordman<br>Clerk-Typist |


## X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH at the Cincinnati address. Copies of this report have been sent to:

1. Seth Thomas Division, General Time Corporation
2. Employee Requestors
3. NIOSH, Region I
4. OSHA, Region I
5. Massachusetts Department of Labor and Industries

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

Results of Personal Air Sampling for "Respirable" Wood Dust

April 28, 1982

| Sample Time (min) | Sample Description* | "Respirable" Wood Dust Air Concentration ($mg/m^3$) |
|---|---|---|
| 243 | Personal Sample - Employee #1 - Sander | 0.48 |
| 115 | Personal Sample - Employee #2 - Hand Sander | 0.88 |
| 150 | Personal Sample - Employee #3 - Sander | 0.53 |

Environmental Criteria - none
OSHA Standard - none

Notes: Employee #1 performed several sanding operations at various locations throughout the main woodworking shop. On the day of the survey, this employee's job involved clock door sanding with a six-inch belt sander. The belt sander was locally exhausted at both ends and the exhaust appeared effective at capturing the wood dust.

Employee #2 was one of about five women who operated hand-held electric sanders at a waist-high bench. Their work generally consisted of fine sanding and finishing of clock pieces before staining. On the day of sampling however, there was little of this work being done and most of the sanding was done manually. No ventilation of any type was present in the hand sanding area. This employee was the only woman who was wearing a paper dust mask.

Employee #3 performed several sanding operations throughout the plant. On the day of the sampling, he was assigned to the hand sanding room and was performing duties similar to those of Employee #2. There was no ventilation at his work station. He did not wear respiratory protection.

Table 2

Results of Air Sampling for "Total" Wood Dust

April 28, 1982

| Sample Time (min) | Sample Description* | "Total" Wood Dust Air Concentration ($mg/m^3$) |
|---|---|---|
| 280 | Personal Sample - Employee #4 - Router | 36.0 |
| 230 | Area Sample - Filter T2 - Rough Mill | 0.15 |
| 297 | Area Sample - Filter T3 - Finishing Mill | 1.1 |
| 308 | Area Sample - Filter T4 - Hand Sander | 4.6 |
| Environmental Criteria (ACGIH - Soft Woods) | | 5.0 |
| OSHA Standard - none | | |

Notes: Employee #4 was positioned at a router located in the central position of the woodworking area. The router was locally exhausted; however, large "curls" of wood were not removed by the exhaust and were a source of exposure to his breathing zone. The majority of the wood dust generated did not appear to be of respirable size. On the day of sampling, this employee was working on pine clock doors.

Area sample "T-2" was located in an area adjacent to the rough wood cutting. Dust did not seem to be a problem in this area of the plant.

Area sample "T-3" was placed on a waist-high bench where hand sanding was performed. The hand sanding operation was located in a remote corner of the facility and had no ventilation. A "cloud" of fine suspended wood dust was apparent when entering the area.

Table 3

Results of Personal Air Sampling for Solvent Vapors

April 28, 1982

| Sample Volume (Liters) | Job Title | Hexane (ppm) | Toluene (ppm) | MIBK (ppm) | Xylene (ppm) | Combined Exposure Index* | Combined Exposure Index** |
|---|---|---|---|---|---|---|---|
| 155 | Lacquer Sealer | 1.6 | 14.2 | 1.1 | 3.8 | 0.22 | 0.12 |
| 180 | Lacquer Sealer | 0.003 | 2.9 | 5.4 | 0.7 | 0.14 | 0.08 |
| 140 | Pine Staining | < 0.003 | 2.4 | 0.5 | 1.0 | 0.04 | 0.03 |
| 162 | Pine Staining | < 0.003 | 0.8 | 0.1 | 0.2 | 0.01 | < 0.01 |
| 158 | Lacquer Spraying | < 0.01 | 2.0 | 1.8 | 3.2 | 0.09 | 0.06 |
| 188 | Lacquer Spraying | < 0.003 | 2.3 | 2.5 | 1.0 | 0.08 | 0.05 |
| 169 | Glazing | < 0.003 | 0.1 | 0.3 | 0.03 | 0.01 | < 0.01 |
| Evaluation Criteria | | 100 | 100 | 50 | 100 | 1.0 | ---- |
| OSHA Standard | | 500 | 200 | 100 | 100 | ---- | 1.0 |

*Based on Evaluation Criteria
**Based on OSHA Standards

Notes: Similar operations were performed in all spray paint booths, except that the type of material being applied varied from booth to booth. On the day of the sampling, a lacquer sealer was being applied to pine clock bodies in Booth #1, a pine stain was being sprayed and hand-wiped in Booth #2, lacquer was being sprayed in Booth #3, and a single worker was applying a glazing material in Booths #4 and #5.

Table 4

Air Flows Measured at the Spray Finishing Booths

| Spray Booth | Average Face Velocity (fpm) | Air Flow Rates (cfm) Actual | Recommended* |
|---|---|---|---|
| #1 | 50 | 7,200 | 11,000-16,500 |
| 2 | 60 | 7,200 | 11,000-16,500 |
| 3 | 45 | 4,800 | 11,000-16,500 |
| 4 | 50 | 7,200 | 11,000-16,500 |
| 5 | 50 | 7,200 | 11,000-16,500 |

*Recommended air flow rates result in velocities of 100-150 fpm at the face of each booth.

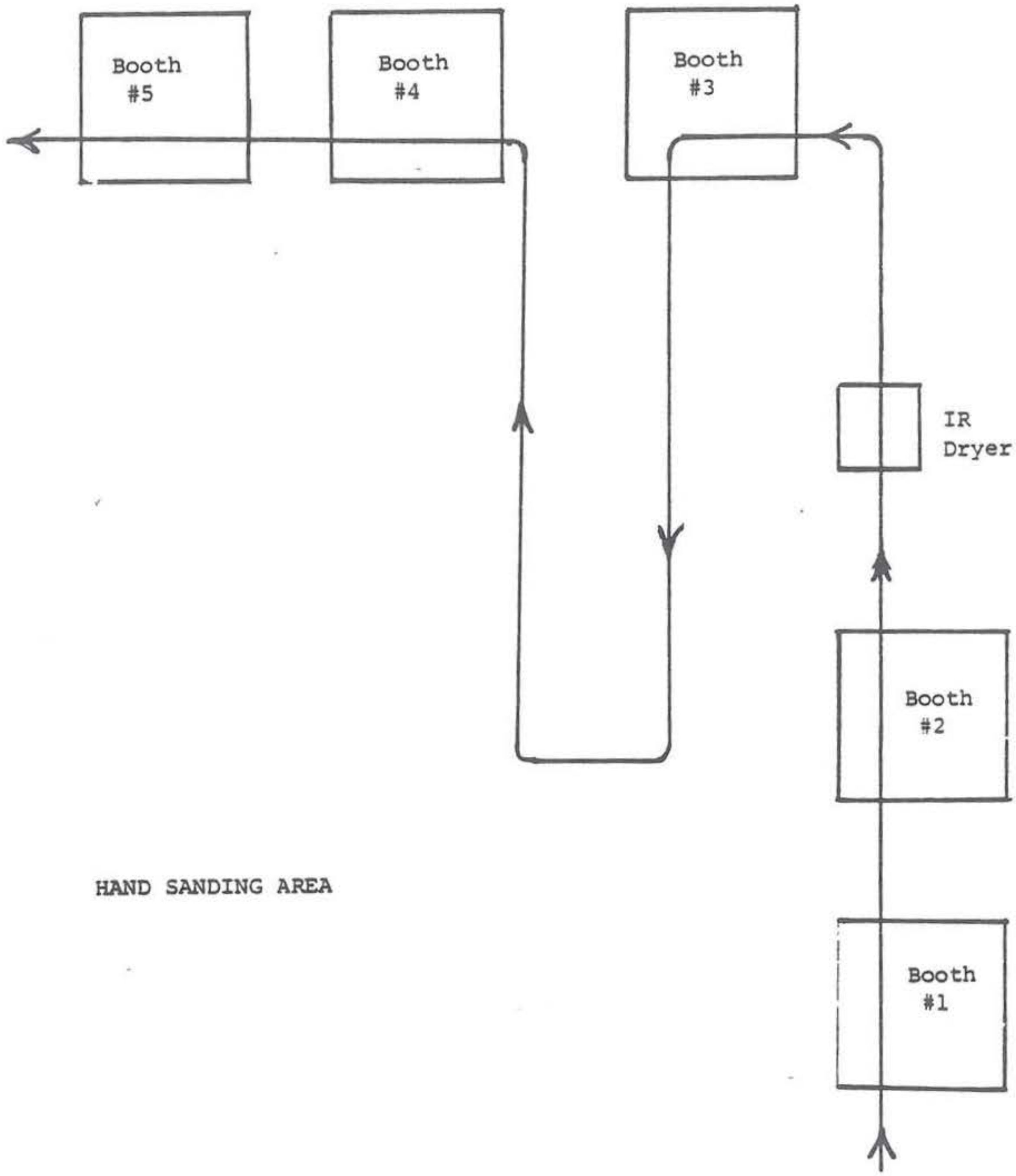


FIGURE 1: General Layout of the Finishing Area

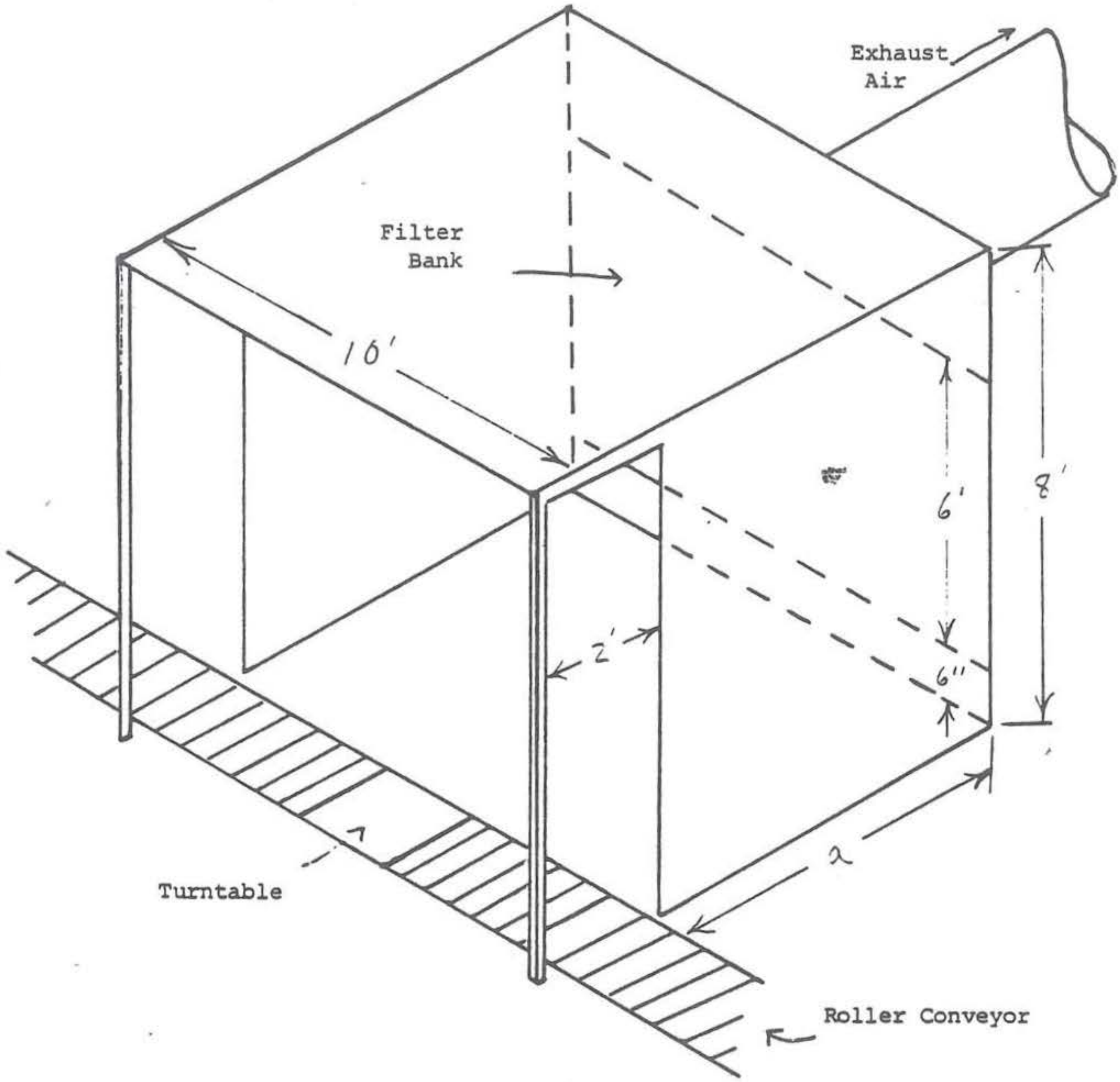


FIGURE 2: General Layout of the Spray Finishing Booths