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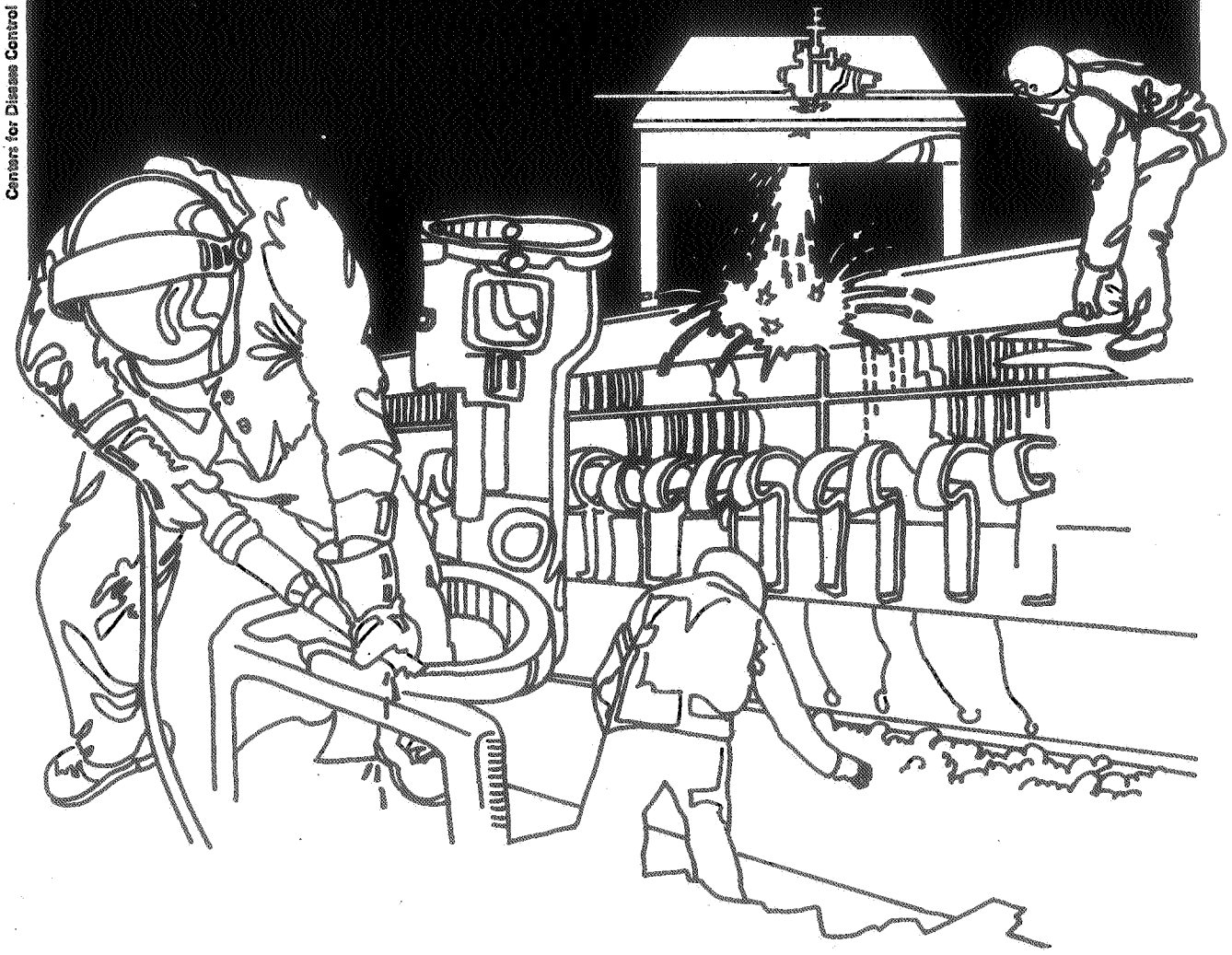
NIOSH



Health Hazard Evaluation Report

HETA 82-136-1175
U.S. ARMY RESEARCH OFFICE
RESEARCH TRIANGLE PARK, NORTH CAROLINA

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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September 1982
U.S. Army Research Office
Research Triangle Park, North Carolina

NIOSH Investigators:
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I. SUMMARY

On February 4, 1982, the U.S. Army Research Office requested a health hazard evaluation of the offset duplicating facility in its office building at Research Triangle Park, NC. Of concern were potential hazards of exposure to chemicals used in operating and cleaning the duplicating equipment. No complaints of adverse health effects were mentioned in the request.

Four survey visits of the facility were made from March 25 through July 16, 1982. The duplicating facility occupies a 16 ft. x 34 ft. room with a design air supply of 700 cubic feet per minute (cfm) along the south wall of a 27,600 sq. ft. one-story air-conditioned building. The duplicating room air supply is frequently off. A fan-powered roof exhaust unit, with its intake located in the ceiling over the offset press, was not operated before February 1982, and now exhausts 400 cfm from the duplicating facility. The fresh air intakes to the entire building are bolted shut.

Two employees are full-time operators of the duplicating equipment, which consists of a photocopier, offset press, collator, and stapler. Other employees enter occasionally to use a Xerox copier or teletype at one end of the room. Several chemicals are used by the two operators. Until February 1982, chemicals most used were methylene chloride and 25% tetrachloroethylene in petroleum naphtha. Since then, petroleum naphtha has replaced these two chemicals. Other chemicals are used in small amounts.

Seven personal and area samples collected in the room were assayed for 20 organic chemicals; up to 0.24 ppm benzene and 1.34 ppm trichloroethylene were detected. Two area particulate samples indicated total dust concentrations of 0.35 and 0.56 milligrams per cubic meter. Accumulations of dust on surfaces and use of an open container for disposal of solvent-wetted rags were observed. A potential noise problem was detected; noise measurements ranged from 72 to 89 dBA.

No acute chemical exposure hazard is apparent with current chemicals and handling procedures and with the room air supply and exhaust operating. Low-level exposure to benzene and trichloroethylene was detected. Calculations indicated that overexposure to methylene chloride could have occurred prior to February 1982 when the room air supply was off for a long period. During long press runs, the press operator may receive in excess of the daily noise exposure limit (based on 85 dBA) unless operators alternate work stations. During average operations, noise limits are not exceeded. The building fresh air supply is an estimated 0.05 cfm/sq. ft. of floor area (0.25 to 0.4 cfm/sq. ft. is recommended).

It is recommended that a) duplicating facility ventilation controls be modified to ensure continuous air turnover; b) any new chemicals be reviewed for toxic properties before being placed in use; c) building fresh air supply be increased; d) the two operators be given medical examinations; e) operators switch stations during long press runs; f) housekeeping procedures be improved. (FOLLOW-UP: Both operators have been given examinations; a closed container is now used for solvent-wetted rag disposal.)

KEYWORDS: SIC 2752; offset duplication, methylene chloride; tetrachloroethylene; benzene; trichloroethylene; office building; noise.

II. INTRODUCTION

On February 4, 1982, the U.S. Army Research Office (ARO) requested a health hazard evaluation of the photo-offset duplication facility in its office building at Research Triangle Park, North Carolina. The request stated that workers are exposed to potentially toxic chemicals in use in the duplicating area.

On-site surveys of the facility were conducted March 25, 1982 by an industrial hygienist and on April 1, May 26, and July 16, 1982 by an industrial hygienist and an engineer. The goals of the surveys were to evaluate the environmental conditions for possible excess respiratory and skin exposure to chemicals, and to develop appropriate recommendations to management to alleviate any problems found. Noise exposure was evaluated on the third and fourth visits because of conditions observed during the first two visits.

III. BACKGROUND

The following information was obtained in initial discussions with management personnel. The ARO occupies a one-story building, built about 1975, which is air-conditioned by three roof-mounted units. The printing operation occupies a 16'x34' room on the south side of the building, and provides duplicating services for the ARO. The printing equipment consists primarily of an electrostatic copier and an offset press which require the use of several liquid and powdered chemicals for their operation and maintenance. A collator and stapler are beside the press, and a dry Xerox copier and teletype machine are located at the east end of the room beyond a partial partition.

Two employees operate the copier, press, collator; and stapler; other employees enter the room occasionally for brief periods to request duplication and/or to pick up materials, or to use the dry copier or teletype machine.

The presence of possibly toxic chemicals was brought to the attention of management and the two operators by a staff chemist who noticed odors while in the room. The Support Services Officer requested the evaluation. Noise was not mentioned as a problem in the request, but was evaluated by the survey team in later visits.

IV. METHODS AND MATERIALS

Environmental evaluation consisted of interviews with ARO officials and operating personnel about environmental conditions, a walk-through industrial hygiene survey, examination of the ventilation system in the area of concern, review of properties of chemicals used, collection of air samples for particulate and organic vapor analyses, and a noise survey. Questionnaires were not used; the two duplicating equipment operators were requested to provide such information as they were able in the interviews.

The quantities of fresh and recirculated air supplied to the affected area were determined from building mechanical plans or calculated from air velocities measured with a rotating vane anemometer. Air drift within the area was determined with smoke tubes.

Seven personal and area air samples were collected, three with charcoal tubes and four with passive organic vapor monitors, and were analyzed for a variety of organic vapors by means of gas chromotography following elution with carbon disulfide. Two area particulate samples were collected and analyzed for total dust concentration in air. Particulate samples were collected in open-face mode on 37 mm-diameter, 5μ pore-size vinyl metricel filters at a rate of 1.7 liters/minute.

Noise levels were measured at normal work stations with equipment both operating and not operating, using a General Radio Model 1565B sound level meter.

V. EVALUATION CRITERIA

The criteria for evaluating the 20 organic vapors assayed and other chemicals used in the duplicating area are the current American Conference of Governmental Industrial Hygienists' Threshold Limit Values (ACGIH-TLVs)(2), NIOSH Criteria Documents (1,5,8,9); NIOSH's Registry of Toxic Effects of Chemical Substances (7); other NIOSH publications (3,4); the Occupational Safety and Health Administration (OSHA) occupational health standards (6); and Material Safety Data Sheets either provided by the supplier of the chemicals used (10) or obtained from other sources (11). Limits appearing in Table I are the lowest recommended limits found among these sources, and the current OSHA standards.

The criterion for evaluating total dust concentrations in air is the ACGIH recommended limit for nuisance dust of 10 milligrams per cubic meter (mg/m^3)(2). The OSHA limit is 15 mg/m^3 (6).

The ventilation criteria used are the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) recommendations for general and dilution ventilation (12,13). These are 0.25 to 0.4 cubic feet per minute (cfm) of fresh air per square foot of floor area served, and 0.75 to 2.0 cfm of total recirculated air per square foot of floor area served, for typical general office ventilation. Criteria for contamination control by dilution ventilation are based on the amount and type of contaminant generated and the generation rate.

Criteria for evaluating noise are the ACGIH and NIOSH recommendations based on an 85 dBA limit for eight hours of exposure (2,14). The corresponding OSHA limit is 90 dBA (6).

TABLE I - EVALUATION CRITERIA FOR CHEMICALS ASSAYED AND USED IN OFFSET DUPLICATING FACILITY

Substance	Ceiling Limit or STEL (ppm)	Limit, 8-hour Time Weighted Average (ppm)	Source	OSHA Limit (6)
Isopentane	610	120	NIOSH (1)	1,000
n-Pentane	610	120	NIOSH (1)	1,000
2,2-Dimethylbutane	510	100	NIOSH (1)	none
3-Methylpentane	510	100	NIOSH (1)	none
2-Methylpentane	510	100	NIOSH (1)	none
n-Hexane	125	100**	ACGIH (2)	500
Cyclopentane	900	600	ACGIH (2)	none
Methylcyclopentane	1,000*	500*	ACGIH (2)	none
n-Heptane	440	85	NIOSH (1)	500
Cyclohexane	375	300	ACGIH (2)	300
Methylcyclohexane	500	400	ACGIH (2)	500
n-Octane	385	75	NIOSH (1)	500
1,1,1-Trichloroethane	350	350	NIOSH (4)	350
Methyl ethyl ketone	300	200	ACGIH (2)	200
Isopropanol	500	400	ACGIH (2)	400
Benzene	1***	-	NIOSH (5)	10
Trichloroethylene	150	25	NIOSH (3)	100
Toluene	150	100	ACGIH (2)	200
Ethylene dichloride (4) 50	15	5	NIOSH	
Xylenes; o,p,m	150	100	ACGIH (2)	100
Methylene chloride	500	75	NIOSH (8)	500
Tetrachloroethylene	100	50	NIOSH (9)	100
Petroleum naphtha (Blankrola)	none	150	MSDS (11)	500
2% K_3FeCN in glycerin	none	none	-	none
Dialkoxyglycol ether/aliphatic hydrocarbons mix	none	400	MFGR (10)	none
Toner (carbon black, iron powder, toner mix)	none	10 mg/m^3	MFGR (10)	none

MSDS = Material Safety Data Sheets (G.E. Company)
MFGR = Manufacturer's recommended exposure limit
* = Proposed TLV
** = TLV of 50 proposed by ACGIH
*** = 2-hr. TWA limit

VI. RESULTS AND DISCUSSION

1. Chemical Exposures

A. Results

A sketch of the duplicating facility is shown in Figure 1. The two employees who work full-time in the press area provided the following information.

Chemicals used in operations and in cleaning equipment are:

Operations

Electrostatic solution (2% K_3FeCN; trace HCN)
Toner (carbon black, iron powder)
Ink (hydrocarbon carrier)
Developer (handled by service contractor)

Cleaning

Ink glaze remover (methylene chloride) - discontinued, Feb. 1982
Ink glaze remover II® (Dialkoxyglycol ether and aliphatic hydrocarbons) - since February 1982
Blankrola® (25% tetrachloroethylene in petroleum naphtha) - discontinued February 1982
Blankrola II® (petroleum naphtha) - since February 1982

Small amounts of toner, ink and electrostatic solution are added periodically to the equipment, depending on workload. Developer is added monthly by the service contractor. Other chemicals used in the area include commercial spray glass cleaner, isopropanol and Xerox duplicator supplies (fuser oil and developer).

The press equipment is cleaned periodically with ink glaze remover and blanket cleaner (Blankrola). Until February 1982, solvents containing methylene chloride and tetrachloroethylene were used (as indicated in the materials list). Since then, substitutes have been used. Figures 2A and 2B show an operator cleaning the press.

Equipment cleaning takes place for 30 minutes each morning, Monday through Friday, and for two to three hours Friday afternoons. Monthly, the service contractor spends four hours in further cleaning. The press room employees do not assist in monthly cleaning but are present. In cleaning, parts are swabbed with wetted rags or pads, which are then placed in an open five-gallon can and discarded at the end of each day. Employees reported that Ink Glaze Remover II proved ineffective and that all cleaning is now done with Blankrola II. A wash sink in the adjacent storeroom is sometimes used to wash parts with water. Rubber gloves are provided and worn during cleaning.

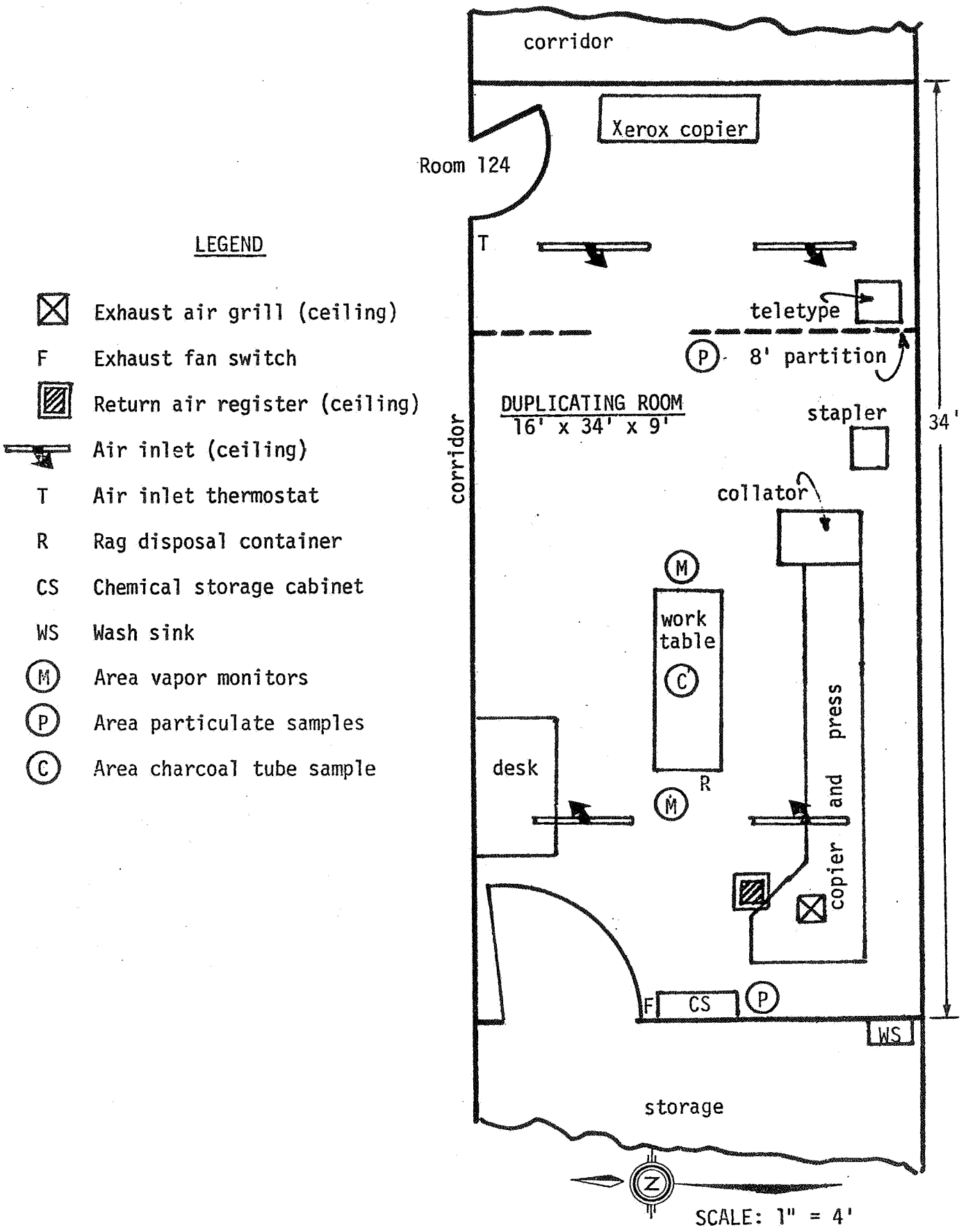
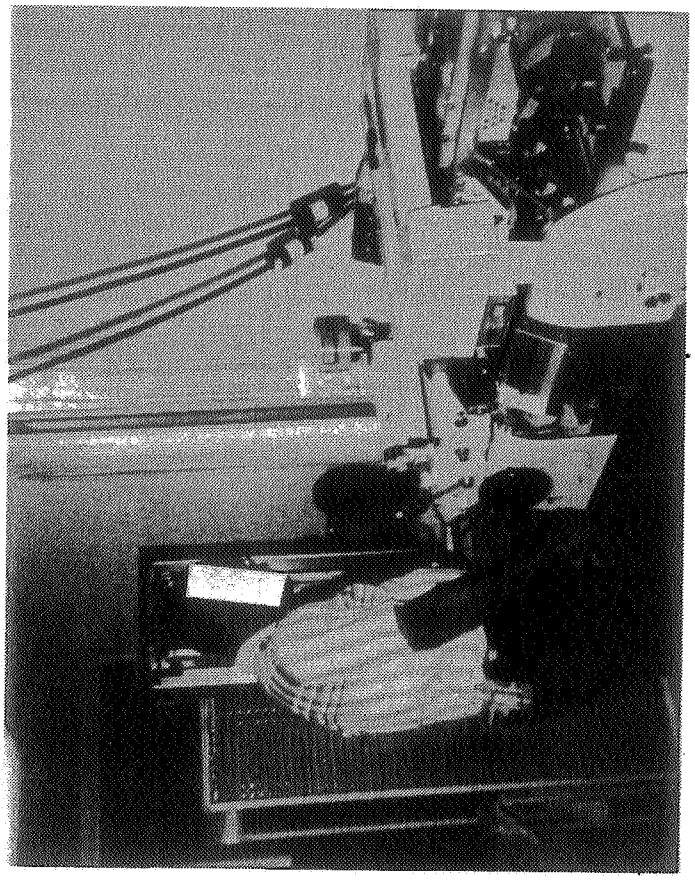


FIGURE 1 - DUPLICATING AREA SHOWING AREA AIR SAMPLE LOCATIONS



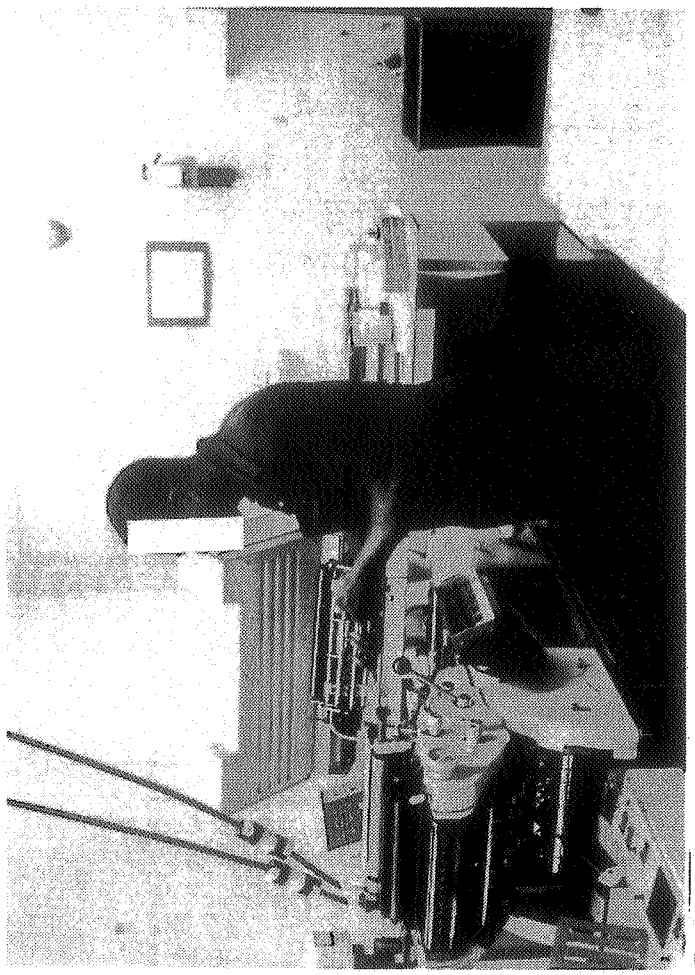


FIGURE 2

A. (Upper left) Operator dismantling the press for cleaning.

B. (Lower left) Operator cleaning parts with petroleum naphtha.

C. (Above) Press and collator in operation with operator at normal work station.

Prior to February 1982, approximately one-half gallon/month of methylene chloride was used in morning and Friday cleanings, and one gallon/month of Blankrola was used for cleaning during operations. Since February 1982, approximately 1-1/2 gallons/ month of Blankrola II are used for all cleaning.

Air is supplied to the duplicating room through four ceiling diffusers, which supply 700 cubic feet per minute (cfm) according to building mechanical drawings. The air flow is controlled by a thermostat in the room ("T" in Figure 1) on a "flow/no flow" basis. Occasionally, the thermostat is used to shut off the air supply to the room. There is a return air grill in the ceiling above the printing equipment which recirculates room air back to the air conditioning unit, using the space above the hung ceiling as the return airway. Heat is supplied by two baseboard heaters.

The air inlet for a fan-powered, roof mounted, exhaust unit is located in the ceiling above the copier. Air velocity was measured at this exhaust inlet and the flow rate was calculated to be 400 cfm. This exhaust unit was installed when the building was built, but the fan was not wired to operate until February 1982. Reportedly, it has been operating since then. Its control switch is in the room. (The OHSG team attached a streamer to the exhaust inlet to provide the operators with a visual indicator of fan operation.)

The building as a whole has 27,600 square feet of floor area and is served by three air conditioning units with a rated air circulation capacity of 31,400 cfm (1.14 cfm recirculated air/sq. ft. of floor area).

The fresh air intakes on all three units were found to be bolted shut. In effect, the fresh air supply to the building is limited to infiltration to replace air exhausted by four powered roof exhaust units; these units are the one in the duplicating room and three more serving restrooms and other areas. These have a total rated or measured flow of 1,275 cfm (0.05 cfm/sq. ft. of floor area). The building is under a slight negative pressure with respect to outside, so this fresh air enters through leaks, and any open windows and doors. Air drift between the duplicating facility and adjacent spaces was equivocal.

Black dust was noticed on horizontal surfaces in the duplicating area, particularly on surfaces not readily accessible for cleaning. Dust in other areas and above the hung ceiling was gray by contrast.

Area air samples were collected March 25 and April 1, 1982 at locations shown in Figure 1. Personal samples were collected April 1 using charcoal tubes worn by the two operators. Passive monitors and personal samples were assayed for the first 20 chemicals listed in Table I, and showed concentrations of < 0.2 ppm for all compounds except in the charcoal tube samples for benzene (0.24 ppm maximum),

isopropanol (0.29-0.52 ppm) and trichloroethylene (0.75-1.34 ppm). None of the containers for materials used had labels indicating benzene or trichloroethylene as constituents. A follow-up visit July 16, 1982 disclosed no potential source of these chemicals except as trace constituents of the petroleum naphtha based Blankrola II cleaning chemical. Two area particulate samples indicated total dust concentrations in air of 0.35 and 0.56 milligrams per cubic meter (mg/m^3).

B. Discussion

Considering quantity of use, methylene chloride and tetrachloroethylene appear to have been the most hazardous chemicals used in this operation. Methylethylene chloride exposure at high concentrations is accompanied by eye and skin irritation, dizziness, fatigue, numbness in the limbs, dyspnea, and heart palpitations; chronic effects are changes in the central nervous system and interference with delivery of oxygen to tissues (8). The NIOSH-recommended limit of 75 ppm is based on the latter two effects.

Tetrachloroethylene exposure has resulted in effects on the central nervous system, mucous membranes, eyes, lungs, liver, kidneys, heart and skin (9). The NIOSH-recommended limit of 50 ppm is based on avoidance of neurological effects and eye and respiratory tract irritation.

Both methylene chloride and tetrachloroethylene are considered to be suspected carcinogens (15).

The replacement solvent used (petroleum naphtha) has a manufacturer's recommended TLV of 150 ppm. Petroleum naphthas vary in composition, and no specific analysis of this particular solvent is available. The detection of small amounts of benzene and trichloroethylene during air sampling at the facility may indicate trace amounts of these chemicals in the naphtha. No other source was evident. Both of these chemicals are considered to be carcinogens (3,5).

The ventilation rate necessary to hold the petroleum naphtha concentration below its TLV (150 ppm) was calculated from the reported use patterns (1/2 gallon/month for cleaning and 1 gallon/month in operations). The required rate was found to be 250 cfm during the cleaning period, using a mixing factor of K=3 and assuming that all the chemical evaporates during the cleaning period. At other times the required rate would be less. Since 250 cfm is less than the 400 cfm exhausted, overexposure under current conditions is unlikely.

An attempt was made to reconstruct potential past concentrations of methylene chloride from information available. Two scenarios were examined. First, the air supply was assumed to be operating at 700 cfm with a mixing factor of K=4, and the exhaust was assumed to be off. A chemical use rate of 3 oz/hr for cleaning was assumed to take place 1/2 hour Friday morning and 2-1/2 hours Friday afternoon,

with all chemicals evaporating during the cleaning period. It was calculated that the concentration would rise to peaks of 75 ppm methylene chloride during the morning period and 115 ppm during the afternoon, with a time-weighted-average (TWA) concentration of 36 ppm. These estimated concentrations are less than NIOSH's recommended limits of 75 ppm for TWA exposure and 500 ppm for peak exposure.

In the second scenario, both air supply and air exhaust were assumed to be off to simulate worst case conditions with no ventilation. Under these conditions, the calculated peak methylene chloride concentration is 730 ppm and the calculated TWA concentration for the day is 220 ppm. The latter is more than twice the NIOSH-recommended TWA limit, and the former is 1.5 times greater than the NIOSH-recommended peak limit. The worst case condition represents the estimated upper limit of potential methylene chloride concentrations, and it is unlikely that these concentrations have actually occurred. However, the "50 percent population identification threshold" (PIT-50%) for methylene chloride is 214 ppm (16). Since odors have been reported in the duplication area, it is evident that rather high concentrations of methylene chloride have occasionally occurred. The PIT-50% is the concentration at which half the population will detect an odor sufficiently to describe its character.

In similar estimations for tetrachloroethylene, the calculated TWA concentration in the first scenario was 4 ppm and the peak 5 ppm. For the second scenario, the calculated TWA concentration was 40 ppm and the peak 80 ppm. These values are less than the NIOSH-recommended limits of 50 ppm for TWA and 100 ppm for peak exposures. Overexposure to tetrachlorethylene in the past is considered to have been unlikely.

In later discussions with ARO officials, it was learned that there have been no complaints of adverse health effects from chemical exposures. Ten employees are selected each year to receive medical examinations. One of the two duplicating facility operators has not been among those selected.

2. Noise

A. Results

Initial visits indicated a possible noise problem during equipment operation, so noise levels were measured May 26 and July 16 at the locations shown in Figure 3, using a General Radio Model 1565B sound level meter. Noise levels were measured in decibels (dB), A-weighted network, slow response for continuous noise and dBA and dBC, fast response for impulse noise. Results were as follows.

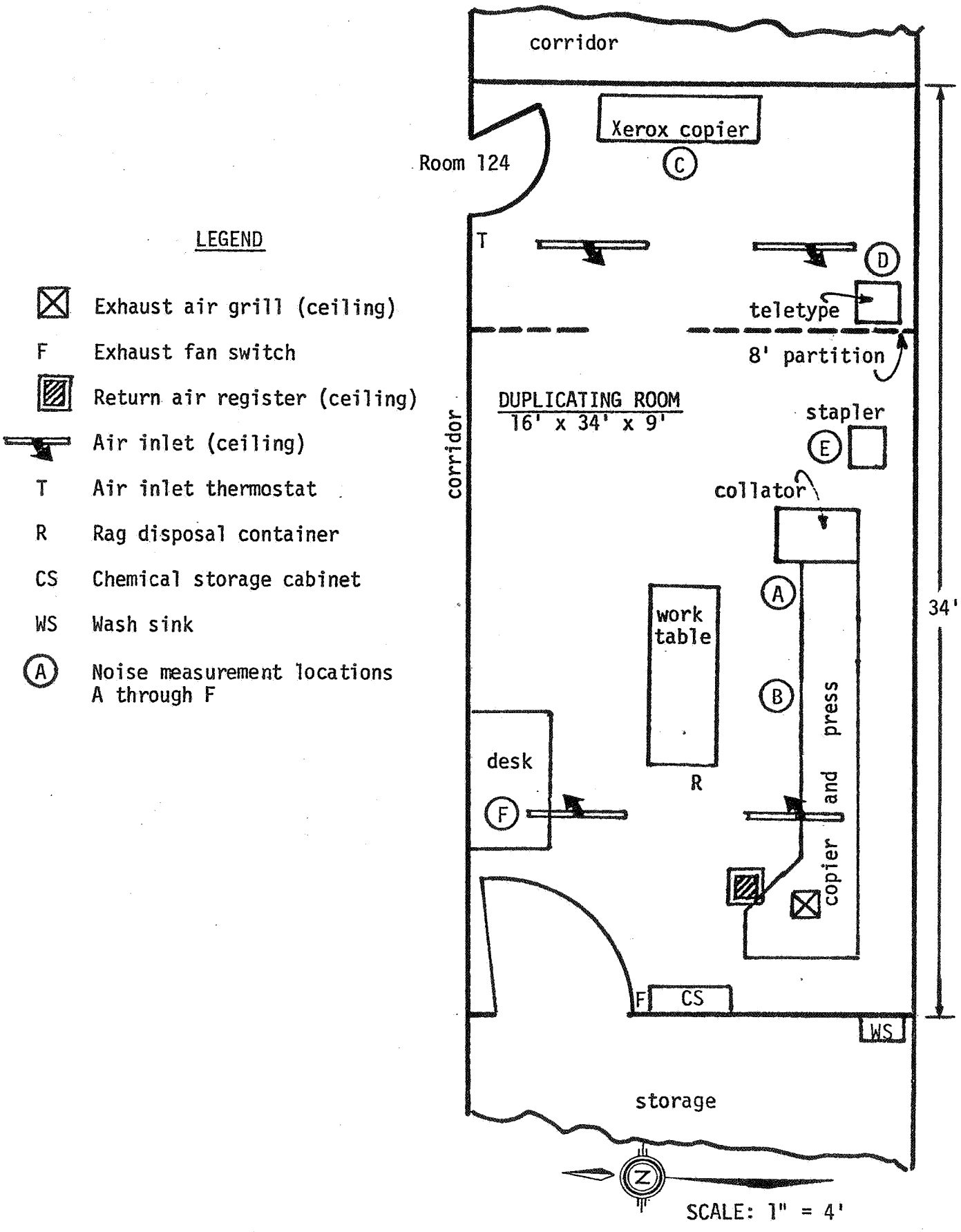


FIGURE 3 - DUPLICATING AREA SHOWING NOISE MEASUREMENT LOCATIONS

EQUIPMENT OPERATING	dBA (slow) at location					
	A	B	C	D	E	F
None operating	← 58-70 →					
Press, copier, collator, teletype, Xerox	87½-89	87	78	80	83	81
Press, copier, collator	87½-89					
Press, collator (idling)	87-88					
Press		87				
Press (idling)	82					
Stapler (30 strokes/min)					86½-87*	
Xerox copier			72			
Teletype: normal				75-76		
at bell				79½		

* dBA and dBC, fast

Operators reported that the press, copier and collator operate for an average of four to five hours per day, the stapler two to three hours per day, and the teletype less than one hour per day. Occasionally, the press is operated nearly all day (estimated 7 hours). Ear protection is provided but is reportedly not worn due to discomfort and because the operators wish to be able to hear if called.

B. Discussion

The press and collator are the major noise sources. Figure 2C shows these units in operation with the operator at his normal position. One operator stays at or near locations A and B (See Figure 3) for much of the time the equipment is operating. The other operator operates the stapler and does other tasks. The operators alternate at these two assignments weekly.

From discussions with the operators, it was estimated that in an average day, the most exposed operator would be exposed for two hours at location A (87.5-89 dBA), two hours at location B (87.5 dBA), one hour at location F (81 dBA), and to below 80 dBA for the remainder of the shift. These exposures amount to 0.83 of NIOSH's recommended daily dose limit, using 85 dBA as a base (14). Normal operations, therefore, do not exceed recommended noise exposure limits (2,14).

On those days when there is a large workload and the press runs all day, the dose for the most exposed operator would be approximately 1.2 times the NIOSH-recommended daily dose limit. Overexposure would be averted if the operators shared press operation on such days.

VII. CONCLUSIONS

1. Before February 1982, when the exhaust fan in the duplicating room was not operating, the air supply was also turned off occasionally, reducing the ventilation in the duplicating room to a very low rate. If this condition occurred when press cleaning was being done with methylene chloride, the NIOSH-recommended TWA exposure limit of 75 ppm could have been exceeded by a factor of nearly three. Overexposure to other chemicals was unlikely.

2. Currently, with room air supply and exhaust fan operating, chemical and particulate exposures in the duplicating facility appear to be well below mandatory and recommended limits.

3. Since the building return air duct is near the room exhaust air inlet, some of the chemicals which become airborne in the duplicating room are recirculated (albeit in dilute concentrations) to other areas in the south half of the building. The significance of this recirculation is uncertain.

4. No source of the benzene and trichloroethylene detected in air sampling was found. It is concluded that these are constituents of the petroleum naphtha based proprietary cleaning material now used in press operations and cleaning. Recommendations include measures aimed at keeping exposure to these chemicals as low as feasible, by limiting their presence in materials used and by ventilation of the work area.

5. The fresh air supply intakes to the building are closed. Fresh air turnover is limited to air which enters through doors and leaks to replace that exhausted through roof ventilators. Fresh air supply is estimated to be 0.05 cfm/sq. ft. of floor area, as compared to a recommended rate of 0.25 to 0.4 cfm/sq. foot. The recommended rates are guidelines, and less fresh air may be sufficient in office buildings with low contaminant generation rates. However, too low a fresh makeup air rate enhances buildup in the air of any chemicals evaporated inside the building, and often causes drafts and dirt accumulation.

6. Under normal duplicating facility workload conditions, recommended noise exposure limits are not exceeded. On days with all-day press runs, the press operator's noise exposure may exceed daily limits.

VIII. RECOMMENDATIONS AND FOLLOW-UP

1. Steps should be taken to ensure that the exhaust fan in the duplicating facility operates continuously during working hours.

2. The existing exhaust system alone does not provide sufficient dilution air if methylene chloride is used. Use of methylene chloride should not be resumed unless the controls of the duplicating room air supply are modified so that air is supplied to the room continuously, or the exhaust air volume is increased to 700 cfm.

3. The duplicating facility operators should be included in the next group of employees to be given medical examinations. (Follow-up discussions indicate that both operators have since been given medical examinations.)

4. Additional chemicals should not be placed in use prior to a review of their hazard characteristics and toxicologic properties by qualified personnel to ensure that they are safe to use.

5. Since benzene and trichloroethylene are potential carcinogens, worker exposure to these chemicals should be kept as low as feasible. Consideration should be given to specifying limits on benzene and trichloroethylene content of solvents purchased, or to requiring a statement of the amounts of these chemicals present in chemicals purchased.

6. A minimum of 5000 cfm of fresh outside air should be supplied to the building. In no case should controlled outside air supply be less than the amount of air exhausted from the building.

7. The duplicating facility should be given a thorough cleaning to remove the buildup of dust on surfaces.

8. Used cleaning rags and pads wetted with solvent should be disposed of or stored in closed containers. (A pedal-operated, self-closing container has been placed in use.)

9. On days with long press runs, press tending should be alternated between operators on a half-day basis to avoid potential overexposure to noise. As an alternate, a full-shift noise survey using dosimeters should be performed to determine precise noise exposures and the need for a hearing conversation program.

IX. REFERENCES

1. Criteria for a Recommended Standard-Occupational Exposure to Alkanes, U.S. Department of Health, Education and Welfare. DHEW(NIOSH) Publication No. 77-151 (March 1977).

2. Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1981, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1981.

3. Special Occupational Hazard Review with Control Recommendations-Trichlorothylene. National Institute for Occupational Safety and Health, Publication NIOSH 78-130 (1978).

4. Pocket Guide to Chemical Hazards, U.S. Department of Health, Education and Welfare and U.S. Department of Labor. DHEW(NIOSH) Publication No. 78-210 (September 1978).

5. Revised Recommendation for an Occupational Exposure Standard to Benzene. U.S. Department of Health, Education and Welfare. Unnumbered NIOSH Publication (1977).

6. General Industry Standards, Occupational Safety and Health Administration, Publication OSHA 2206 (November 1978).

7. Registry of Toxic Effects of Chemical Susbtances, Vols. 1 and 2, R. J. Lewis and R. L Tatken, Editors. U.S. Department of Health and Human Services. DHHS (NIOSH) Publication No. 81-116 (February 1982).

8. Criteria for a Recommended Standard - Occupational Exposure to Methylene Chloride. U.S. Department of Health, Education and Welfare. DHEW (NIOSH) Publication No. 76-138 (March 1976).

9. Criteria for a Recommended Standard - Occupational Exposure to Tetrachloroethylene. U.S. Department of Health, Education and Welfare. DHEW(NIOSH) Publication No. 76-185 (July 1976).

10. Addressograph-Multigraph Material Safety Data Sheets (various). AM Corporation, Mt. Prospect, IL 60056.

11. Material Safety Data Sheets, J. M. Nielsen, Editor. General Electric Company, Schenectady, NY 12305 (1980).

12. ASHRAE Handbook and Product Directory, Applications, 1978. American Society of Heating, Refrigerating and Air-Conditioning Engineers, p. 3.7 (1978).

13. ASHRAE Handbook and Product Directory, Systems, 1980. American Society of Heating, Refrigerating and Air-Conditioning Engineers, pp. 21.4-21.9 (1980).

14. Criteria for a Recommended Standard - Occupational Exposure to Noise, U.S. Department of Health, Education and Welfare (1972).

15. Suspected Carcinogens - A Subfile of the Registry of Toxic Effects of Chemical Substances. U.S. Department of Health, Education and Welfare. HEW Publication (NIOSH) 77-149 (December 1976).

16. Verschueren, K. Handbook of Environmental Data on Organic Chemicals, Von Nostrand Reinhold Co., New York, NY pp. 12, 461 (1977).

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. DISTRIBUTION AND AVAILABILITY

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