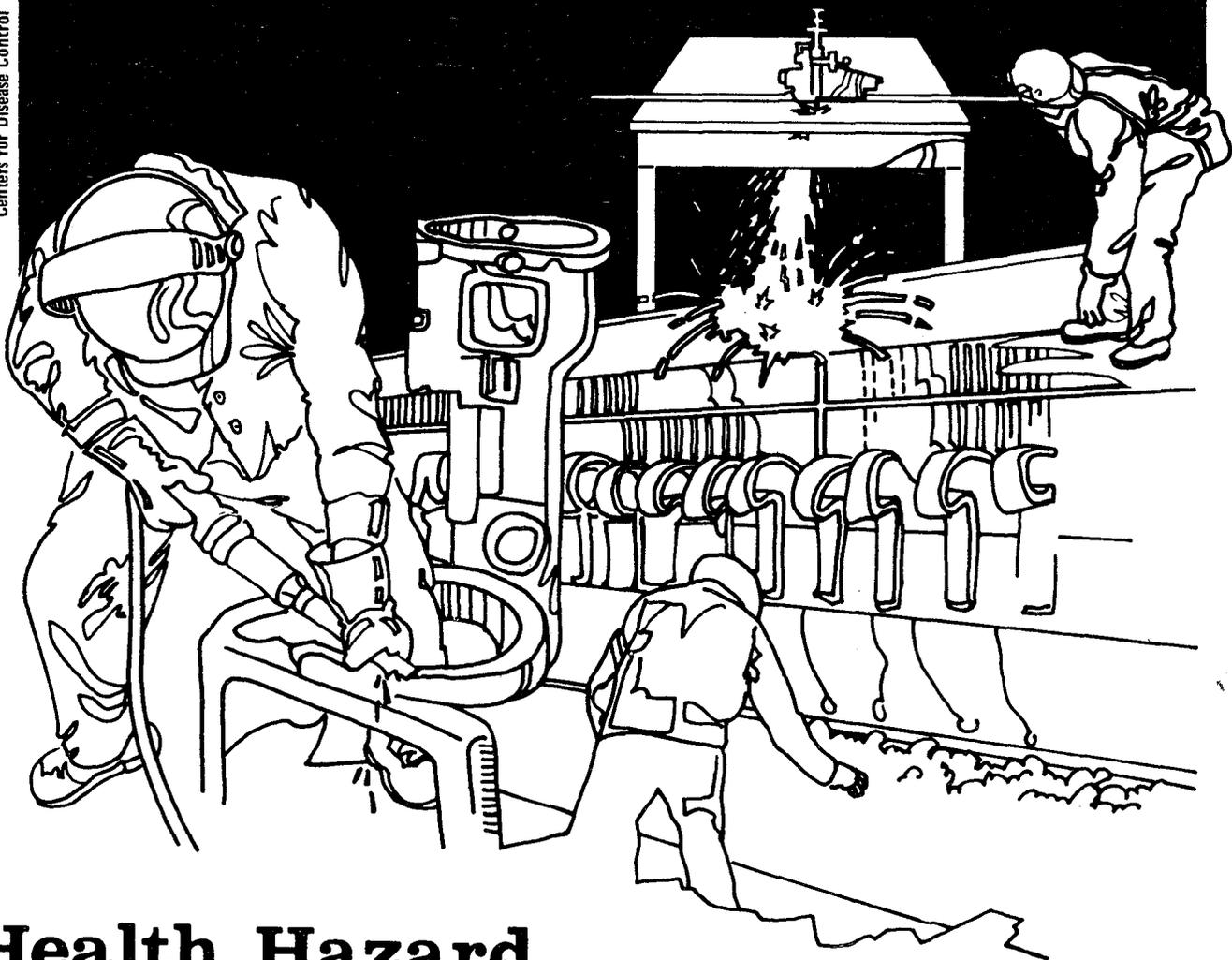


U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

TA 80-111-826
DEPARTMENT OF COMMERCE
WASHINGTON, D.C.

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH 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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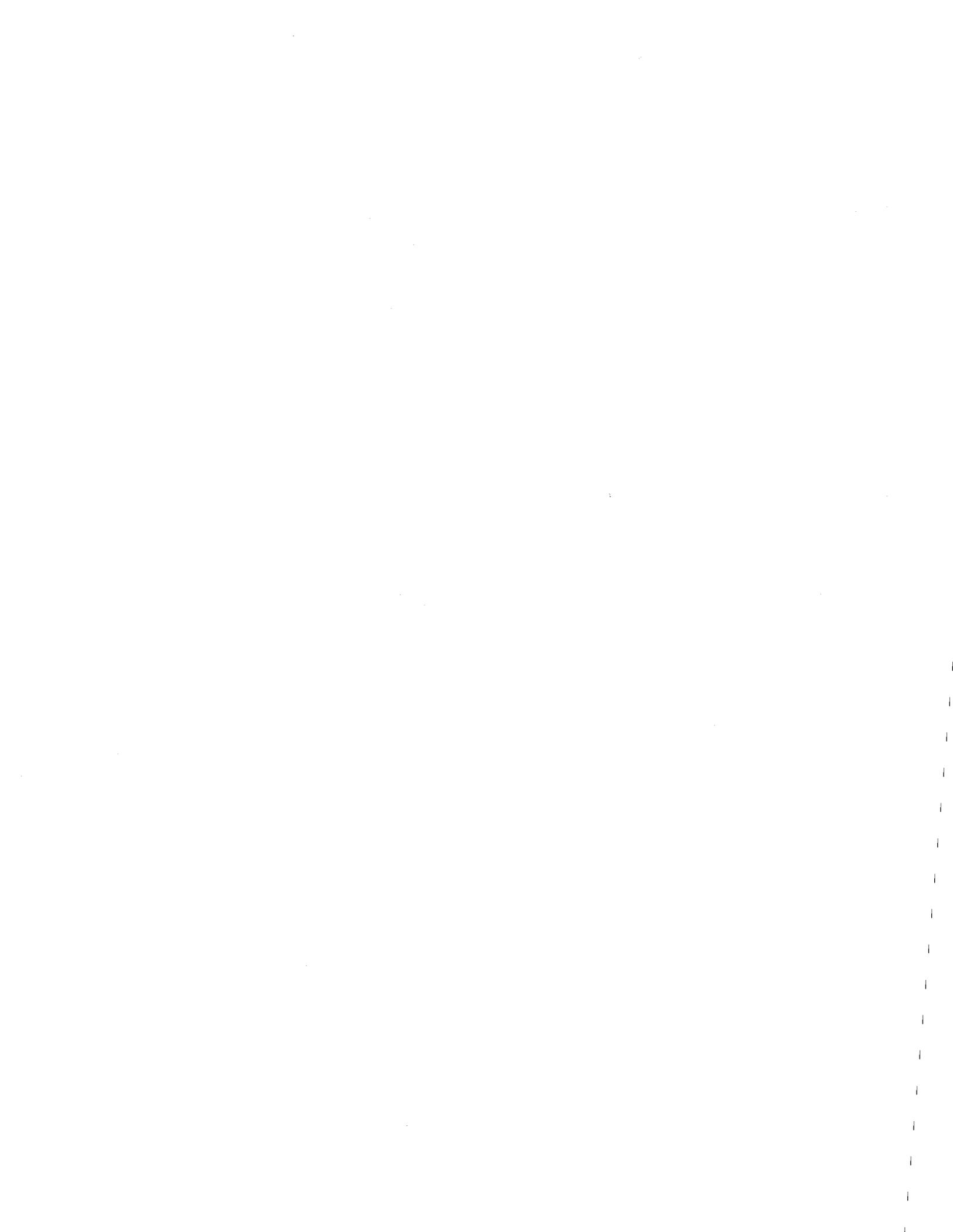
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6. Abstract (Limit: 200 words)

Increased blood alcohol concentrations among workers at the Washington, D.C. lithographic printing facility (SIC-3573) of the Department of Commerce were evaluated on August 26 and 27, 1980. The evaluation was requested by the United States Department of Commerce/National Oceanic and Atmospheric Administration/National Ocean Survey/Reproduction Division on behalf of 20 employees. Workers were questioned about job related health problems, and general and breathing zone air samples were collected for analysis. Worker exposures to isopropanol (67630), 1,1,1-trichloroethane (71556), xylene (1330207), and ethyl-benzene (100414) were below the respective OSHA 8 hour time weighted average standards of 400, 350, 100, and 100 parts per million. The ventilation system was poorly designed. Fourteen workers reported symptoms associated with cleaning the alcohol press, such as dizziness and nausea. The authors conclude that variations in press operating procedures and poor ventilation caused the occasional symptoms reported by the workers. They recommend redesigning the ventilation system, improving housekeeping procedures, using protective gloves when handling solvents, and reducing the isopropanol concentrations in the fountain solution.

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b. Identifiers/Open-Ended Terms	
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NIOSH INVESTIGATORS:
Steven A. Lee, IH
Quita G. Mullan, RN

I. SUMMARY

In August 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the U.S. Department of Commerce/National Oceanic and Atmospheric Administration/National Ocean Survey/Reproduction Division to evaluate reports of elevated blood alcohol levels among employees at the Washington, D.C., lithographic printing facility.

NIOSH conducted an environmental and medical survey on August 26 and 27. The medical investigator interviewed all 20 printing employees on both the day and night shifts in order to investigate occupationally related health complaints. Bulk-air samples were collected on charcoal tubes in various areas of the pressroom. Qualitative analysis by gas chromatography/mass spectrophotometry revealed isopropanol as the major contaminant. Smaller amounts of 1,1,1-trichloroethane, ethyl benzene, and xylene were also present.

Personal breathing-zone air samples were collected from all the day shift employees present at the time of the NIOSH survey. Eight-hour time-weighted average (TWA) concentrations of isopropanol ranged from 54 parts per million (ppm) to 200 ppm, with a mean concentration of 120 ppm. The NIOSH-recommended TWA exposure standard for isopropanol is 400 ppm. The combined TWA exposure concentrations of all the other organic contaminants were less than 1/5 of environmental criteria. Combined short-term exposure levels for cleaning solvents were about 2/3 of NIOSH-recommended standards during cleaning of a printing press.

Fourteen of 20 workers reported probable work-related health problems, with dizziness and nausea being the major symptoms. However, no blood tests for alcohol had actually been conducted.

On the basis of the data obtained in this investigation, NIOSH determined that hazards from exposure to lithographic printing solvents were not present during the NIOSH survey. However, the excess prevalence of reported symptoms indicated that deviations in press operation and ventilation performance were probably causing intermittent health problems.

Recommendations on ventilation design and work practices have been included in this report as a guide to the control of solvent vapors.

KEYWORDS: SIC 2752 (Lithographic Printing), isopropyl alcohol, isopropanol, 1,1,1-trichloroethane, ethyl benzene, xylene, neurologic effects, dizziness, nausea.

II. INTRODUCTION

In August 1980, NIOSH received a request from the U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA)/National Ocean Survey/Reproduction Division to evaluate reports of elevated blood alcohol levels among employees at the Washington, D.C., lithographic printing facility. NIOSH conducted an environmental and medical survey on August 26 and 27. In November 1980, a preliminary report that included qualitative air sampling results and employee interview results was sent to NOAA.

III. BACKGROUND

The basic lithographic printing process is illustrated in Figure 1.1. Essentially, lithographic printing is based on the principle that oil and water do not mix. The plate is dampened with an aqueous fountain solution to wet the nonimage area and then the ink is applied to the entire plate but will adhere only to the image area.¹

The Reproduction Division of NOAA is responsible for the printing of navigational charts and maps. There were four lithographic printing presses in the printing branch at the time of the NIOSH survey, but only two were in operation. One of the presses required the use of a 25% isopropanol fountain solution. The five employees who work on this press receive the highest exposures to isopropanol as it volatilizes from the fountain system and the lithographic plate surface. Also, due to the dilution ventilation system, isopropanol vapors spread freely throughout the rest of the pressroom. Workers also are rotated every 13 weeks so that everyone eventually works with the alcohol press. Other organic vapors are being liberated via the use of aromatic and chlorinated aliphatic solvents for periodic cleaning of the presses (5-10 minutes duration, 2-6 times per day).

NIOSH had conducted an earlier industrial hygiene study of the lithographic pressroom in August 1974. Isopropanol concentrations ranged from 29 to 140 ppm, with a mean of 80 ppm. Toluene levels ranged from 1.9 to 45 ppm, with a mean of 20 ppm. 1,1,1-trichloroethane concentrations ranged from 1 to 3 ppm. At that time, the NIOSH industrial hygienist concluded that worker exposures to solvent vapors were within safe limits. During the August 1980, NIOSH study, it was the prevailing opinion among employees that the ventilation system had deteriorated in the past 6 years.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

A total of five bulk air samples were taken at locations near the printing presses and near the solvent storage room. The samples were drawn by battery-powered sampling pumps at 1.5 liters per minute for 1 hour during printing and cleaning of the rollers. Each charcoal tube sample was desorbed in carbon disulfide and scanned by gas chromatography/mass spectrophotometry for qualitative analysis.

Thirteen full-shift personal breathing-zone samples for organic vapors were taken from the day shift workers. Samples were collected on charcoal tubes by battery-powered sampling pumps operated at 20 cc/min.

Short-term personal breathing-zone samples were taken during cleaning of the rollers on the "alcohol press." It was noted that the highest potential acute solvent exposure lasted about 2 minutes, during hand cleaning of the press rollers with solvent-soaked cloth. Therefore, two 2-minute samples were taken to document peak exposure levels. Also, two 10-minute samples were taken for comparison with NIOSH-recommended ceiling exposure limits. The short-term samples were collected on charcoal tubes by battery-powered sampling pumps operated at a flowrate of 150 cc/min.

Area samples were taken near the alcohol press during both the day and evening shifts because some workers speculated that evening alcohol levels may have been higher. For further comparison, 15-minute personal breathing-zone samples were taken from the evening operators of the alcohol press.

All quantitative organic vapor samples were desorbed in carbon disulfide and analyzed by gas chromatography according to NIOSH Method P&CAM 127.

B. Medical

A non-directed questionnaire was used to assess symptoms and perceived exposures. Approximately 20 workers, 10 per shift (2 permanent shifts), were employed in the pressroom. The 10 on day shift were all present and interviewed on August 27, 1980 as were two from the night shift. The remaining 8 night shift employees were interviewed 5 weeks later.

V. EVALUATION CRITERIA

Isopropanol vapors are moderately irritating to the eyes and the upper respiratory tract at 400 ppm. At 800 ppm, these effects are still not severe. There are very few case reports of poisoning from inhalation of isopropanol. Acute intoxication from ingestion is well documented and is manifested by nausea, vomiting, headache, depression and coma. A few cases of contact dermatitis from isopropanol have been reported, but, in general, isopropanol produces minimal, if any, adverse skin effects. Although the complete metabolic pathway for isopropanol has not been elucidated, acetone has been identified in the urine and in exhaled air as a metabolite. Isopropanol concentrations in the blood can be accurately determined by gas-liquid chromatography.¹

On the basis of preventing excessive eye, nose, and throat irritation, NIOSH recommends that employee exposure to isopropanol should not exceed 400 ppm determined as a TWA exposure for up to a 10-hour workday, 40-hour workweek, with a ceiling of 800 ppm as determined by a sampling time of 15 minutes.

The evaluation criteria of the other substances investigated in this study are listed in Table I.

VI. RESULTS

A. Environmental

Qualitative analysis of the bulk air samples showed that the major contaminant throughout the pressroom was isopropanol, with smaller amounts of 1,1,1-trichloroethane, ethyl benzene, and xylene also being present.

8-Hour, Time-Weighted Average Exposures

The personal breathing-zone and area sample results are listed in Table II. The five workers on the "alcohol press" were exposed to isopropanol at a range of 120 to 200 ppm, with a mean of 170 ppm. Isopropanol exposures throughout the rest of the pressroom ranged from 54 to 90 ppm, with a mean of 76 ppm. 1,1,1-Trichloroethane exposures throughout the pressroom ranged from 4.2 to 24 ppm, with a mean of 17 ppm. Xylene concentrations ranged from 3.3 to 14 ppm, with a mean of 11 ppm. Ethyl benzene levels ranged from 0.8 to 3.8 ppm, with a mean of 1.9 ppm.

Short Term Exposures

The 10-minute ceiling exposure levels of isopropanol were 280 and 410 ppm; 1,1,1-trichloroethane, 88 and 81 ppm; xylene, 32 and 51 ppm; and ethyl benzene, 9.2 and 14 ppm. Assuming that the combined toxic effects of these organic solvents are additive, then printers were exposed to isopropanol, 1,1,1-trichloroethane, and xylene at levels that were 66% of NIOSH-recommended ceiling exposure limits during cleaning of the rollers. No overexposure would be indicated unless the additive concentrations exceeded 100%.

Ventilation

The dilution ventilation system was poorly designed with respect to controlling airborne contaminants. Fresh air was supplied by air conditioning ducts along the ceiling directly over the printing presses. Air was exhausted through grills located on the walls around the periphery of the pressroom. This arrangement served to sweep contaminated air from the presses and then across the work areas before being exhausted at the walls.

B. Medical

All 20 employees were men. Their age range was 27-55 years, with a median of 39. The range of duration of employment was 4 months to 35 years, with a median of 15 years.

All the workers had the same job title, performed essentially the same work activities, and, presumably over a period of time, had the same exposures.

Fourteen of the 20 employees reported one or more symptom temporally associated with working on, especially cleaning, the alcohol press (Table III). Symptoms were intermittent but tended to be more frequent later in the shift. Symptoms were also reported to be more frequent on days when the pressroom was hot and humid.

Each of the workers was asked if he knew of any blood alcohol tests that had been conducted. All responses were negative except for one man who thought his doctor had once found "some problems" in tests he had run. The physician told NIOSH that all tests yielded normal results and no blood samples for isopropanol were taken.

VII. CONCLUSIONS

All organic vapor concentrations in the pressroom were found to be within NIOSH-recommended standards, but about half of the printers reported dizziness and other neurological symptoms associated with their work. Such symptoms from the inhalation of isopropanol had not been reported previously in other studies. In fact, nose and throat irritation were the only symptoms reported in the literature. However, the lack of such data does not necessarily preclude the possibility that isopropanol exposure causes neurological effects. In addition, the concomitant exposures to the other organic solvents may have added to such symptoms. Neurological effects have been well documented from occupational exposure to many organic solvents, although such effects generally result from higher concentrations than those found in the NOAA pressroom. However, variances in the performance of the ventilation system or in the operation of the presses could result in occasional deviations in solvent vapor concentrations and cause intermittent symptoms.

VIII. DISCUSSION AND RECOMMENDATIONS

NIOSH recommended that ventilation in the pressroom be improved to reduce the intermittent adverse health effects. NOAA was planning extensive improvement and/or replacement of much of the existing heating, ventilating, and air conditioning (HVAC) systems in the pressroom and supporting areas at the time of the NIOSH study. Provisions for the control of airborne pressroom contaminants should be a crucial part of such planning. The existing air supply and exhaust system in the pressroom seemed to be just the opposite of general recommended practice. Air should actually be exhausted directly over the presses while the fresh made-up air is being supplied around the periphery of the pressroom. This system would provide for a more immediate removal of contaminants and generally lower solvent concentrations throughout the pressroom. Unfortunately, the disadvantages would be to those employees who must sometime work on top of the presses since the contaminated air would travel upward through their breathing zone before being exhausted.

Alternative ventilation plans were submitted by the private engineering firm which conducted the NOAA HVAC and Plumbing study. They recommended a laminar flow air distribution system in the pressroom. Air would be introduced evenly from one entire surface of the room through a perforated panel and returned through the entire surface on the other side of the room. They maintained that the advantage of laminar flow is that air will follow a predictable pattern, which provides a mechanism for direct removal of contaminants continually generated within the room and without excess air movement. This kind of dilution ventilation system can sometimes be considered acceptable for industrial applications such as the pressroom where lower toxicity vapors (exposure standard >100 ppm) are the primary concern. It might also be superior to the existing dilution system for many pressroom workers. The system may be worse, however, for those printers whose work area is located "downwind" of their printing press.

Advantages and disadvantages such as those discussed above should be carefully weighed when designing a ventilation system. Each work area should be thoroughly evaluated with respect to what impact the air distribution will have on each individual worker. In general, the closer one can come to designing local exhaust ventilation, the better.

Housekeeping could be greatly improved in areas such as the solvent storage room. Drums of cleaning solvents should be closed at all times to prevent the release of vapors into the workplace. Spills should also be cleaned up immediately with water. Allowing standing puddles of volatile solvents to remain on top of storage drums and on the floor helps contribute to the buildup of solvent vapors.

Skin contact with cleaning solvents should be avoided by the use of solvent-resistant gloves and aprons whenever such solvents are handled, especially while cleaning the press rollers.

Management representatives discussed the possibility of reducing the isopropanol concentrations used in the fountain solution. At that time the solution was maintained at 25% isopropanol content. However, experimentation with fountain solutions containing as little as 10% isopropanol had produced favorable results. Such a change could cause a significant reduction in the workplace isopropanol vapor contamination.

IX. AUTHORSHIP AND ACKNOWLEDGEMENTS

Evaluation Conducted and Report
Prepared by:

Steven A. Lee
Industrial Hygienist
Industrial Hygiene Section

Mariquita G. Mullan
Occupational Health Nurse
Office of Extramural Coordination
and Special Projects

Field Assistance:

John Love
Industrial Hygienist
Industrial Hygiene Section

Originating Office:

Hazard Evaluations and Technical
Assistance Branch
Division of Surveillance, Hazard
Evaluations and Field Studies
Cincinnati, Ohio

Report Typed by:

Jackie Woodruff
Clerk/Typist
Industrial Hygiene

X. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this report are currently available, upon request, from NIOSH, Division of Technical Services, Publications Dissemination, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia 22161.

Copies of this report have been sent to:

1. National Oceanic and Atmospheric Administration
2. American Federation of Government Employees, Local 2640
3. U.S. Department of Labor, Region III
4. NIOSH, Region III

XI. REFERENCES

1. Printing Ink Handbook, ed 3. Harrison, NY, National Association of Printing Ink Manufacturers Inc., Production and Technical Publications Committee, 1976, 95 pp.
2. Criteria for a Recommended Standard, Occupational Exposure to Isopropyl Alcohol, U.S. Department of Health and Human Services, 1976, 119 pp.

FIGURE I

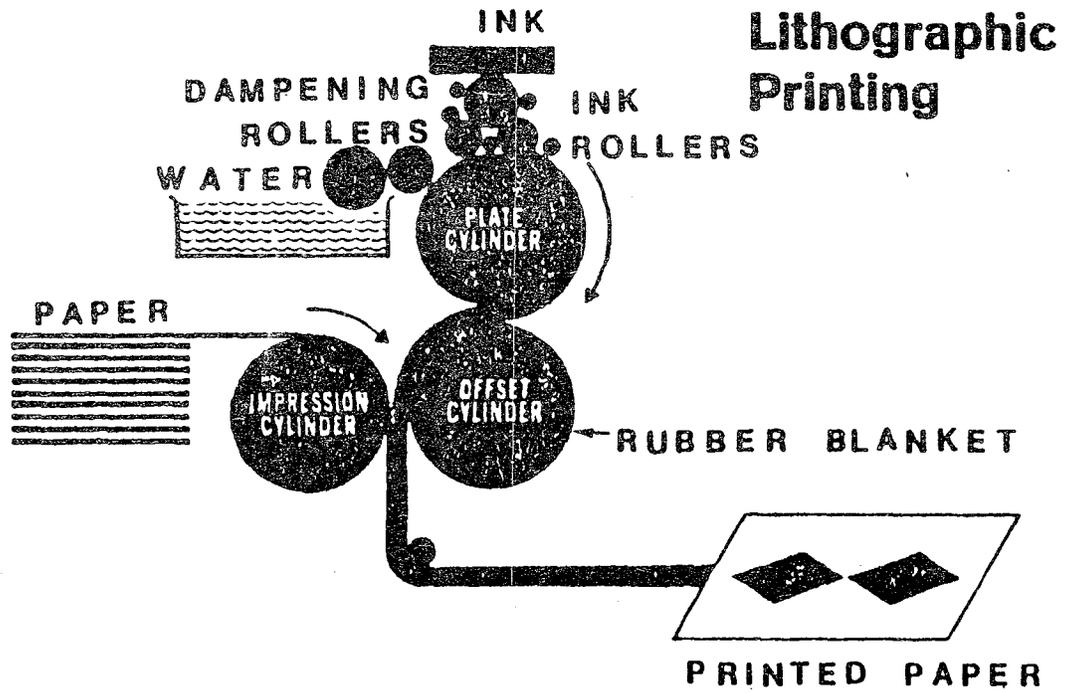


FIGURE 1 BASIC PRINCIPLES OF LITHOGRAPHIC (PLANOGRAPHIC) PRINTING

Adapted from reference 1

TABLE I

EVALUATION CRITERIA FOR LITHOGRAPHIC PRINTING SOLVENTS

NOAA PRESSROOM
WASHINGTON, D.C.

<u>Substance</u>	<u>OSHA Permissible Exposure Limit</u>	<u>Survey Criteria</u>	<u>Health Effects</u>
Isopropanol	400 ppm, 8 hour-TWA	400 ppm, 10 hour-TWA 800 ppm, 15-minute exposure limit*	eye, nose and throat irritation
1,1,1-Trichloroethane	350 ppm, 8 hour-TWA	350 ppm, 15-minute exposure limit*	eye, nose and throat irritation; dry, scaly and fissured dermatitis; dizziness, incoordination, drowsiness
Xylene	100 ppm, 8 hour-TWA	100 ppm, 10 hour-TWA 200 ppm, 10-minute exposure limit*	eye, nose and throat irritation; nausea, vomiting; dizziness, incoordination, drowsiness
Ethyl Benzene	100 ppm, 8 hour-TWA	100 ppm, 8 hour-TWA 125 ppm, 15-minute exposure limit**	eye, nose and throat irritation; dry, scaly and fissured dermatitis

* NIOSH Recommended Exposure Limits

** American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value

TABLE II

ORGANIC VAPOR CONCENTRATIONS, PARTS PER MILLION (PPM)

NOAA PRESSROOM
WASHINGTON, D.C.

August 26, 1980

<u>Job/Location</u>	<u>Sampling Time</u>	<u>Isopropanol</u>	<u>1,1,1-Trichloroethane</u>	<u>Xylene</u>	<u>Ethyl Benzene</u>
Printer/Alcohol Press	7:45 am-3:00 pm	200	17	11	2.8
Printer/Alcohol Press	7:45 am-3:00 pm	170	17	11	2.6
Printer/Alcohol Press	7:45 am-3:00 pm	190	16	12	2.8
Printer/Alcohol Press	7:45 am-3:00 pm	180	23	12	2.8
Printer/Alcohol Press	7:45 am-3:00 pm	120	9.5	6.9	1.6
Printer/Press #5	8:00 am-3:15 pm	90	24	14	3.8
Printer/Press #5	8:00 am-3:15 pm	73	24	14	3.8
Printer/Press #5	8:00 am-3:15 pm	77	12	9.4	2.2
Printer/Press #5	8:00 am-3:15 pm	89	19	13	3.0
Printer/Press #5	8:00 am-3:15 pm	86	18	13	3.3
Helper/General Floor Area	8:00 am-3:15 pm	54	4.2	3.3	0.8
Helper/General Floor Area	8:15 am-3:30 pm	86	18	13	3.3
Fork-Lift Operator	8:15 am-3:30 pm	65	19	12	3.0
Area Sample/Solvent Storage Room	8:30 am-3:30 pm	120	13	11	2.5
Area Sample/Alcohol Press Day Shift	8:30 am-3:30 pm	560	13	11	3.0
Area Sample/Press #4	8:40 am-3:30 pm	39	4.5	4.0	1.4
Printer/Cleaning Alcohol Press	11:20 am-11:22 am	570	330	200	51
Printer/Cleaning Alcohol Press	11:20 am-11:22 am	820	270	190	25
Printer/Cleaning Alcohol Press	1:00 pm-1:10 pm	410	81	32	9.2
Printer/Cleaning Alcohol Press	1:00 pm-1:10 pm	280	88	51	14
Printer/Alcohol Press Evening Shift	4:12 pm-4:27 pm	250	6.4	8.0	2.5
Printer/Alcohol Press Evening Shift	4:18 pm-4:33 pm	140	4.1	4.1	1.0
Printer/Alcohol Press Evening Shift	4:15 pm-4:30 pm	120	5.1	5.6	1.6
Area Sample/Alcohol Press Evening Shift	4:22 pm-4:37 pm	510	4.8	5.8	1.7

TABLE III
PREVALENCE OF REPORTED SYMPTOMS AMONG 20 EMPLOYEES
U.S. DEPARTMENT OF COMMERCE

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Reported symptoms temporally associated with exposure to isopropyl alcohol:

<u>Symptoms</u>	<u>Number</u>	<u>Percent</u>
Dizziness	8	40
Nausea	6	30
Headache	1	5
Fatigue	1	5
Difficulty in breathing	2	10



