U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HAZARD EVALUATION AND TECHNICAL ASSISTANCE REPORT
TA 80-32

EVERETT SCHOOL DISTRICT
EVERETT, WASHINGTON
JUNE, 1980

I. SUMMARY

At the request of the Public School Employees of Washington, an environmental/medical evaluation was conducted at the Everett School District by the National Institute for Occupational Safety and Health (NIOSH) from February 5 to February 15, 1980, to determine if vapor from duplicator fluid emitted during the use of "spirit duplicators" was the cause of any adverse health effects and if the deaths of three former teacher aides were related to their exposure to duplication fluid.

There are 58 spirit duplicators used by as many as 84 teacher aides in 18 schools in the district. The duplication fluid was found to consist of 99% methyl alcohol. The 15-minute methyl alcohol vapor air concentration from 20 duplicators with no local exhaust ventilation ranged from 365-3080 parts of vapor per million parts of air (ppm). Fifteen of the 20 measurements exceeded the NIOSH recommended 15-minute exposure limit of 800 ppm. Eleven of the 20 machines had exhaust ventilation, and repeated measurements with these systems in operation showed concentrations ranging from 80-1340 ppm (only one exceeded 800 ppm). Nine of these 11 ventilation systems were installed within the preceding few months.

The results of a questionnaire survey showed that 45% of the teacher aides experienced some symptoms such as blurred vision, headache, nausea and dizziness, which are consistent with the toxic effects of methyl alcohol. There was no indication that the deaths of the three teacher aides were related to their exposure to methyl alcohol.

Toxicity Determination

Based on the medical and environmental data collected during this investigation NIOSH has determined that a health hazard due to excessive exposure to methyl alcohol existed in the operation of "spirit duplicators" in the Everett School District.

Recommendations to reduce the exposure to the methyl alcohol vapors are incorporated in detail on page 11. Examples of three suggested local exhaust ventilation designs are found in Figures 1, 2 and 3.

II. INTRODUCTION

Under Section 20(a)6 of the Occupational Safety and Health Act of 1970, NIOSH investigates the toxic effects of substances found in the workplace. The Public School Employees of Washington requested such an investigation to determine if vapor from duplication fluid emitted during the use of "spirit duplicators" could have any adverse health effects and if the deaths of three former aides were related to their exposure to duplication fluid.

The request was received on December 31, 1979. An initial environmental survey was conducted on January 21, 1980, and the environmental and medical survey from February 5 to 15. A report that included the environmental findings and recommendations and preliminary medical findings was sent to the Everett School district and the union on February 19, 1980.

III. BACKGROUND

A "spirit duplicator" is a machine that uses methyl alcohol, or spirits, to reproduce printed material. The process consists of taking a master copy with a reverse image printed on it in an alcohol soluble dye and placing it on the drum of the duplicator. The paper to be printed is fed under and in contact with a wick that is saturated with methyl alcohol. A thin layer of alcohol is laid on the paper. As the alcohol-wetted paper comes in contact with the master copy, the alcohol dissolves a small portion of the dye and transfers the image to the finished sheet. The evaporated methyl alcohol may result in an inhalation exposure to the operator. When the duplicated papers are stacked the methyl alcohol slowly evaporates. Methyl alcohol evaporates at a faster rate when each sheet of paper is exposed to the air, such as during collating and stapling.

The amount of time a teacher aide spends duplicating varies from day to day and school to school. For example, an aide may spend two to three hours a day, four days a week duplicating, then on the fifth day spend four to five hours. Others may spend four to six hours a day. Hence, it is not easy to characterize a typical work day but a typical work week may be described.

Exposure of teacher aides was also likely to have occurred as a result of skin absorption during the handling of paper wet with methyl alcohol or washing hands with methyl alcohol. Several aides wore rubber gloves, but this was not a common practice.

The majority of the duplicators in the school district had no local or general mechanical exhaust. Eleven of the 21 units surveyed in this study had some means of mechanical exhaust; nine of these exhaust systems had been added within two months prior to the survey. The mechanical exhaust systems present consisted of a hodge-podge of devices (open duct ends, wall fans, ceiling fans and free standing kitchen range hoods), none of which utilized good ventilation designs or adequate air volumes.

IV. EVALUATION DESIGN AND METHODS

1. Environmental

Breathing zone samples were collected for methyl alcohol vapors over 15-minute sampling periods. Because the exposure time varies from day to day, 15-minute samples were collected to indicate the potential exposure while operating the duplicator and to determine if the methyl alcohol concentrations exceeded the NIOSH 15-minute recommended exposure level.

The breathing zone air concentrations were measured using a Wilks Miran 1A* gas analyzer with the following settings: Wavelength, 9.5 microns; slit width, 0.5 millimeters; response times, 1 sec; path length, 2.25 or 0.75 meters; absorbance range, 0-1 absorbance units.

2. Medical

a) Evaluation of deaths of three teacher aides

Death certificates and autopsy information was obtained for the three aides identified by the Public School Employees, who died between 1975 and 1979. This information was evaluated for the presence of a common pattern and consistency with the known health effects of methyl alcohol.

Efforts were made to determine whether any other aides had died during the last 10 years. A list was obtained from the School District of all teacher aides who ever worked in the school district. This list was sent to Washington State Department of Retirement Systems for information on whether any of those people had died, and if so, the cause of death reported.

b) Questionnaire Survey

A medical questionnaire was administered to all female teachers, clerical staff, and teacher aides at work in the Everett School District on February 22 and 23. Only female employees were surveyed because all but one of the teacher aides were female. Instructions were given to the principals of the various schools that the questionnaires were to be self-administered and the respondents were not to discuss them or keep them over the lunch period. Envelopes were provided to

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*Mention of commercial names or products does not constitute endorsement by NIOSH.

maintain the confidentiality of the questionnaires. The questionnaire was designed to elicit information on work place activities involving "spirit duplicators" as well as the prevalence of various kinds of symptoms particularly as related to methyl alcohol toxicity.

V. EVALUATION CRITERIA

The environmental evaluation criteria for methyl alcohol are the eight hour time-weighted average (TWA) of 200 ppm (OSHA standard) and the short term exposure level for any 15-minute period of 800 ppm (NIOSH recommended level).

The two most common routes of occupational exposure to methyl alcohol are inhalation and absorption through the skin. Signs and symptoms of methyl alcohol intoxication include headache; dizziness; nausea; vomiting; weakness; vertigo; chills; shooting pains in the lower extremities; unsteady gait; dermatitis; multiple neuritis characterized by paresthesia, numbness, prickling and shooting pain in the back of the hands and forearms as well as edema of the arms; nervousness; gastric pain; insomnia; blurred vision; general visual distrubances; blindness and acidosis[1] (metabolic disturbance).

Methyl alcohol is not known to be a liver toxin in humans, however, there have been no long-term epidemiologic studies of chronic, low-level occupational exposure[1]. There have been a few older animal studies[2,3,4] where autopsy revealed deterioration of basic liver tissue (parenchymatous degeneration) proceeding, in the more severe cases, to focal necrosis (localized areas of tissue death). It is difficult to interpret these reports of liver toxicity in animals which were done in the early 1900's. The data is presented summarily and not in sufficient detail for careful evaluation. In general, the animal data is inconclusive. It is reported that primates and non-primates metabolize methyl alcohol differently, and the importance of this difference is not well known.

There have been autopsy reports of pancreatic necrosis in humans after acute ingestion of methyl alcohol. As with liver toxicity, the pancreatic pathology in humans is not specific, and chronic ethanol intake is usually an important confounding and likely causative factor.

VI. RESULTS AND DISCUSSION

1. Environmental Results

Methyl alcohol concentrations were measured in the breathing zone of the aides while operating the duplicators and while collating and stapling duplicated papers. Measurements were made in 12 of the 18 schools and involved 21 of the 58 duplicators. This grouping represented a cross-section of small and large rooms, rooms with windows that could be opened and rooms with non-operable

windows or no windows at all, rooms that had no local exhaust ventilation and some that had wall or ceiling fans or kitchen range type hoods above the duplicators. Individual sample results are shown in Table I.

The 15-minute methyl alcohol vapor air concentration during the use of the duplicators with no local exhaust ventilation ranged from 365 to 3080 ppm. Fifteen of the 20 measurements exceeded 800 ppm. With the 11 possible local exhaust ventilation systems turned on, the concentrations ranged from 80 to 1340 ppm. Only one exceeded 800 ppm. When enclosures were constructed around six duplicators by the NIOSH investigator using the existing exhaust systems, the concentrations ranged from 9 to 130 ppm. These concentrations represent a 90% - 98% reduction in the corresponding concentrations as measured with no exhaust systems and a 33%-94% reduction in the corresponding concentrations as measured with the existing systems in use. In areas where aides were collating and stapling papers, which were duplicated up to 3 hours earlier, concentrations of methyl alcohol ranged from 180-870 ppm (15-minute periods).

The daily TWA exposure to any individual employee is a combination of the methyl alcohol concentration and the duration of exposure. For example, at 800 ppm a total exposure time of two hours in a day would give a TWA of 200 ppm if there was no other exposure during the day. As the levels increase, the allowable exposure time is reduced. It is probable that the 200 ppm TWA exposure may have been exceeded by some of the operators one or more times a week. It is very probable that the 800 ppm recommended 15-minute exposure limit may have been exceeded on any given day when the duplicators were used without some means of local exhaust ventilation.

It was demonstrated that with good enclosures and using the existing ventilation rates, both the TWA and 15-minute recommended exposure limit can be met.*

2. Medical Findings

Review of the death certificates or autopsy information of the three deceased aides showed three distinct causes of death; cancer of the ovary; cancer of the liver, resulting from metastasis of a primary oat cell carcinoma of the lung; and acute pancreatic necrosis and severe post necrotic cirrhosis of the liver, presumably secondary to hepatitis. There is no indication that these deaths were related to exposure to methyl alcohol.

No further deaths of aides were found upon searching records of the Retirement System. However, 50 former members have terminated their participation in the Retirement System, and it is not known if they are still alive.

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*As of the publication of this report, the Everett School District is no longer using the spirit duplicators in their school system.

The 66 aides that responded to the questionnaire were compared to a group of 66 teachers randomly selected from the other people given the questionnaire. The two groups were found to be statistically comparable in age: teachers' mean age was 37.5 years (range 24-59) and the aides' mean age was 39.8 (range 24-60). The two groups were compared for the prevalence of symptoms experienced during the months prior to the investigation. The most significantly different symptom was blurred vision reported by 15 (23%) of the aides and 1 (1.5%) of the teachers (X^2=12.01, $p < 0.001$). Aides also reported more headaches 34% compared with 18% for the teachers ($p < 0.05$), as well as dizziness 30% vs. 1.5% ($p < 0.001$), nausea 18% vs. 6% ($p < 0.10$) and skin problems 11% vs. 1% ($p < 0.10$). No differences existed for symptoms such as dry/sore throat, painful urination, jaundice, or diarrhea, which are unrelated to methyl alcohol toxicity and which should be similar in both groups. The prevalence of symptoms is shown in Table II.

For more comprehensive comparisons, a case of probable methyl alcohol toxicity was defined as having one of the following sets of symptoms: 1) visual changes or blurred vision; or 2) one acute and one chronic symptom, or 3) two acute symptoms; or 4) three chronic symptoms. Forty-five percent (45%) of the aides met the criteria for a case, compared with 23.7% of the techers. The association between being an aide and being a case was significant at $p < 0.025$ (X^2=6.6). When the analysis was performed controlling for age, the aides had a greater attack rate in every five year age stratum except for age 41-45 (see Table III). The Mantel-Haenzel Chi-square Test for the case rate in the various age strata was significant at $p < 0.05$.

An appraisal of the case attack rate by percent weekly time the aides spent at a duplicating machine showed that as the percent-time increased so did the proportion of the group classified as a case (Figure 4). Aides, who spent greater than 60% of their time near duplicating machines, had a 50% attack rate. A dose-response relationship existed for both aides and teachers. The analysis of the exposure information must be considered in light of the variability in work requirements and exposures of both groups. Nonetheless, a clear trend of increasing effect with increasing exposure was observed.

The data indicated that teacher aides had symptoms suggestive of methyl alcohol toxicity twice as frequently as did teachers. The most significant symptom, blurred vision, occurred fifteen times more frequently in the aides. The attack rate for cases suggestive of methyl alcohol toxicity increased as the amount of time spent at a spirit duplicator increased. These data were gathered via self-administered questionnaires during a period when emotions were quite high and discussion of the issue extensive. The possibility exists that symptom prevalences may have increased as a result of the heightened awareness of the respondents. Both groups, however, responded similarly to questions involving symptoms not associated

with methyl alcohol exposure indicating that the questionnaires were not answered indiscriminantly. Further, the positive responses of the teachers may also have been augmented since some of them worked with the duplicators. Therefore, the relative differences in symptom prevalences are not necessarily raised in favor of one group or the other and are thus probably comparable.

VII. CONCLUSIONS

1. The majority (75%) of the spirit duplicating machines that were tested exceeded the limit recommended by NIOSH for methyl alcohol exposure. Simple engineering controls are available to control these types of exposures.

2. Certain work practices, such as the collating and stapling of freshly duplicated papers, and the washing of hands with methyl alcohol resulted in exposure, not only by inhalation, but by skin absorption.

3. A variety of adverse health effects consistent with methyl alcohol toxicity were observed in teacher aides and the prevalence of such effects appeared to increase with the amount of time spent at a duplication machine. The most significant health effects were blurred vision, headache, nausea, and dizziness.

VII. RECOMMENDATIONS

1. Provide local exhaust ventilation (see drawings figures 1, 2 and 3) on "spirit duplicators" unless measured air concentrations for the duplicator fluids indicate ventilation is not necessary.

2. Prevent re-entry of exhausted vapors through nearby open windows or doors.

3. Allow duplicated paper to "air" for 24 hours before collating and stapling.

4. Do not wash hands with the duplicator fluids to remove inks from the hands. Use soap and water or a waterless hand cleaner.

5. Provide rubber gloves for those individuals who handle papers.

IX. REFERENCES

1. Criteria for a Recommended Standard...Occupational Exposure to Methyl Alcohol, U.S Department of Health, Education, and Welfare, PHS, CDC, NIOSH, March 1976, publication number 76-48.

2. Tyson H.H., Schoenberg M. J., J. Am Med Association 63: 915, 1914.

3. Scott E., Helz MM, McCord, CP; Am J. Clin Pathol 3:311, 1933.

4. Patty F.A. ed., Industrial Hygiene and Toxicology, Second Edition, Interscience Publishers, New York, p. 1415, 1962.

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XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this complete Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days, the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Informtion regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Everett School District;
2. Public School Employees of Washington, Puyallup, Washington;
3. Washington Industrial Safety and Health Agency, Olympia, Washington;

4. U.S. Department of Labor, Occupational Safety and Health Administration, Region X, Seattle, Washington.

5. National Institute for Occupational Safety and Health, Region X, Seattle, Washington.

TABLE I

EVERETT SCHOOL DISTRICT
METHYL ALCOHOL AIR CONCENTRATIONS*
IN PPM

SCHOOL	ROOM#	COMMENTS	COLLATING & STAPLING PAPERS	NO LOCAL EXHAUST VENTILATION	WALL FAN ON	CEILING FAN ON	CEILING FAN WITH OPEN DUCT OVER DUPLICATOR	KITCHEN RANGE TYPE HOOD	NIOSH FABRICATED ENCLOSURE FOR TEST
Eisenhower	24	Hood installed Oct. 79		1100				120	
Emerson	Off Office	Fan installed Jan. 80		365 (2)	80				9
Evergreen	104	Hood installed Feb. 80		1180				135	15
Garfield	12			1365					
	28			915					
	38			1000					
Hawthorne	8			435					
	22		870 (5)	1275					
Monroe	311	Fan installed about 3 yrs. ago		575			480		
	321	" " "		1250				650	130
	314		685 (3) 35 (7)						
Port Gardner	14	Hood installed Sept. 79 (lowered Jan. 80)						120 (4) 265 (3)	35 (6)
	41	Fan installed Sept. 79		1040 (3)	375				
Roosevelt	10			500 (3) (5) 940 (1) (5)					
Silver Lake	34	Fan installed Jan. 80		3080			430		
	42	Fan installed Jan. 80	180 (3)	1185		680			
	B-20	Fan installed Jan. 80	490 (1)	1270	410				15
View Ridge	10			410 (3) 970 (1)					
	10	Duplicator returned to room to simulate past (1976) conditions		1290					
Washington	301	Fan installed Sept. 79		1440	1340				90
Whittier	7		190 (4)	685					

(1) Window closed

(2) Window open

(3) Door closed

(4) Door open

(5) Papers duplicated 0-3 hours before

(6) Papers duplicated 24 hours before

(7) Papers duplicated 48 hours or more before

Evaluation Criteria for methyl alcohol:

1. Short term exposure level for any 15 minute period - 800 PPM (NIOSH recommended levels)

2. Eight hour time weighted average - 200 PPM (WISHA standards)

*Concentrations listed represent 15 minute sampling periods

TABLE II

Prevalence of Symptoms

Symptoms	Prevalence (Percent experiencing symptoms during month prior to investigation) Teachers n=66	Aides n=66
Trouble sleeping	10.6	13.6
Unusually tired	24.2	24.2
Headache	18.1	34.8
Dizzy/lightheaded	1.5	30.3
Irritable	10.6	12.1
Giddiness	0	1.5
Poor memory/confusion	1.5	6.0
Muscle weakness	1.5	3.0
Dry/sore throat	16.6	16.6
Burning/itching/tearing of the eyes	12.1	25.7
Trouble with or changes in your vision	10.6	15.7
Blurred vision	1.5	22.7
Chills	9.0	12.1
Poor appetite	1.5	0
Unusual weight loss	0	1.5
Nausea/upset stomach	6.0	0
Vomiting	0	0
Diarrhea	0	0
Painful urination	4.5	3.0
Skin problems	1.5	10.6
Jaundice	0	0
Numbness in hands and arms	6.0	7.5
Other	13.6	19.6

TABLE III

Age Distribution of Cases

Number, and percent of age group, of cases.

AGE	TEACHERS	AIDES
20-25	0 (0)	2 (40)
26-30	4 (23)	3 (37)
31-35	1 (7)	4 (57)
36-40	3 (23)	7 (53)
41-45	5 (100)	5 (41)
46-50	1 (20)	5 (62)
51-55	1 (25)	3 (50)
56-60	0 (0)	1 (25)
	n=15	n=30

FIGURE 1

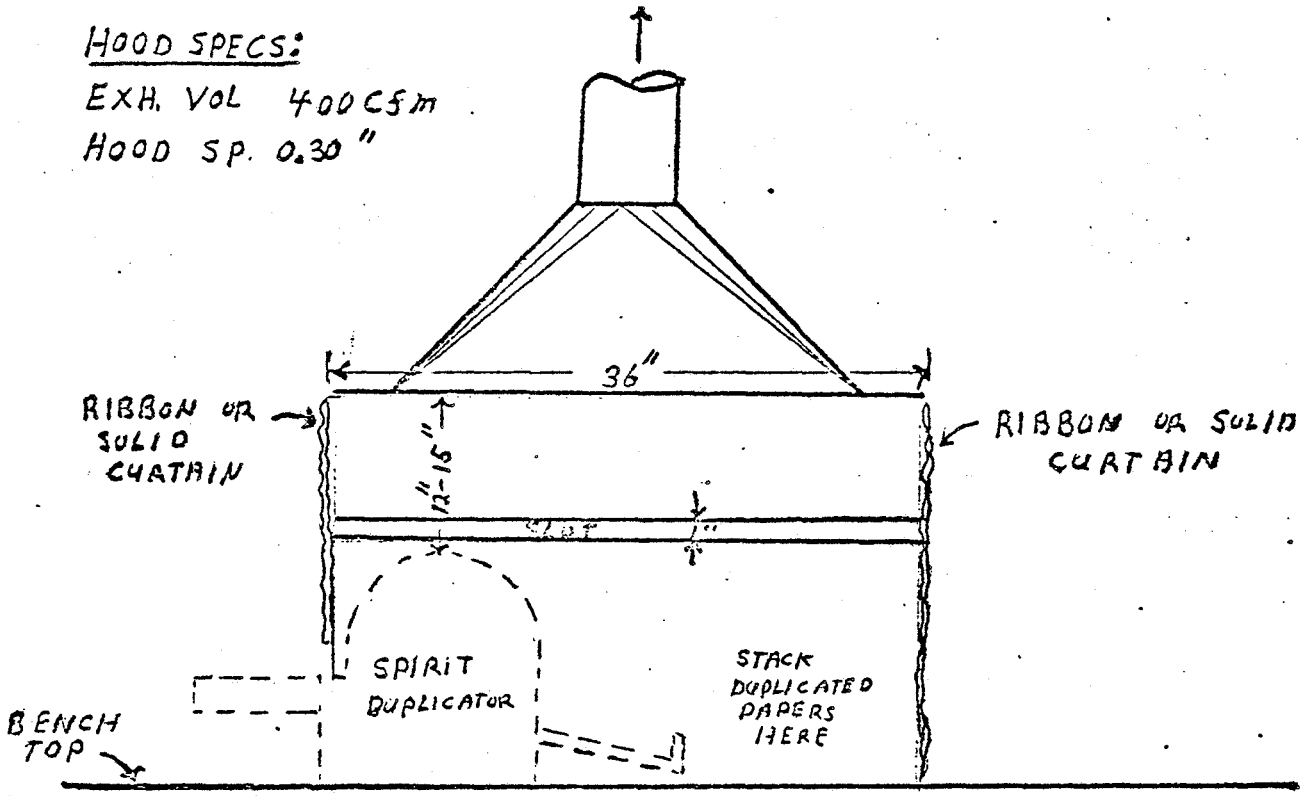
"DUPLICATING MACHINE EXHAUST"

-PREFERRED METHOD-

GOOD ENCLOSURE WITH SLOT EXHAUST

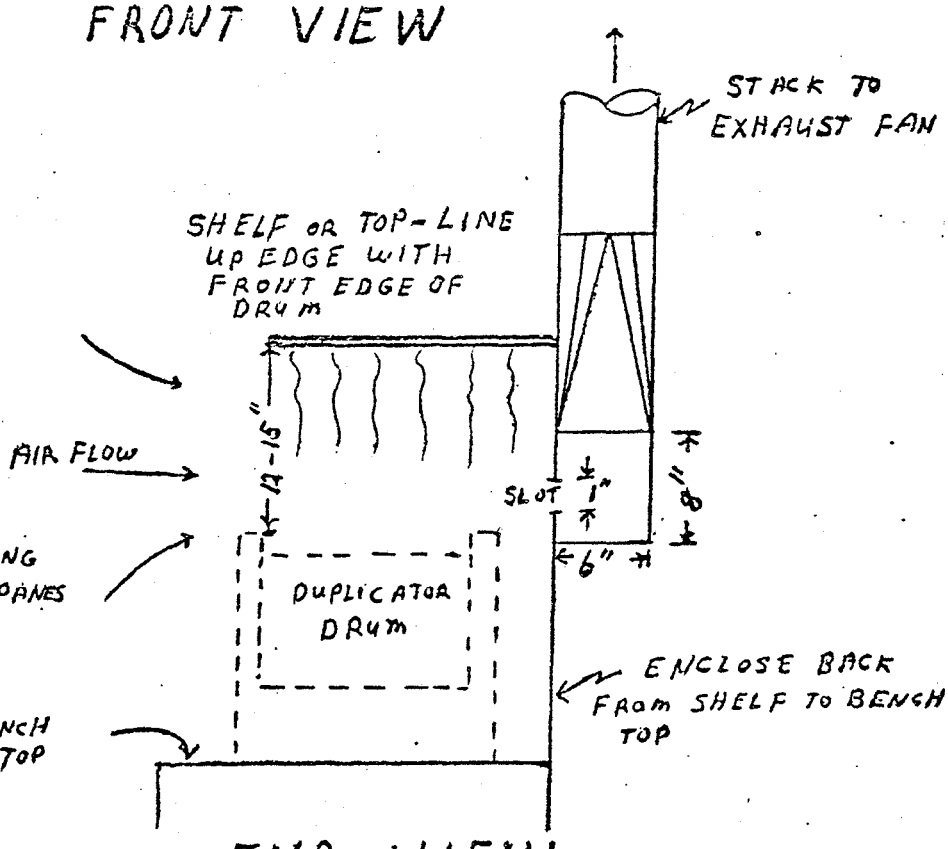
ARVIN G. APOL NIOSH REGION 10 SEATTLE, WA. 206-442-0530
R. P. HIBBARD DEPT OF ENV. HEALTH U OF WASH. SEATTLE, WA

HOOD SPECS:
EXH. VOL 400 CFM
HOOD SP. 0.30"



FRONT VIEW

NOTE:
- ADD HOOD SP TO SYSTEM SP FOR FAN SIZE
EXH. TAKE OFF CAN BE DOWN
- PROVIDE FOR MAKE-UP AIR eg. VENT IN DOOR
- LOCAL CODES MAY PROHIBIT EXHAUSTING THROUGH WINDOW PANES



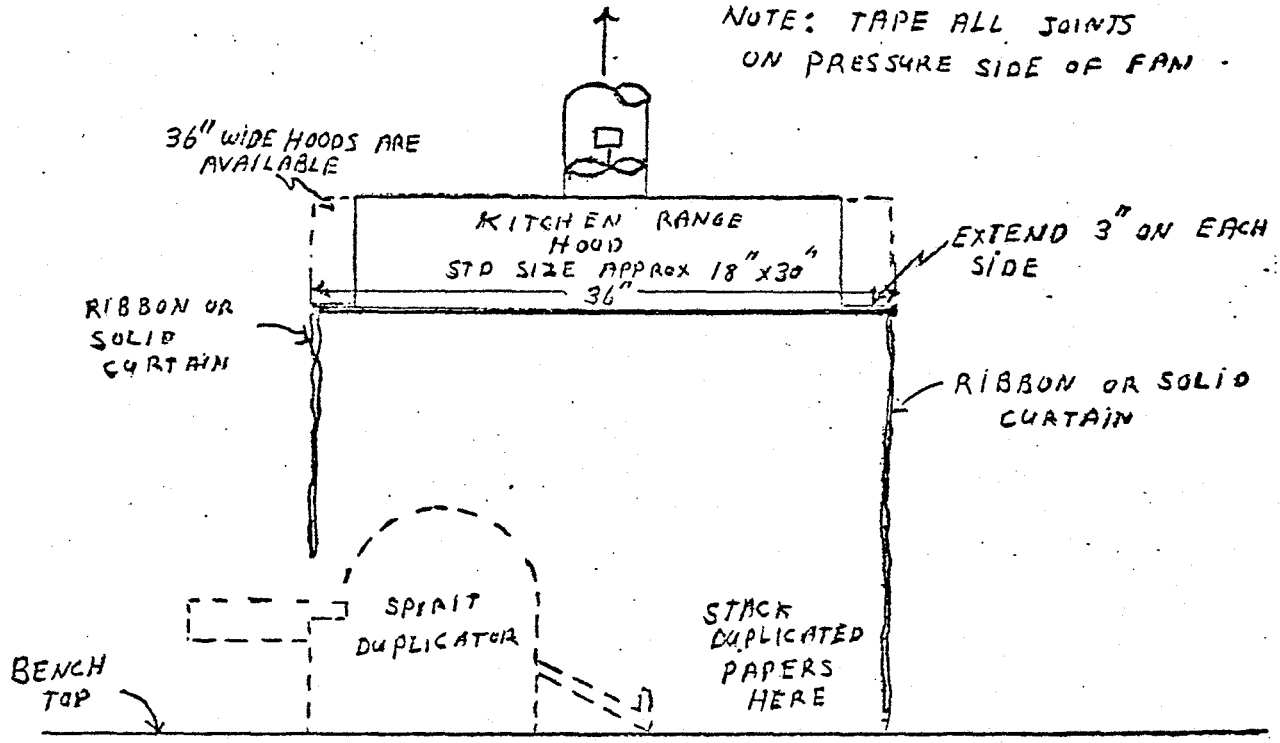
END VIEW

FIGURE 2

DUPLICATING MACHINE EXHAUST

-ALTERNATE METHOD-
KITCHEN RANGE TYPE HOOD WITH GOOD ENCLOSURE

ARVIN G APOL NIOSH REGION 10 SEATTLE, WA.
R.P. HIBBARD DEPT OF ENV. HEALTH U. OF WASH SEATTLE, WA.

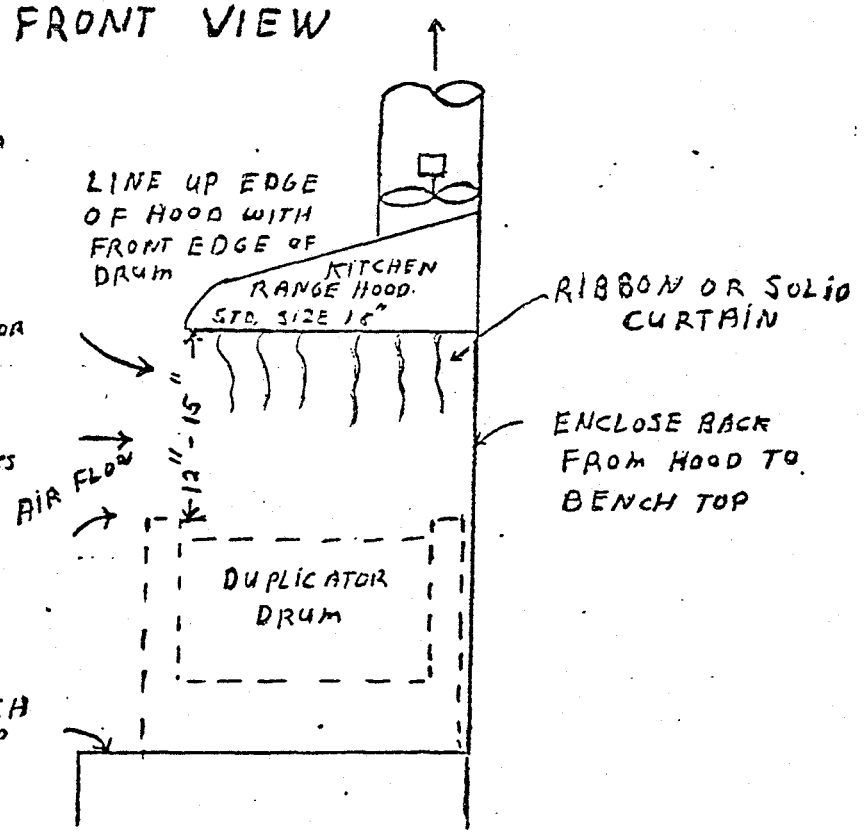


FRONT VIEW

EXH. VOL
400 CFM minimum

NOTES:

- PROVIDE FOR MAKE-UP AIR eg VENTS IN DOOR
- LOCAL CODES MAY PROHIBIT EXHAUSTING THROUGH WINDOW PANES



END VIEW

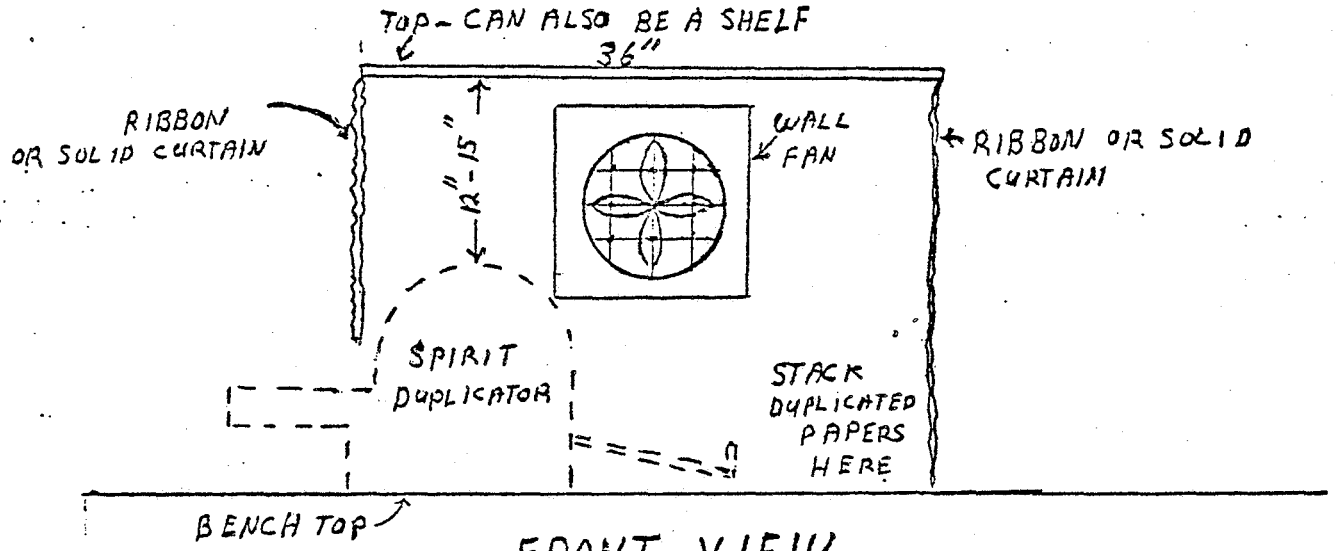
FIGURE 3

"DUPLICATING MACHINE EXHAUST"

- ALTERNATE METHOD -

WALL FAN WITH GOOD ENCLOSURE

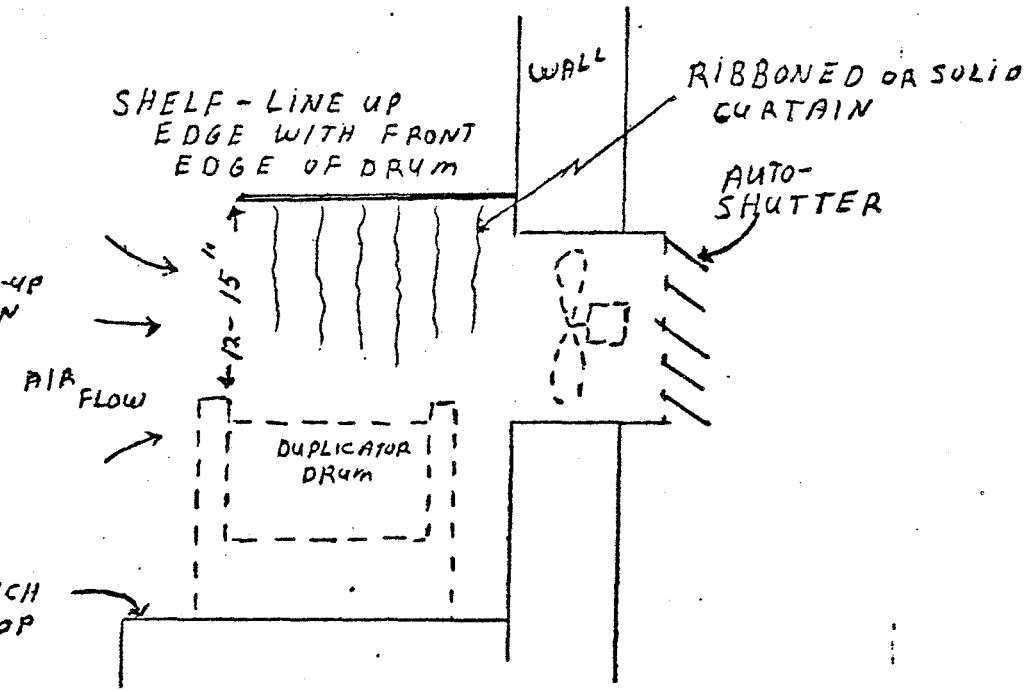
ARVIN G. APOL NIOSH REGION 10 SEATTLE, WA.
R.P. HIBBARD DEPT OF ENV. HEALTH U OF WASH SEATTLE WA.



FRONT VIEW

EXH FAN:
WALL TYPE WITH AUTO-SHUTTER
400 cfm MINIMUM

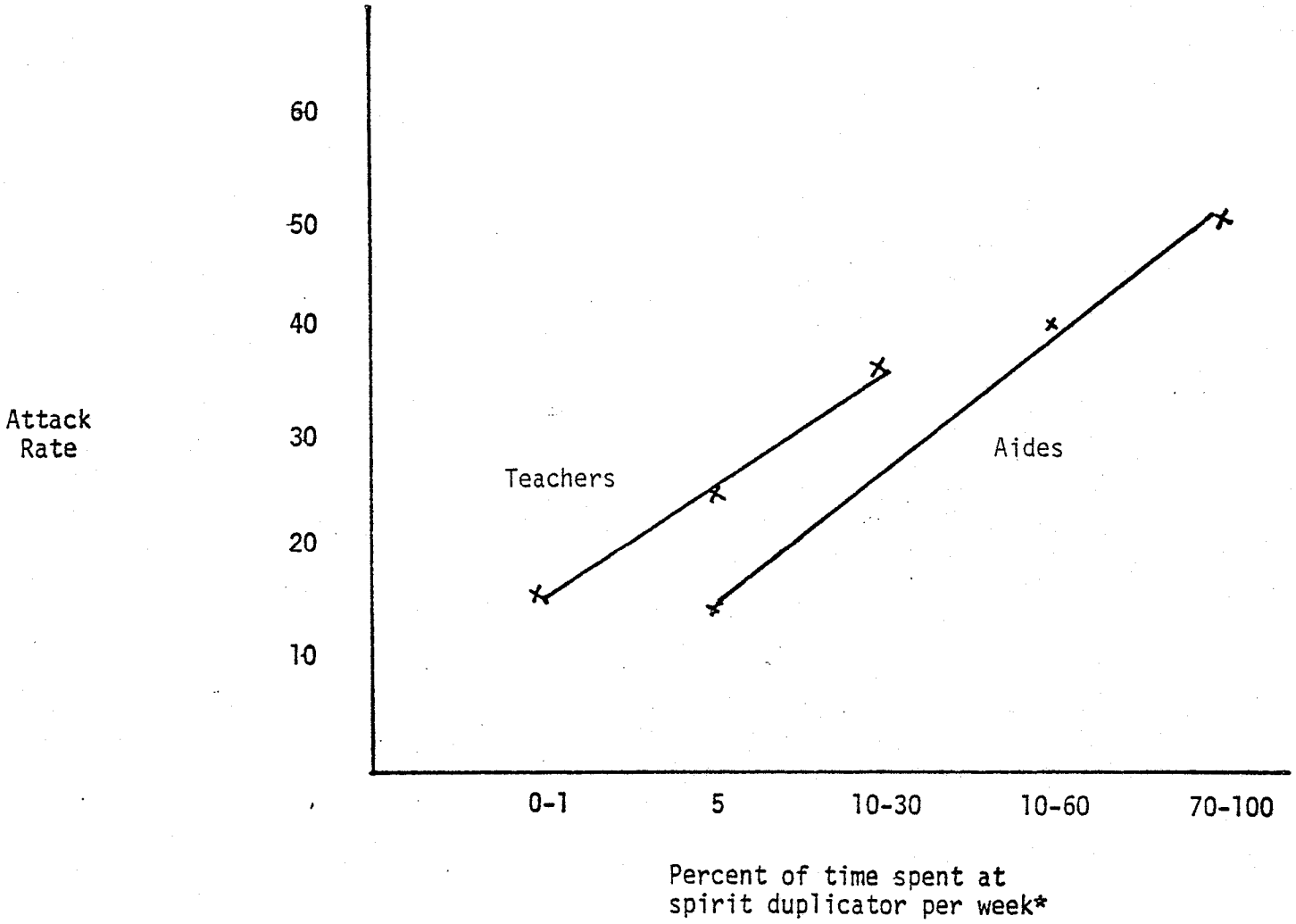
NOTE:
- LOCAL CODES MAY PROHIBIT WINDOW MOUNT
- PROVIDE FOR MAKE-UP AIR eg VENTS IN DOOR.



END VIEW

Figure 4

Relationship between percent of time spent at spirit duplicating machine and attack rates.



* The categories on the axis are not equal in size and are used only for descriptive purposes so that the trend may be shown.

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Feburary 1980

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NA

16. Abstract (Limit: 200 words)
Environmental sampling and medical surveys were conducted between February 5 and 15 1980 at 12 schools (SIC-2731) using spirit duplicating equipment in the Everett School District of Washington. The evaluationrequest came from an authorized representative of the Public School Employees of Washington to determine if a methyl alclhol (67561) exposure hazard existed for the district's 84 teacher aides and if the deaths of three former teacher's aides were related to exposure. The 15 minute methyl alcohol air concentration from 20 duplicators with no local exhaust ventilation ranged from 365 to 3,080 parts per million (ppm). The NIOSH recommended standard of 800ppm for a 15 minute period was exceeded in 15 of the 20 measurements. When 11 local exhaust ventilation systems were put in operation, concentrations ranged from 80 to 1,340ppm with only one measurement exceeding 800ppm. Additional exposures reduced concentrations to a range of 9 to 130ppm. The questionnaire survey revealed that 45 percent of the teacher's aides experienced some symptoms consistent with methyl alcohol toxicity. Review of the death certificates and autopsy information of the three deceased aides gave no indication that their deaths were related to methyl alcohol exposure. The authors note that 75 percent of the spirit duplicating machines tested exceeded the methyl alcohol exposure limits recommended by NIOSH, but that simple engineering controls were available to reduce these exposures.

17. Document Analysis a. Descriptors
Elementary-and-secondary-schools
Hazard-confirmed
Duplicating-machines
Office-machines
Education
Alcohols

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement
AVAILABLE TO THE PUBLIC

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20. Security Class (This Page)

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22. Price

(See ANSI-Z39.18)

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