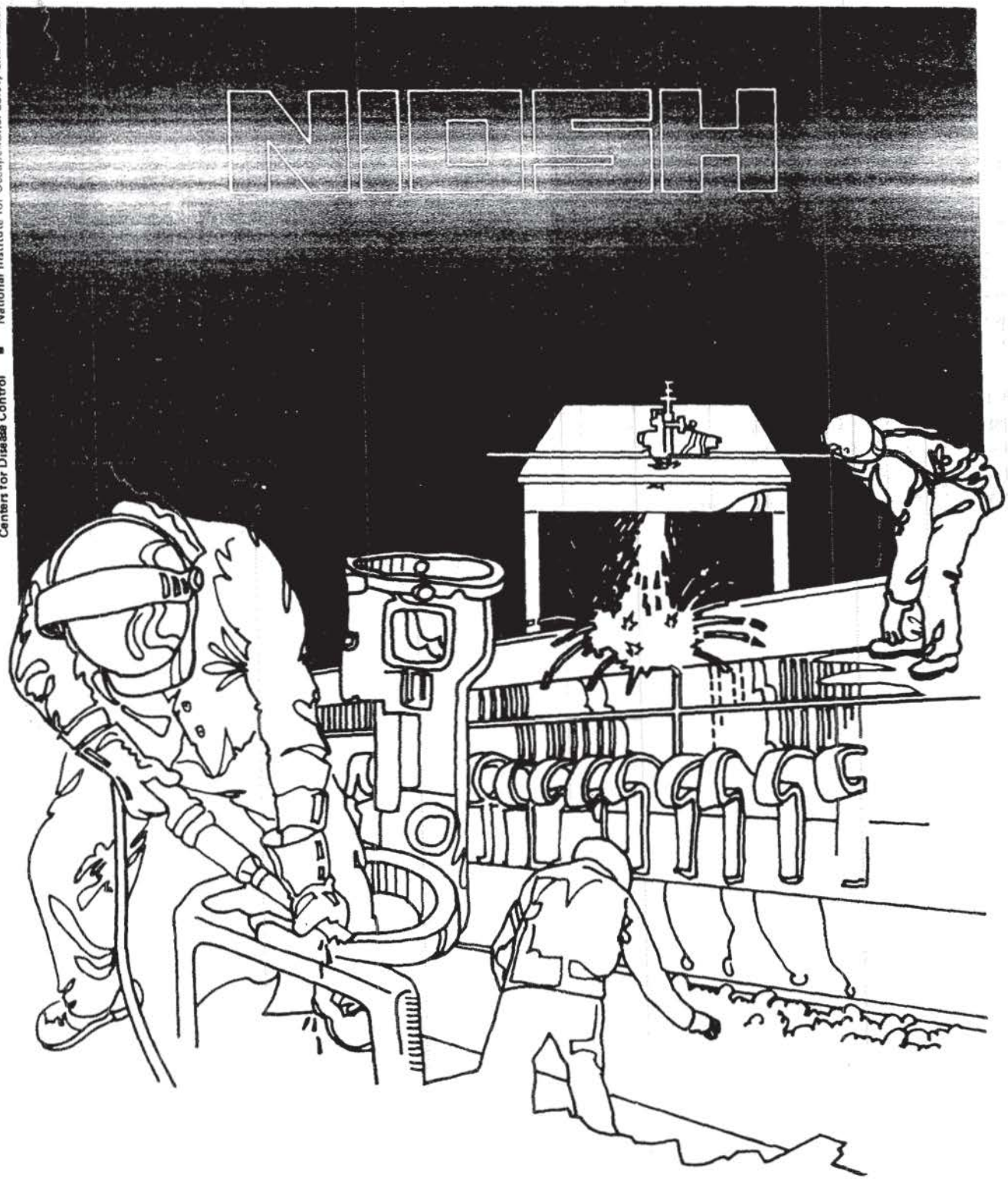
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 82-372-1220
INDIAN BROOK ELEMENTARY SCHOOL
PLYMOUTH, MASSACHUSETTS

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.

HETA 82-372-1220
NOVEMBER 1982
INDIAN BROOK ELEMENTARY SCHOOL
PLYMOUTH, MASSACHUSETTS

NIOSH INVESTIGATOR:
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I. SUMMARY

On September 1, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the Plymouth School Committee to provide an air quality survey at the Indian Brook Elementary School. Specifically requested was an industrial hygiene characterization of methyl alcohol levels emitted during the use of "spirit duplicators", and an evaluation of the ventilation system.

On September 29, 1982, NIOSH conducted environmental monitoring. Methyl alcohol measurements were taken in the teachers lounge during the operation of two duplicating machines using a Wilks Miran 1A gas analyzer. Exposure levels ranged from 3000 ppm in the breathing zone of the operator to 200 ppm ten feet away at the lunch table. There was no local exhaust ventilation for the duplicating machines.

The NIOSH Recommended exposure limit for methyl alcohol is 800 ppm for 15 minutes.

NIOSH also measured the fresh air supply ducts of two of the ventilation systems using a Kurz Air Velocity Meter Model 441. Corresponding readings were recorded for each of the settings on the modular control panel from 0 - 100% fresh air. The results of the ventilation survey indicated that the modular control panels were not calibrated to deliver the indicated amount of fresh air to the building. In fact, at 10% on the dial (the customary winter setting), essentially no fresh air was allowed into the system.

Based on the environmental survey results it can be determined that duplicating machine operators are over-exposed to methyl alcohol vapor after only 4 minutes of continuous copying (3000 ppm for more than 4 minutes will result in a 15-minute exposure in excess of the NIOSH recommended standard of 800 ppm). Recommendations are made to provide local exhaust ventilation on "spirit duplicators".

Also, with the control modules on the HVAC systems set at 10%, the air quality in the building does not meet the ASHRAE minimum standard for educational facilities. This can easily be corrected by increasing the settings to at least 35%.

KEYWORDS: SIC 8211, Spirit duplicators, Indoor air pollution, Methyl alcohol.

II. INTRODUCTION

On September 1, 1982, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Plymouth School Committee, Plymouth, Massachusetts, to provide an air quality survey at the Indian Brook Elementary School. Specifically requested was an industrial hygiene characterization of methyl alcohol levels emitted during the use of "spirit duplicators", and an evaluation of the ventilation system.

III. BACKGROUND

The duplicating operation involves 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. Skin contact with methyl alcohol also occurs when handling the recently copied papers.

The Indian Brook Elementary School had two duplicating machines located in the teachers lounge. There was no local exhaust ventilation for these machines. The teachers lounge is tied in with the general air recirculation system.

The school is designed for energy efficiency and has no openable windows. Air circulation is accomplished by the use of 6 heating, ventilation and air conditioning (HVAC) systems located on the roof. Each HVAC system has a modular control panel which allows the system operator to control the amount of fresh outside air admitted into the system. During the warm weather months the systems are set to circulate 100% fresh air throughout the school. However, during the colder months, the systems are set to only allow 10% fresh outside air into the building.

IV. EVALUATION DESIGN AND METHODS

On September 29, 1982 NIOSH conducted environmental monitoring which consisted of the following:

Methyl Alcohol

Since a typical length of exposure could not be ascertained, NIOSH attempted to characterize the potential exposures by performing a time versus exposure study in the teachers lounge while two duplicating machines where operating.

Breathing zone measurements were collected during the operation of the "spirit duplicators". The results were compared to the NIOSH 15 minute recommended exposure level of 800 ppm.

General area samples were also collected to determine the parameters of the exposure area.

All 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 time, 1 second; path length, 2.25 meters; absorbance range, 0-1 absorbance units. The range of detection of methyl alcohol was 25 to 3000 ppm. This unit was calibrated using known concentrations of methyl alcohol on the morning of the survey.

HVAC System

Since all of the HVAC units have essentially the same design, NIOSH collected air velocity measurements on two representative units: Unit #2 which is 8 years old, and Unit #3 which is 3 years old. Measurements were taken in the fresh air duct using a Kurz Air Velocity Meter Model 441. Corresponding readings were recorded for each of the settings on the modular control panel from 0 - 100% fresh air.

V. EVALUATION CRITERIA

Methyl Alcohol

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).

Methyl alcohol can affect the body if it is swallowed, is inhaled, or comes in contact with the skin or eyes.

Swallowing, or breathing very high concentrations of methyl alcohol may produce headache, weakness, drowsiness, lightheadedness, nausea, vomiting, blindness and death. A person may get better and then worse again up to 30 hours later.[2]

Prolonged exposure to higher concentrations of methyl alcohol may result in headaches, burning of the eyes, dizziness, sleep problems, digestive disturbances and failure of vision. Repeated or prolonged skin contact may cause skin irritation.[2]

Ingestion of methyl alcohol is a well-known cause of optic neuropathy and may be lethal. Severe acidosis may result from ingestion or high exposures. Animals exposed to vapor concentrations above 8000 to 10,000 ppm show narcotic effects progressing from lethargy, to ataxia, to prostration and death in a state of profound acidosis due in part to the metabolic formation of formaldehyde and formic acid. Occupational exposure to high concentrations of methyl alcohol vapor has been reported to cause death or blindness, usually from working in a confined space. A woman died after exposure for 12 hours to vapor

concentrations calculated at 4000 to 13,000 ppm. Chronic poisoning is manifested by marked diminution of vision and enlargement of the liver has been reported in a workman exposed at levels of 1200 to 8000 ppm for a period of four years. Direct skin contact with methyl alcohol may cause dermatitis, erythema and scaling.[2]

The odor threshold of methyl alcohol has been reported by May[3] and Summer[4] as 5900 ppm. The AIHA Hygienic Guide states that the odor is faint at 2000 ppm. Methyl alcohol is said to have poor warning properties for overexposure.

HVAC System

The ventilation system measurements were compared to the design specifications.

The American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE) Standard 62-1981 lists ventilation requirements for acceptable indoor air quality.

The purpose of the ASHRAE standard is "to specify indoor air quality and minimum ventilation rates which will be acceptable to human occupants and will not impair health". The ASHRAE standard for classrooms in educational facilities calls for a minimum of 5 cubic feet per minute per person (cfm/person) of outside air, to dilute the carbon dioxide produced by metabolism and expired air from the lungs. The ASHRAE standard for rooms in educational facilities where smoking is allowed, i.e., the teachers lounge, calls for a minimum of 25 cfm/person of outside air to dilute cigarette smoke to acceptable levels.

VI. RESULTS AND DISCUSSION

Methyl alcohol concentrations were measured in the breathing zone of the would be operators. With the operator standing in the normal operating position, the breathing zone concentration of methyl alcohol reached 900 ppm after 15 copies, and greater than 3000 ppm after only producing 35 copies. This level remained fairly constant until the operator was finished. The odor of methyl alcohol was detectable during the operation.

During the duplicating operation, the general area within a 3 foot radius of the machine reached air concentration levels of about 500 ppm in a very short time (about 3 minutes).

These tests were run with the ventilation system off but since the measurements were taken so close to the source, one would not expect much variability with the system operating.

The stack of copies that was produced was allowed to stand for about 2 hours. Source readings were then taken from the top piece of paper, a middle copy, and the bottom copy. All readings were above 1000 ppm. No attempt was made to determine how long it would take for all of the methyl alcohol to evaporate from the stacked copies.

The following table lists the maximum allowable exposure times for the various exposure levels indicated, according to the established criteria.

Permissible Exposure Levels as a Function of Time.

Level (ppm)	Allowable Time	
200	8 hours	
300	5.3 hours	
400	4 hours	OSHA Standard
500	3.2 hours	
600	2.7 hours	
700	2.2 hours	
800	15 minutes	
900	13.3 min	
1000	12 min	
1100	10.9 min	
1200	10 min	
1300	9.2 min	
1400	8.5 min	
1500	8 min	NIOSH Recommendation
1600	7.5 min	
1700	7 min	
1800	6.7 min	
1900	6.3 min	
2000	6 min	
2500	4.8 min	
3000	4 min	

HVAC System

The results of the ventilation survey are tabulated on the following page. The system operator explained that the HVAC units operate in the "Day" mode from 7:30 am to 2:30 pm at which time fresh air is allowed into the system. The amount of fresh air is regulated by the control module on each unit. After 2:30 pm the system shifts to "Night" mode which automatically overrides the control module and sets the system at 0% fresh air. The system is totally shut off on weekends and vacations (unless there is a possibility of freeze up, in which case the system is left in the "Night" mode.

The results of the ventilation survey indicate: 1) that the control modules on the HVAC systems are not calibrated to deliver the indicated amount of fresh air to the building; 2) when the system shifts from the "Night" to the "Day" mode, there is essentially no fresh air admitted into the system unless the control module is set at greater than 30%; and 3) the control modules are more accurate when they begin at the top (100%) end and work their way down.

Reading (a) was taken with the control module going from 0-100%
Reading (b) was taken with the control module going from 100-0%

HVAC UNIT #2
TOTAL DESIGN CAPACITY 13,000 cfm
DUCT SIZE 56"x 20" DUCT AREA 7.78 sq. ft.

Module Setting %	Measured fpm (ft/min)	Calculated cfm 7.78 x col 2	Design cfm 13,000 x col 1
0%	(a) 10	78	0
	(b) 10	78	
10%	(a) 10	78	1,300
	(b) 10	78	
20%	(a) 10	78	2,600
	(b) 50	389	
25%	(a) N/A	N/A	3,250
	(b) 300	2,334	
30%	(a) 375	2,917	3,900
	(b) 450	3,501	
40%	(a) 600	4,668	5,200
	(b) 650	5,057	
60%	(a)1,250	9,725	7,800
100%	(a)1,600	12,448	13,000
	(b)1,600	12.448	

HVAC UNIT #3
TOTAL DESIGN CAPACITY 7,200 cfm
DUCT SIZE 56"x 20" DUCT AREA 7.78 sq. ft.

Module Setting %	Measured fpm (ft/min)	Calculated cfm 7.78 x col 2	Design cfm 7,200 x col 1
0%	(a) 10	78	0
	(b) 10	78	
10%	(a) 10	78	720
	(b) 10	78	
20%	(a) 10	78	1,440
	(b) 125	972	
30%	(a) 200	1,556	2,160
	(b) 300	2,334	
40%	(a) 300	2,334	2,880
	(b) 475	3,695	
50%	(a) 500	3,890	3,800
	(b) 600	4,668	
100%	(a) 900	7,002	7,200
	(b) 900	7,002	

VII. CONCLUSION

Based on the environmental survey results it can be determined that duplicating machine operators may be over-exposed to methyl alcohol vapor after only 4 minutes of continuous copying (3000 ppm for more than 4 minutes will result in a 15-minute exposure in excess of the NIOSH recommended standard of 800 ppm).

The handling of freshly copied papers results in additional exposure, not only by inhalation, but by skin absorption. This exposure may also be passed on to the students if the copied material is handed out soon after being duplicated.

With the control modules on the HVAC systems set at 10%, the air quality in the building does not meet the ASHRAE minimum standard for educational facilities. This can easily be corrected by increasing the settings to at least 35%.

VIII. 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. Allow duplicated paper to air dry for at least 24 hours before collating and stapling, or handing out to students.

3. To assure that the HVAC systems will provide adequate amounts of fresh outside air to the building, the "Day" setting on all systems should be at least 40%. An alternative means of accomplishing this end would be to install a mechanism that would automatically run the system at 100% fresh air for the first ten minutes of the "Day" mode and then automatically reduce the fresh air intake to a "Day" setting of 30%. This would allow one complete air change inside the building before reverting to a normal operating condition of 30% fresh air. The air change would remove any air contaminants that would have accumulated overnight or during a vacation period.

IX. REFERENCES

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2. NIOSH/OSHA - Occupational Health Guidelines For Chemical Hazards, DHHS/NIOSH Publication No. 81-123, January 1981.

3. May, J.: "Solvent Odor Thresholds for the Evaluation of Solvent Odors in the Atmosphere", Staub-Reinhalt, 26:9, 385-389, 1966.

4. Summer, W.: Odor Pollution of Air: Causes and Control, L. Hill, London, 1970.

5. Criteria for a Recommended Standard...Occupational Exposure to Methyl Alcohol, DHEW/NIOSH Publication No. 76-48, March, 1976.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

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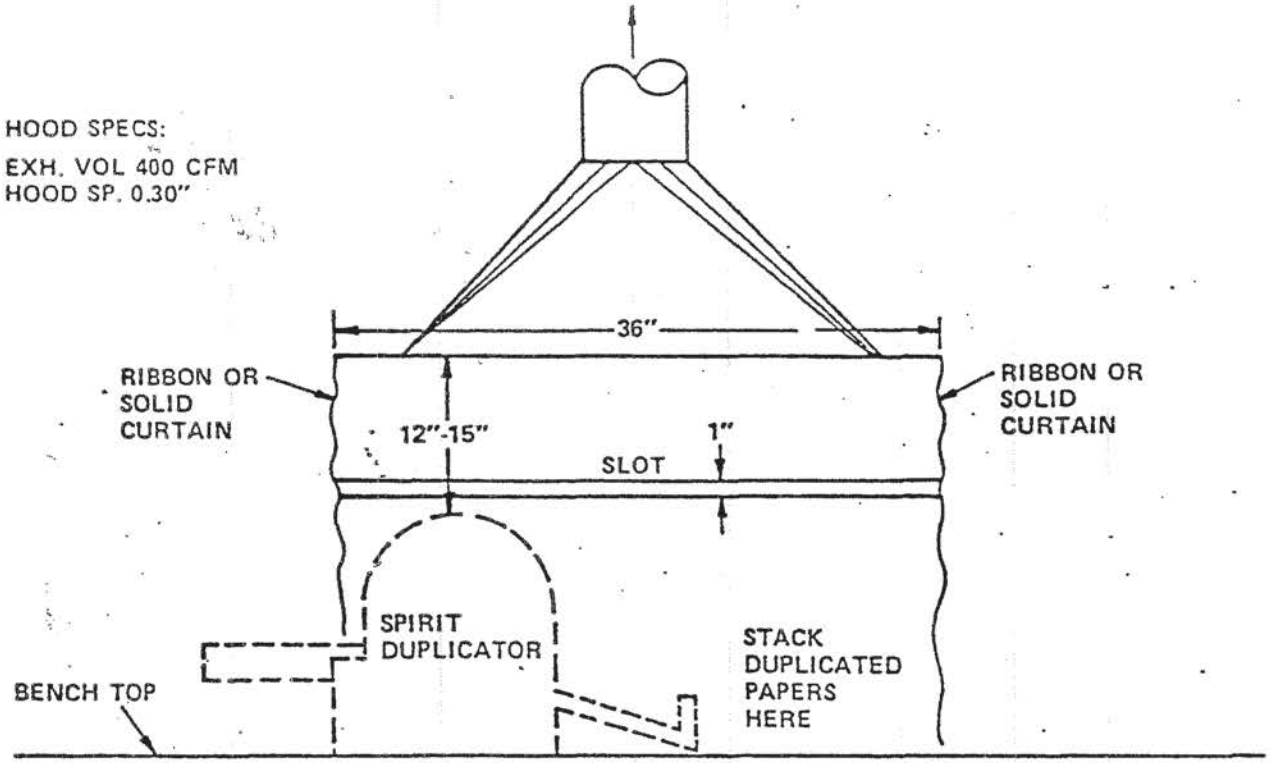
1. Superintendant of Schools, Plymouth, Massachusetts
2. NIOSH, Region 01
3. OSHA, Region 01

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.

"DUPLICATING MACHINE EXHAUST"

–PREFERRED METHOD–
GOOD ENCLOSURE WITH SLOT EXHAUST



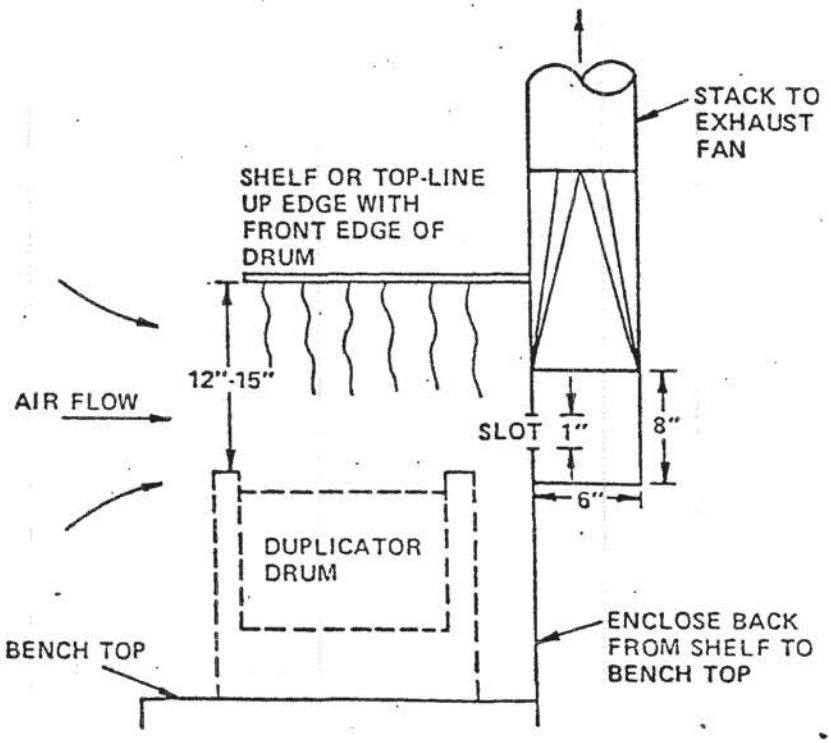
FRONT VIEW

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

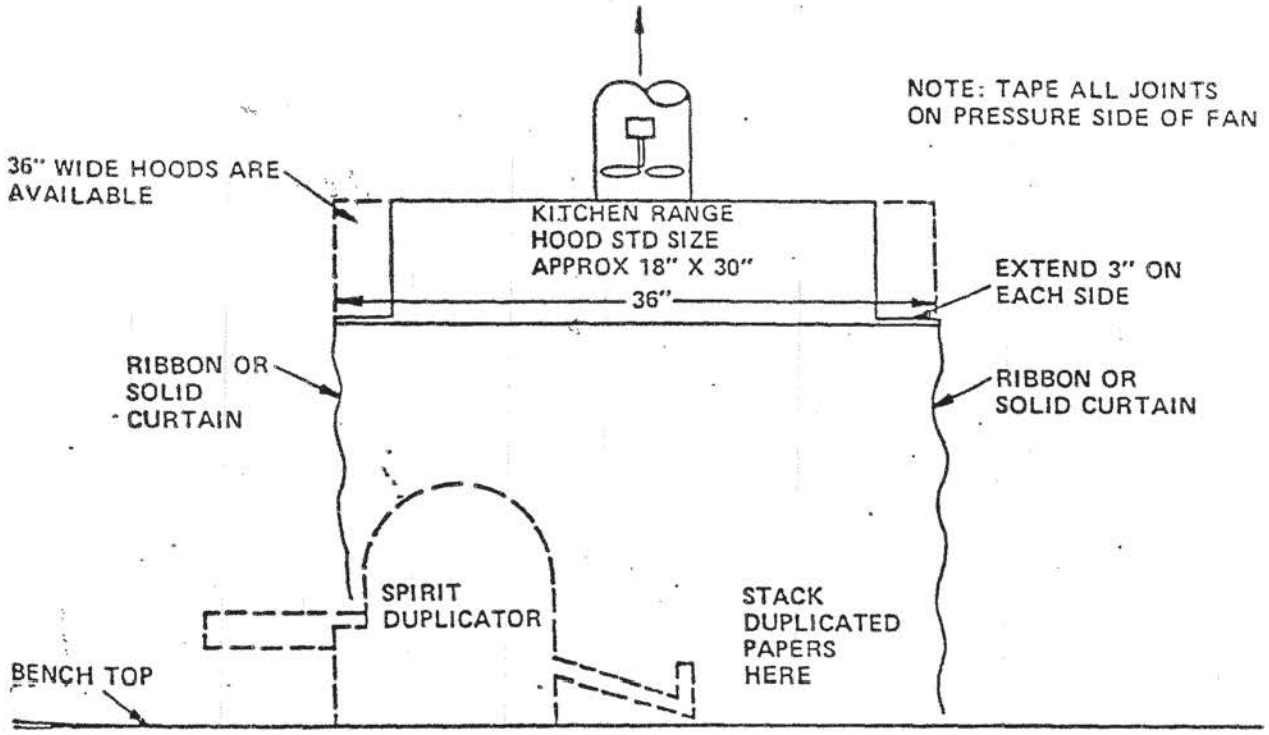


END VIEW

FIGURE 2

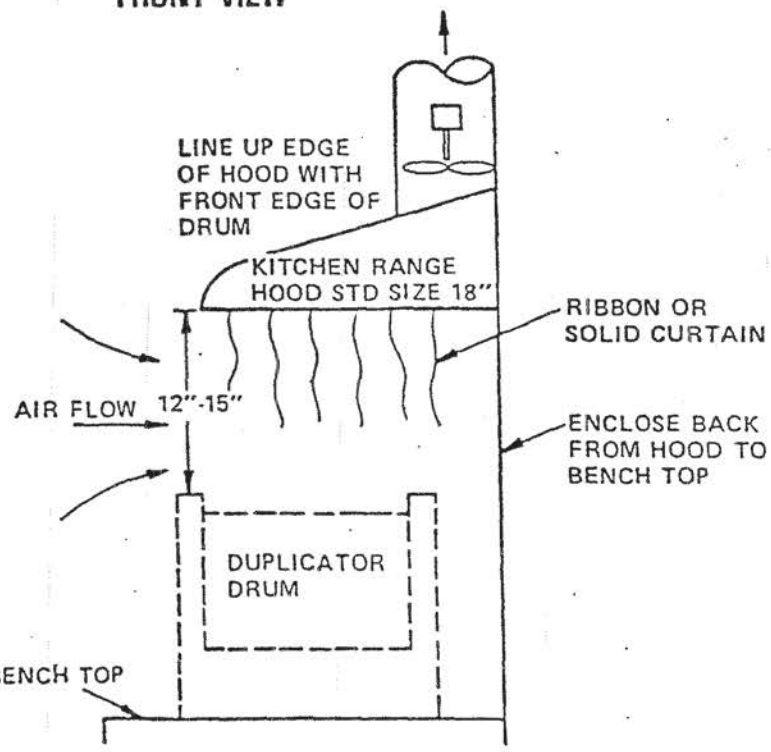
"DUPLICATING MACHINE EXHAUST"

–ALTERNATE METHOD–
KITCHEN RANGE TYPE HOOD
WITH GOOD ENCLOSURE



FRONT VIEW

EXH. VOL
400 CFM
MINIMUM



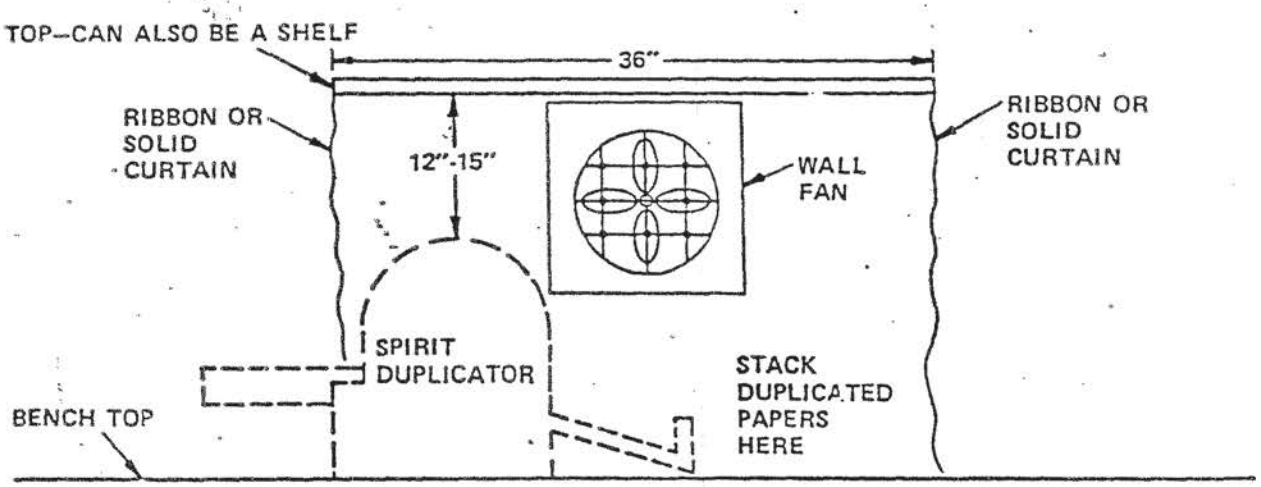
END VIEW

NOTES:
–PROVIDE FOR MAKE-UP AIR EG. VENTS IN DOOR

–LOCAL CODES MAY PROHIBIT EXHAUSTING THROUGH WINDOW PANES

"DUPLICATING MACHINE EXHAUST"

–ALTERNATE METHOD–
WALL FAN WITH GOOD ENCLOSURE



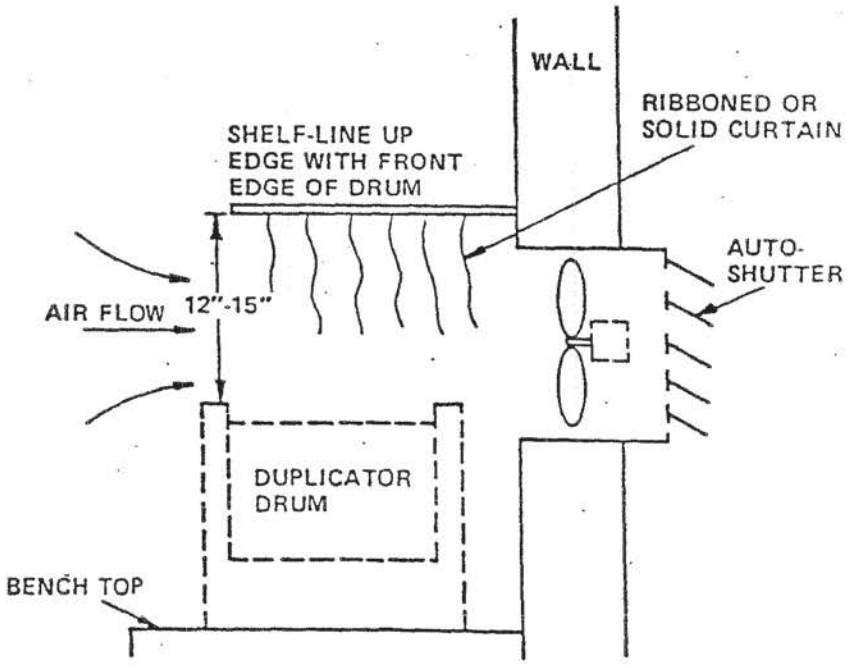
FRONT VIEW

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