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 85-052-1623
ALASKA NATIVE HOSPITAL
ANCHORAGE, ALASKA

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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ALASKA NATIVE HOSPITAL
ANCHORAGE, ALASKA

NIOSH INVESTIGATOR
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I SUMMARY

In November 1984, the National Institute for Occupational Safety and Health (NIOSH) was requested by the Indian Health Service, to evaluate the employees' exposures to formaldehyde, ethyl alcohol and xylene in the histology laboratory at the Alaska Native Hospital.

On November 28 and 29, the NIOSH investigator collected three formaldehyde, three ethyl alcohol and three xylene air samples to determine the workers' exposures to these substances. The employees were interviewed regarding current and past adverse health effects. Additional formaldehyde samples were collected on March 11 and 13, 1985.

The pathologist's exposures to formaldehyde vapors while conducting gross tissue examinations on four days were 0.50, 0.55, 0.58 and 1.23 ppm. The pathologist also was exposed to 8.2 ppm of ethyl alcohol and 0.5 ppm xylene. The technician was exposed to 3.9 ppm xylene. The general air in room 1W5 contained 9.6 ppm ethyl alcohol, 1.3 ppm xylene and 0.04 ppm formaldehyde. During tissue examination the formaldehyde concentrations were <0.15 and 0.81 ppm. The technician or any other person in this room would have been exposed to those concentrations.

The pathologist stated that her eyes often teared and were irritated.

On the basis of the data collected for this investigation, NIOSH determined that the pathologist's exposure to formaldehyde is potentially toxic. This is based on 1) sample results that showed formaldehyde exposures of 0.50, 0.51, 0.58 and 1.23 ppm during gross tissue examination on four days; and 2) the 1981 NIOSH position that formaldehyde is a potential carcinogen and should be controlled to the lowest feasible level. The technician's and pathologist's exposures to ethyl alcohol and xylene are not considered toxic as used or found. Recommendations involving exhaust ventilation and work practices are included in Section VIII.

KEY WORDS: SIC 8071 (Medical Laboratories) Formaldehyde, Ethyl Alcohol, Xylene, Ventilation.

II INTRODUCTION

In November 1984, the National Institute for Occupational Safety and Health (NIOSH) was requested by the Indian Health Service, Environmental Health Section to determine the employees' exposure to formaldehyde, ethyl alcohol and xylene in the histology laboratory at the Alaska Native Hospital.

The environmental survey was conducted on November 28-29, 1984. An interim report including the environmental results and recommendations was submitted to the Indian Health Service on March 8, 1985. Additional formaldehyde samples were collected on March 11 and 13, 1985.

III BACKGROUND

The Alaska Native Hospital is located in Anchorage, Alaska. This request involves only the histology laboratory. A technician works in the laboratory full time and a pathologist examines tissues from one to two hours a day. There are a number of chemicals used; however, formaldehyde, ethyl alcohol and xylene comprise the bulk of the usage.

Biological specimens are sent from surgery to the histology lab and are preserved in formaldehyde solution. Once a day, for approximately one to two hours, the pathologist conducts a gross examination of tissue. Portions of the tissue are removed for slide mounting. The specimens are replaced in formaldehyde for storage in the autopsy room. The removed tissue is mounted in a paraffin block, sliced with a microtome and mounted on a slide. The mounted slide then goes through a series of solutions where the stains are applied and the slides fixed. The cover slips are applied and the slides are complete. The technician prepares the slides and works in the histology laboratory the entire shift. The pathologist examines the tissue and later views the slides. The pathologist spends only a portion of her work in the histology laboratory. The pathologist also conducts autopsies.

The histology laboratory consists of two adjoining rooms that are 14 feet by 20 feet in size. Figure 1 is a layout of the laboratory. In the room is a 24" by 36" bench mounted hood where the tissue examination is performed. The opening is 20" by 32" or 4.44 square feet. There is an exhaust fan mounted in the top of the hood that is connected to a two inch plastic duct to the outside. The total exhaust volume was 40 cfm, which calculates to an average face velocity through the hood opening of 9 fpm. The average face velocity should be at least 100 fpm, and the total volume 450 cfm. With this volume, the duct should be at least 6 inches in diameter. The two inch pipe was not connected to the fitting that goes through the wall; hence it terminated in the room. There is a 14 inch propeller fan mounted in the window. The exhaust rate of this fan was not determined. Directly below the wall fan is an enclosure that contains an automatic tissue processor. There is an exhaust unit on the hood that contains an activated charcoal filter to remove the organic vapors. The exhausted air returns to the room. The charcoal filter becomes saturated with the solvents vapor. When this occurs, the vapors are passed through the filter and return back to the room. A better approach is to vent the exhaust of the unit directly to the outside atmosphere.

The pathologist removes the tissue to be examined from the formaldehyde solution which is then poured into the adjacent sink. The tissue is examined and sliced. The pathologist often puts her head directly over the tissue to examine it. Smoke tube tests showed that any vapors from the tissue pass directly through the breathing zone. Smoke tube tests also showed that the exhaust rate through the hood opening was so low that it would have no effect in capturing the formaldehyde vapors emitted from the tissue.

Xylene and ethyl alcohol are used in the preparation of the slide. The odors of formaldehyde, xylene and ethyl alcohol were prominent in the room.

IV EVALUATION DESIGN AND METHODS

The environmental survey consisted of measuring the employees' exposure to airborne vapors of formaldehyde, xylene and ethyl alcohol. Three breathing zone samples were collected for each of the contaminants. An additional four formaldehyde samples were collected on March 11 and 13, 1985. The employees were questioned regarding symptoms during the use of formaldehyde. Listed below are the sampling and analytical methods used in this evaluation.

Substance	Collection Method	Flow rate	Analytical Method (1)
Ethyl Alcohol	silica gel tubes	50 cc/min	NIOSH method 1400
Formaldehyde	impinger, 1% sodium Bisulfite	1.0 lpm	NIOSH method 3500
	XAD-2 formaldehyde tubes	50 cc/min	NIOSH method 354
Xylene	Charcoal tubes	50 cc/min	NIOSH method 1400

At the time the first sampling (samples 1-4) was conducted, XAD-2 formaldehyde tubes were not available to NIOSH. Ethyl alcohol and xylene produce a negative interference when formaldehyde is collected by sodium bisulfite; therefore, the formaldehyde concentrations measured could be slightly lower than actually present. Samples 5-8 were collected on March 11 and 13 using XAD-2 formaldehyde tubes. Ethyl alcohol and xylene do not produce negative interferences with the sampling method.

V EVALUATION CRITERIA

A. Environmental

The environmental criteria for exposure to toxic substances used in this evaluation are based on the NIOSH Criteria Documents, Recommended Standards for Occupational Exposure to Formaldehyde (2,3), to Xylene (4) and the U.S. Department of Labor, OSHA, and

Occupational Health Standards. The OSHA standard has a permissible 8 hour time weighted average formaldehyde exposure level of 3 ppm. In 1976, NIOSH recommended a permissible formaldehyde exposure level of 1 ppm for any 30 minute period. However, in 1981, based on research that indicated formaldehyde is a potential occupational carcinogen, NIOSH recommended that formaldehyde exposure be reduced to the lowest feasible limit.

The OSHA standard for ethyl alcohol is a time weighted average exposure of 1000 ppm and for xylene 100 ppm. In its criteria document for xylene, NIOSH also recommends a permissible time weighted average exposure of 100 ppm.

B. Toxicology

1. Formaldehyde (3)

"Formaldehyde has induced a rare form of nasal cancer in both Fischer 344 rats and in B6C3F1 mice as reported in an ongoing study by the CIIT. In a second study by NYU, formaldehyde appears to have induced the same type of cancer in Sprague-Dawley rats. Although humans and animals may differ in their susceptibility to specific chemical compounds, any substance that produces cancer in experimental animals should be considered a cancer risk to humans. Formaldehyde has also demonstrated mutagenic activity in several test systems. Although a substance cannot as yet be designated a potential occupational carcinogen based solely on results of mutagenicity tests, positive results in mutagenicity tests should be used as supporting evidence for identifying a potential occupational carcinogen.

Based on these results, NIOSH recommends that formaldehyde be handled in the workplace as a potential occupational carcinogen. Safe levels of exposure to carcinogens have not been demonstrated, but the probability of developing cancer should be reduced by decreasing exposure. An estimate of the extent of the cancer risk to workers exposed to various levels of formaldehyde at or below the current 3 ppm U.S. Department of Labor, OSHA Standard has not yet been determined. In the interim, NIOSH recommends that, as a prudent public health measure, engineering controls and stringent work practices be employed to reduce occupational exposure to the lowest feasible limit."

Other Health Effects - "The first signs or symptoms noticed on exposure to formaldehyde at concentrations ranging from 0.1 to 5 ppm are burning of the eyes, tearing (lacrimation), and general irritation to the upper respiratory passages. Higher exposures (10 to 20 ppm) may produce coughing, tightening in the chest, a sense of pressure in the head, and palpitation of the heart. Exposures at 50 - 100 ppm and above can cause serious injury such as collection of fluid in the lungs (pulmonary edema), inflammation of the lungs (Pneumonitis), or death.

In one report, five nurses working near an artificial kidney (hemodialysis) machine developed wheezing and recurrent episodes of productive cough. The attacks generally occurred in winter and often followed colds. The formaldehyde used to sterilize the machine was found to have caused this respiratory distress.

Dermatitis due to formaldehyde solutions or formaldehyde-containing resins is a well-recognized problem. After a few days of exposure, a worker may develop a sudden inflammatory (eczematous) reaction of the skin of the eyelids, face, neck, scrotum, and flexor surfaces of the arms. An eczematous reaction may also appear on the fingers, back of the hands, wrists, forearms, and parts of the body that are exposed to the rubbing of clothing. This sometimes occurs after years of repeated exposure."

2. Xylene (5)

"Repeated prolonged exposure to this vapor may produce conjunctivitis of the eyes and dryness of the mouth, throat and skin. Direct liquid contact may result in flaky or moderate dermatitis. Inhalation of the vapor may cause CNS excitation then depression, characterized by paresthesia, tremors, apprehension, impaired memory, weakness, nervous irritation, vertigo, headache, anorexia and nausea.

VI SAMPLE RESULTS

The results of the environmental samples are shown in Table 1. The formaldehyde results for samples 1-4 may be slightly low since the method of collection used passed the air through a bubbler that contained a one per cent sodium bisulfite solution. Ethyl alcohol and xylene both produce negative interferences when this method is used. The amount of interference is not known. There is a new method that does not exhibit these interferences; however, the sampling devices were not available at the time samples 1-4 were collected. Samples 5-8 were collected in March 1985 using these sampling devices.

An area sample was taken in room 1W5 during the work shift, but did not include the time that gross tissue examination was being conducted. The formaldehyde concentration was 0.04 ppm, the ethyl alcohol was 9.6 ppm and the xylene concentration was 1.3 ppm. The technician uses xylene and ethyl alcohol in slide preparation. The technician's breathing zone sample showed her exposure to xylene was 3.9 ppm. The pathologist's exposure to ethyl alcohol during gross tissue examination was 8.2 ppm and to xylene was 0.5 ppm. These are consistent with the area samples collected in the same room. The ethyl alcohol and xylene exposures are far below the respective criteria of 1000 ppm and 100 ppm for these

substances. Area samples were collected on March 11 and 13, 1985, for formaldehyde during the time gross tissue examination was being conducted. On March 11 there was a spill of about 50 ml of formalin solution. The formaldehyde concentration was 0.81 ppm. On March 11 it was <0.15 ppm.

The pathologist spends about one to one and a half hours a day conducting gross tissue examinations. On two consecutive days in November the formaldehyde concentrations were 0.58 and 0.50 ppm. In March 1985 two additional breathing zone samples showed 1.23 and 0.51 ppm. There was a small spill the time the 1.23 ppm sample was collected. Excluding this sample, the other 3 days were around 0.50 ppm. At times, the pathologist's nose is very close to the specimen and she stated that her eyes often tear and are irritated. NIOSH recommends that formaldehyde be considered a potential carcinogen and as a prudent public health measure, engineering controls and stringent work practices should be employed to reduce occupational exposures to the lowest feasible level. Recommendations to reduce the formaldehyde exposure are listed in Section VIII of this report.

VII CONCLUSIONS

On the basis of the data collected for this investigation, NIOSH determined that the pathologist's exposure to formaldehyde is potentially toxic. This is based on 1) sample results that showed the formaldehyde exposures of 0.50, 0.51, 0.58 and 1.23 ppm during gross tissue examination on four days; and 2) the 1981 NIOSH position that formaldehyde is a potential carcinogen and should be controlled to the lowest feasible level. The technician's and pathologist's exposures to ethyl alcohol and xylene are not considered toxic as used or found.

VIII RECOMMENDATIONS

1. A new local exhaust system should be designed and installed where the gross tissue examination is conducted. When installing a new hood or modifying the existing hood, the following items should be taken into consideration:

   - The face velocity of the air entering the hood should be between 100-150 fpm or, in other terms, 100-150 cfm per square foot of open face area.

   - Enclose the hood on all sides as much as possible. The object is to take all the available exhaust air and have it enter the hood over the point of work. This concept gives a greatly increased capture efficiency.

   - The hood can be constructed out of quarter inch clear acrylic plastic or shatter proof glass that permits light to enter and also provides visibility.

- Hinged lids can be provided to increase the versatility of the hood.

- The hood for the gross tissue examination could be patterned after the design shown in figure 2.

2. This hood or a second hood should cover the sink to prevent the formaldehyde vapors from entering the room when the specimen containers are emptied, and when new formaldehyde solution is added to the sample container.

3. Gross examination of tissue should be done in a hood where all the vapors are drawn away from the pathologist and into the hood with none of the vapors escaping into the room atmosphere.

4. The light source in the hood should be increased so the tissue can be examined without getting extremely close to it.

5. The exhaust air from the hood of the "automatic tissue processor" should exhaust directly outside and not through a charcoal filter and back into the room as it is difficult to tell when the vapors are no longer being absorbed by the charcoal and breakthrough has occurred. The exhaust rate should be 100-150 cfm/square foot of the hood opening.

6. The point outside the building where the exhaust from the hood terminates should not be near any windows or vents that can be opened.

7. Whenever air is removed from a room by local exhaust, that air must be replaced. If the local and PHS regulations permit, a louvered opening in the door to the hallway may be adequate.

8. All disposal of old specimens should be done in a sink that is provided with a well-designed, local exhaust ventilation system that will capture all vapors released.

9. The specimen being disposed of should be thoroughly rinsed with water and placed in a closed container or one that is under an exhaust hood.

10. Keep all containers of xylene and formaldehyde covered when not being used.

11. All specimen containers should be completely sealed so that no vapors are released while they are in storage on the shelf.

12. Employees should be informed as to the hazards of formaldehyde, its control, and appropriate personal hygiene procedures.

IX REFERENCES

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X AUTHORSHIP AND ACKNOWLEDGEMENTS

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XI DISTRIBUTION AND AVAILABILITY OF REPORT

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

1. Alaska Area Indian Health Service
2. The National Institute for Occupational Safety and Health (NIOSH) Region X.
3. The Occupational Safety and Health Administration (OSHA) Region X.

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table 1

FORMALDEHYDE, ETHYL ALCOHOL AND XYLENE
AIR CONCENTRATIONS

ALASKA NATIVE HOSPITAL
HISTOLOGY LABORATORY
ANCHORAGE, ALASKA
HETA 85-052

Job Description or Location	Date	Sample Number	Sample Time Minutes	Formaldehyde ppm	Ethyl Alcohol ppm	Xylene ppm
Area Sample Room 1W5-Histology Lab	11-28-84	1	335	0.04	9.6	1.3
BZ-Technician	11-28-84	2	325	---	---	3.9
BZ-Pathologist during Gross Tissue Exam.	11-28-84	3	72	0.58	8.2	0.5
BZ-Pathologist during Gross Tissue Exam	11-29-84	4	75	0:50	---	---
Area Sample Room 1W5-Histology Lab	3-11-85	5	82	0.81*	---	---
BZ-Pathologist during Gross Tissue Exam	3-11-85	6	34	1.23*	---	---
Area Sample Room 1W5-Histology Lab	3-13-85	7	179	<0.15	---	---
BZ-Pathologist during Gross Tissue Exam	3-13-85	8	51	0.55	---	---

*50 cc of formaldehyde was spilled during this sample period.

FIGURE 1
ROUGH LAYOUT OF HISTOLOGY LABORATORY

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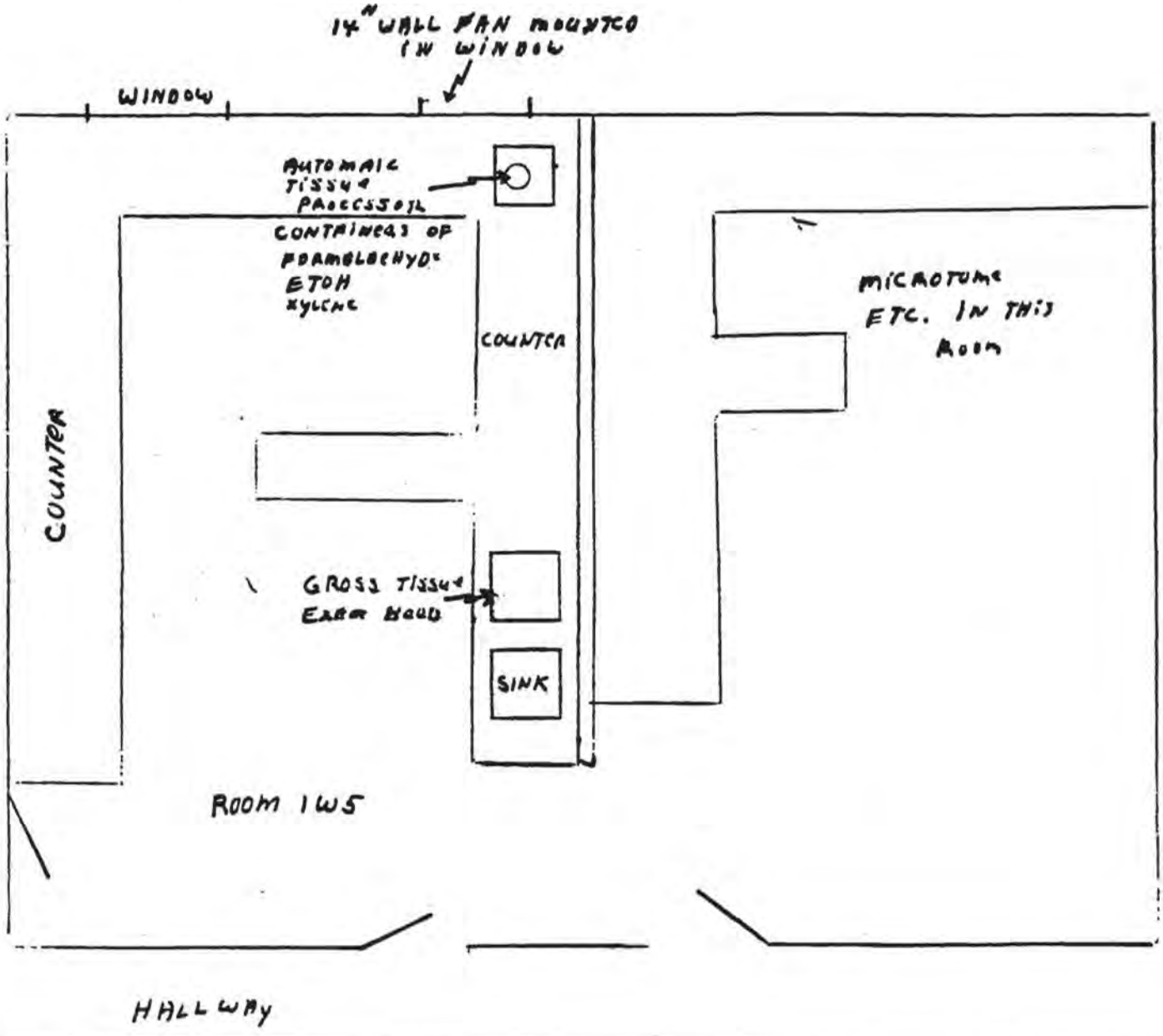

FIGURE 2
TYPE OF HOOD THAT CAN BE USED FOR GROSS TISSUE EXAMINATION

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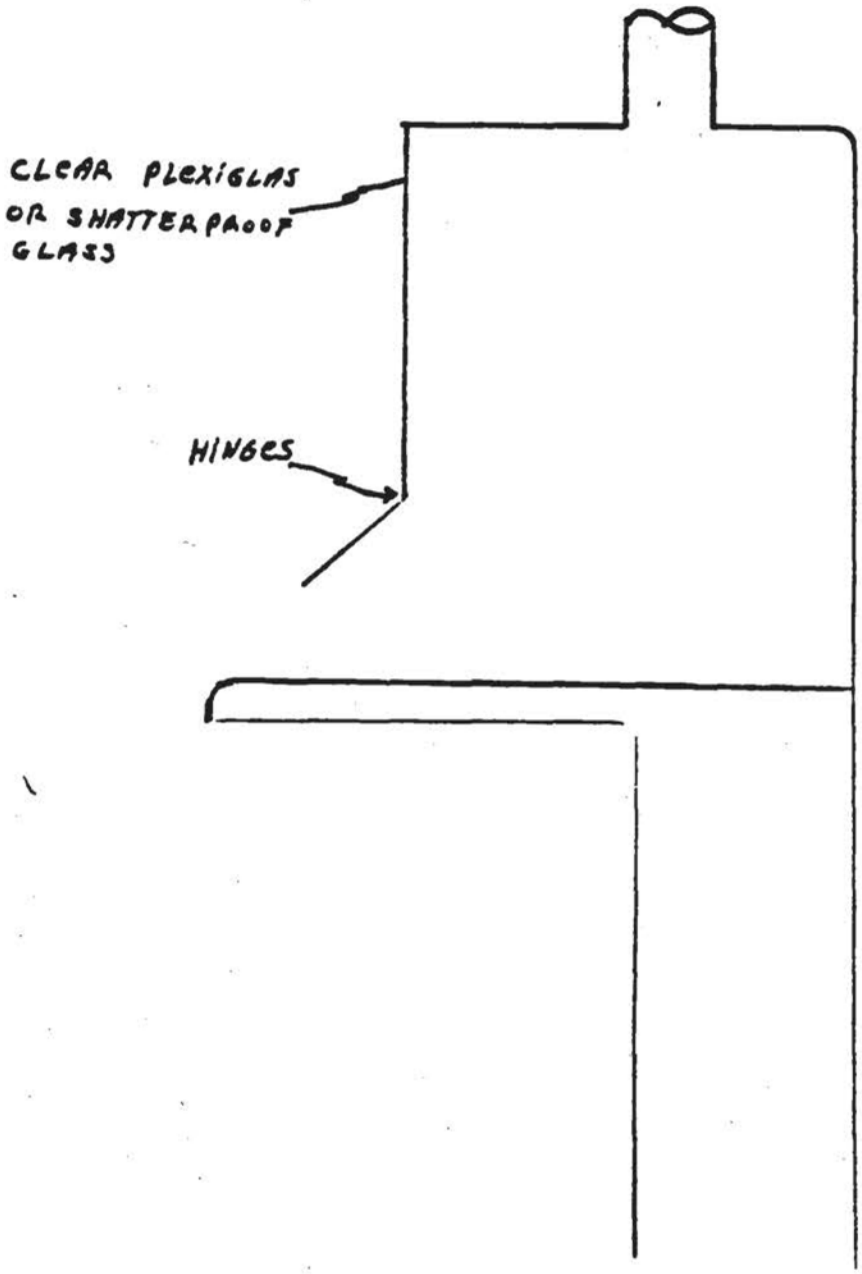

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