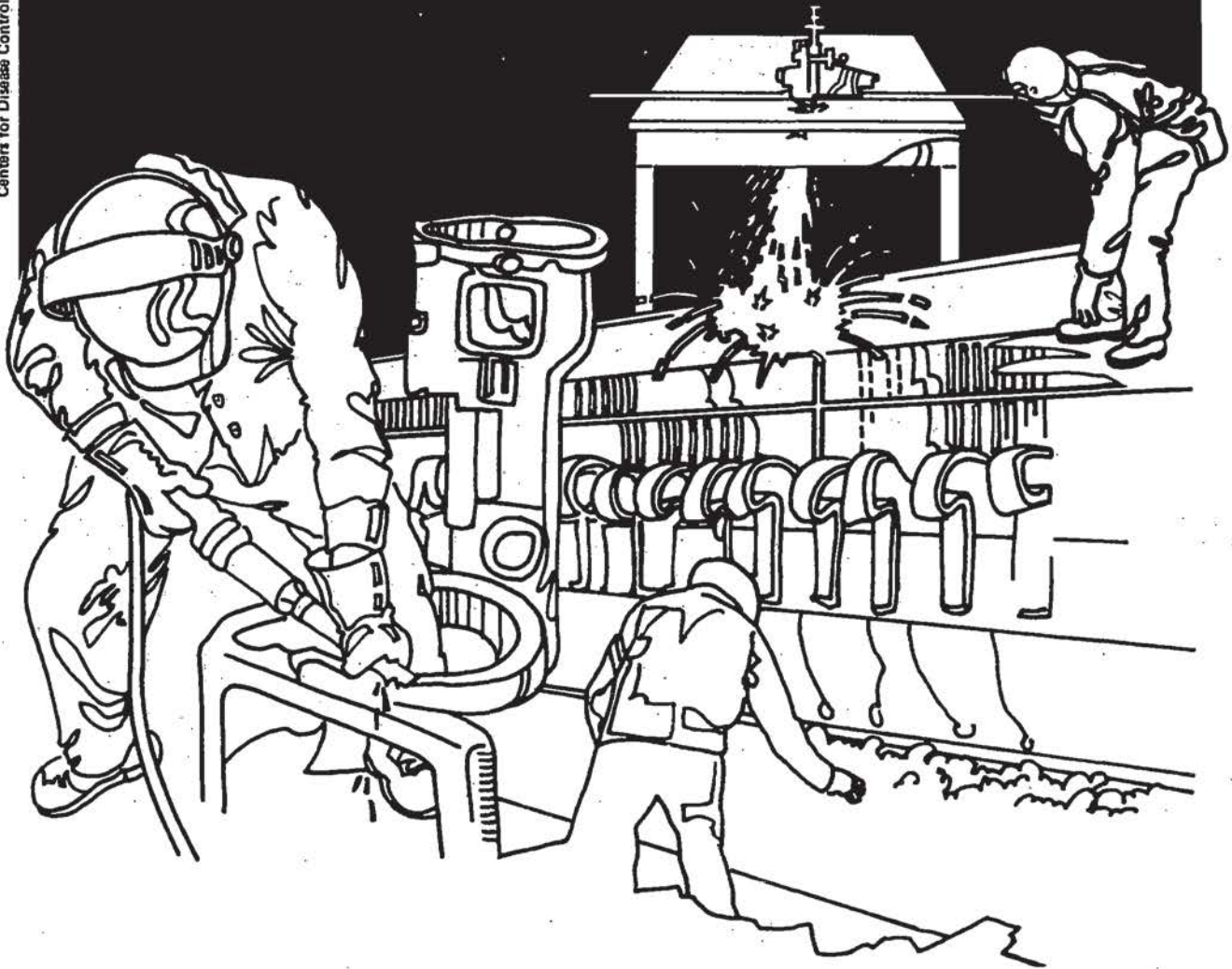


# NIOSH



## Health Hazard Evaluation Report

HETA 83-348-1397  
LITTLETON HISTORICAL MUSEUM  
LITTLETON, COLORADO

## 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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 83-348-1397  
DECEMBER 1983  
LITTLETON HISTORICAL MUSEUM  
LITTLETON, COLORADO

NIOSH INVESTIGATORS:  
Bobby J. Gunter, Ph.D

## I. SUMMARY

In September 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate ethylene oxide (EtO) exposures to employees of the Littleton Historical Museum, Littleton, Colorado during the sterilization of museum artifacts.

On September 15 and 16, 1983, NIOSH Hygienists performed an environmental evaluation. The environmental evaluation consisted of collecting breathing zone and general room air samples for measurement of exposure to EtO. All three employees were interviewed for symptoms related to workplace exposure.

Excessive exposures were found on seven (7) out of eight (8) air samples taken. Concentrations of EtO ranged from 0.01 mg/m<sup>3</sup> to 137 mg/m<sup>3</sup>. The average for the eight samples was 37.4 mg/m<sup>3</sup>. The OSHA standard is 90 mg/M<sup>3</sup> and NIOSH recommends the lowest feasible level. At the time of this evaluation there were leaks in the fumigation chamber which permitted overexposure to all employees.

The three employees who were interviewed reported no medical problems.

On the basis of the environmental data, NIOSH concluded that a health hazard existed from overexposure to ethylene oxide during the normal operation of the fumigation chamber. Recommendations for improving the work environment are included in this report.

KEYWORDS: SIC 8411 (fumigation of artifacts), Museums, Ethylene oxide

## II. INTRODUCTION

In September 1983, the National Institute for Occupational Safety and Health (NIOSH) received a request from employees of the Littleton Historical Museum, Littleton, Colorado, to evaluate a potential health hazard from exposures to EtO used to fumigate museum artifacts such as wool, statues, papers, clothing, and animal specimens.

On September 15 and 16, 1983, NIOSH conducted an environmental evaluation. Results of the environmental sampling were discussed with the requester on October 19, 1983.

## III. BACKGROUND

The Littleton Historical Museum has an ethylene oxide (EtO) fumigating chamber. This chamber is constructed of metal and is equipped with a recirculating and exhaust blower. The chamber is about 120 cubic feet in size. The chamber is filled with various specimens, closed, then approximately two (2) pounds of EtO (weighed with bathroom type scales) is allowed to enter the chamber. This gas is circulated for about twenty-four hours. After this procedure the chamber is purged for twenty minutes then opened and the specimens are removed.

## IV. ENVIRONMENTAL DESIGN AND METHODS

Eight samples were collected by drawing air through a charcoal tube containing 400 mg charcoal (front tube) and a 200 mg charcoal tube (back tube) placed in series. Samples were collected on the day that articles were placed in the fumigation chamber and the next day when the chamber was purged and then opened. These samples were taken on the workers and in close proximity of the fumigation chamber. The EtO was analyzed by gas chromatography and the analyte was confirmed by mass spectrometry.

## V. EVALUATION CRITERIA

### A. Environmental

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are

absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

Two sources of criteria used to assess the workroom concentrations of the chemicals were (1) the NIOSH criteria for a recommended standards, and (2) the Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910.1000), July 1980. NIOSH recommendations are lower than the corresponding OSHA standards and are usually based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8 to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Permissible Exposure Limits  
8-Hour Time-Weighted  
Exposure Basis

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Ethylene Oxide

lowest feasible level NIOSH  
90 mg/m<sup>3</sup> OSHA

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mg/m<sup>3</sup> = approximate milligrams of substance per cubic meter of air.

### B. Toxicology

Ethylene oxide (EtO) is known to be a mutagen in many animal tests. It has been implicated in the development of leukemia and is suspected to be a human carcinogen. There have been reports that exposure to EtO may cause an increases in cataract formation. (1). Based on NIOSH studies and consistent findings of others, evidence supports the conclusion that EtO is an mutagenic, carcinogen, and is capable of causing adverse reproductive effects.<sup>2</sup>

No safe level of exposure to a carcinogen has been demonstrated for humans. The possibility of developing cancer will be reduced by decreasing exposure. NIOSH has concluded that exposure to EtO should be reduced to the lowest possible level.

## VI. ENVIRONMENTAL RESULTS

On September 15 and 16, 1983, NIOSH investigators conducted an environmental evaluation. Five breathing zone and three general room air samples for measurement of EtO were collected. Sampling times were from 20 minutes to 90 minutes which included the entire time the employees were working with EtO. Values ranged from 0.01 to 137 mg/m<sup>3</sup>. Seven out of eight of the samples showed very high exposure. The highest was taken inside the chamber while workers were removing artifacts. Refer to Table I for all concentrations found.

All three employees working with the EtO on the day of this survey were interviewed. None had health problems which they thought were related to their work.

There was no dilution or exhaust ventilation in the room where the EtO fumigation chamber was located.

## VII. DISCUSSION AND CONCLUSIONS

Based on the environmental results, a health hazard exists at all times when the EtO fumigation chamber is in use. Due to the present type of ventilation system in use and the extreme toxicity of EtO, it would be very difficult to operate this system and not overexpose workers.

## VIII. RECOMMENDATIONS

1. Do not use fumigation chamber unless some qualified individual equips the chamber in such a way as to drastically reduce the EtO exposure. However, ventilating this machine is probably not feasible. Due to the low exposure limit of EtO there is no economically feasible method of ventilating this chamber.
2. An aeration chamber should be installed to hold articles during the post fumigation of gasing period.
3. Consult the guidelines for minimizing worker exposure to ethylene oxide as contained in Appendix I of the NIOSH Current Intelligence Bulletin.<sup>2</sup>

## IX. REFERENCES

1. Jay, M.D., Walter M.; Thomas R. Swift, M.D.; David S. Hull, M.D.; Possible Relationship of Ethylene Oxide Exposure to Cataract Formation., American Journal of Ophthalmology, 93:727-732, 1982.
2. NIOSH Current Intelligence Bulletin #35, Ethylene Oxide, May, 1981.

X. AUTHORSHIP AND ACKNOWLEDGMENTS

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XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. 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. Littleton Historical Museum
2. Colorado State Department of Health
3. U.S. Department of Labor/OSHA -- Region VIII.
4. NIOSH -- Region VIII.
5. Curator, Littleton Historical Museum

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

TABLE I  
BREATHING ZONE AND GENERAL ROOM AIR CONCENTRATIONS  
OF ETHYLENE OXIDE (EtO)

Littleton Historical Museum  
Littleton, Colorado

September 15 & 16, 1983

SAMPLE #	DATE	SAMPLE LOCATION	TYPE OF SAMPLE	SAMPLING TIME	mg/M <sub>3</sub> EtO
1	9/15/83	attached to worker	Personnel	8:40-10:10	9.53
2	9/15/83	attached to worker	Personnel	8:40-10:10	0.01
3	9/15/83	on fumigator	Area	8:40-10:10	31.5
4	9/16/83	attached to worker	Personnel	8:30-9:10	41.2
5	9/16/83	attached to worker	Personnel	8:30-9:10	3.14
6	9/16/83	attached to worker	Personnel	8:30-9:10	3.42
7	9/16/83	Inside fumigator	Area	8:50-9:10	137
8	9/16/83	Outside fumigator	Area	8:50-9:10	73

Evaluation Criteria  
Laboratory limit of Detection 1 nanogram/sample

\* LFL

\* Ethylene oxide is considered a carcinogen and a worker exposure should be reduced to the lowest feasible level.



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