

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

HEALTH HAZARD EVALUATION DETERMINATION

REPORT NO. HE 79-31-699

UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH  
MAUNA LOA OBSERVATORY  
HILO, HAWAII 96720

JUNE, 1980

I. SUMMARY

A health hazard evaluation (HHE) was conducted by the National Institute for Occupational Safety and Health (NIOSH) at the Mauna Loa Observatory, Hawaii on September 24-26, 1979. The requestor was concerned that workers may be periodically exposed to various contaminants when the volcano fumes. Personal breathing zone samples and area air samples were collected to determine concentrations of methyl chloride, methyl iodide, inorganic mercury, sulfur dioxide, sulfuric acid, hydrogen sulfide and various metals in the telescope control room and the telescope dome room.

Airborne concentrations of methyl iodide, mercury, sulfuric acid, trace metals and hydrogen sulfide were below the limits of detection. Atmospheric concentrations of methyl chloride ranged from 0.02 - 0.08 parts of substance per million parts of air (ppm) (Table I) and were well below the threshold limit value (TLV) of 50 ppm as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). The airborne concentrations of sulfur dioxide which ranged from .30-.50 ppm (Table II) were all below the NIOSH recommended criterion of 0.5 ppm with the exception of one sample which was at the recommended criteria.

Based upon environmental data collected during this survey, NIOSH determined that a health hazard exposure to methyl chloride, methyl iodide, inorganic mercury, sulfuric acid, hydrogen sulfide, sulfur dioxide and various metals at the Mauna Loa Observatory did not exist.

## II. INTRODUCTION

On December 11, 1978 the National Institute of Occupational Safety and Health received a request for a health hazard evaluation from an authorized employer representative at the University Corporation for Atmospheric Research. Several Hawaiian newspaper articles reported that contaminants such as methyl chloride and methyl iodide are being emanated from volcanoes around the world. Thus, the requestor became interested in learning whether the solar observers and engineers working at the Mauna Loa high-altitude observatory may be exposed to toxic chemicals which emanate from the Mauna Loa volcano just five miles away.\*

Another major concern, based on volcanologists predictions, was that the Mauna Loa volcano was anticipated to erupt, hence long term fissure fuming would occur. The station manager stated that the workers occasionally smelled sulfur odors and/or experienced a slight eye irritation whenever the volcano fumed and downslope winds were present. (The last volcanic eruption occurred in 1975. Also, the downslope wind typically carries the sulfur fumes towards the observatory during the hours of 5:00 PM - 8:00 AM.)

## III. BACKGROUND

The Mauna Loa Observatory has been at its present location since December, 1965. The observatory was undergoing major renovation when the HHE request was submitted to NIOSH in December, 1978; therefore, the initial survey was delayed until all construction was complete.

Two shifts of personnel, consisting of two solar observers and one engineer, conduct solar monitoring during one of two shifts (5:30 AM - 12:00 PM or 11:30 AM - 6:00 PM) from the telescope control room (10' x 16') and occasionally from the telescope dome. The control room has general air conditioning for the purpose of keeping the monitoring equipment cool.

## IV. EVALUATION DESIGN AND METHODS

Environmental air sampling (Personal and Area) for methyl chloride, methyl iodide, mercury, sulfuric acid, hydrogen sulfide and selenium was collected from two rooms: the control room and the telescope dome, using a direct reading instrument, gas detector tubes, charcoal tubes and filters. Conditions at the Mauna Loa Observatory do not vary from hour to hour unless fuming occurs, so any chosen period of time is considered to be representative of exposure for the full shift (about 6 hours). Thus short term (2-2 1/2 hr.) high volume samples were collected.

- a. Methyl Chloride and Methyl Iodide - Vacuum pumps were used to draw a known volume of air through a 150 milligram (mg) charcoal tube according to the NIOSH sampling data sheets.<sup>1,2</sup> Separate charcoal tubes were collected for

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\*Section 20(a) (6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a) (6) authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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.

methyl chloride and methyl iodide and analyzed by NIOSH method S99 (modified)<sup>3</sup> and S98 (modified)<sup>4</sup> respectively. The limits of detection were calculated to be 0.02 mg for methyl chloride and methyl iodide.

- b. Mercury - Air sampling for inorganic mercury was conducted using a direct reading mercury vapor analyzer "sniffer" model MV-2.\* The mercury "sniffer" has a dual range which measures from 0.01 - 1.0 milligrams per cubic meter of air ( $\text{mg}/\text{m}^3$ ), and provides mercury vapor concentrations instantaneously.
- c. Sulfuric Acid - Vacuum pumps were used to draw a known volume of air through a three piece 37 millimeter (mm) cellulose membrane filter (type AA); after which the filter was removed from its cassette and sealed in a vial. The filter was later analyzed for sulfate ions by ion chromatography with a Dionex<sup>®</sup> Model 10 ion chromatograph. The filters were placed in scintillation vials to which 10 milliliters (ml) of deionized water was added. Samples were allowed to stand overnight, sonicated for 10 minutes and injected into the ion chromatograph. The limit of detection was calculated to be 10 micrograms.
- d. Hydrogen Sulfide - Several NIOSH certified gas detector tubes (Draeger<sup>®</sup>) were used to measure workers exposure (range of detection 1-20 ppm) in the control room and the telescope dome. In order for a gas detector tube to be certified, it must have + 35 percent accuracy at one-half the exposure limit and + 25 percent accuracy at 1-5 times the exposure limit. Further explanation of the regulations regarding gas detector tubes appear in the Code of Federal Regulations (CFR) as Title 42 CFR Part 84 under the authority of the Occupational Safety and Health Act of 1970.
- e. Selenium and Other Metals - Vacuum pumps were used to draw a known volume of air through a two piece 37-mm, 0.8 micrometer ( $\mu$ ) DM-800 filters. The filters were ashed using nitric acid, and the resulting solutions were analyzed for trace metals by inductively coupled argon plasma - atomic emission spectroscopy. The limit of detection for these samples was 0.5 micrograms per sample.
- f. Sulfur Dioxide - Vacuum pumps were used to draw a known volume of air through a 150 mg charcoal tube impregnated with potassium hydroxide. These charcoal tubes were analyzed for sulfur dioxide by ion chromatography with a Dionex<sup>®</sup> Model 10 Ion Chromatograph using a method "Determination of Sulfur Dioxide by Absorption on a Solid Sorbent Followed by Ion Chromatographic Analysis" developed by David L. Smith, Walter S. Kim and Richard E. Kupel of NIOSH, Measurement Support Services. The limit of detection was 1.0 micrograms.

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\*Mention of Company name or product does not constitute endorsement by the National Institute for Occupational Safety and Health.

V. EVALUATION CRITERIA

A. Environmental

There are several criteria used to evaluate the toxic air contaminants of an employee's work environment: (1) NIOSH Criteria Documents for a Recommended Occupational Health Standard, (2) Proposed and Recommended Threshold Limit Values (TLV's) as suggested by the American Conference of Governmental Industrial Hygienists (ACGIH), 1979, (3) The Federal Occupational Safety and Health Administration Standards (OSHA). Hawaii enforces the Federal-OSHA standards through the Division of Occupational Safety and Health (DOSHS).

The concentration of each contaminant is based upon current state of knowledge concerning toxicity of these substances. The criteria are designed to allow an occupational exposure for up to a 10-hour work day, 40-hour work week as a time weighted average (TWA) over a normal lifetime without the worker experiencing adverse health effects at or below the TWA.

There are some airborne contaminants for which this TWA is inadequate; consequently, the substance may be preceded by the letter "C". This letter indicates a ceiling value for a sampling interval of 30 minutes or less. The ceiling value is used to identify hazardous substances which are fast acting, and it should never be exceeded.

The airborne substances monitored at the Mauna Loa Observatory have been tabulated, footnoted and compared to the Hawaii-OSHA standard.

TABLE A  
TIME WEIGHTED AVERAGE (TWA)

<u>Substance</u>	<u>8-Hour</u>	<u>10-Hour</u>	<u>Ceiling Value</u>	<u>Minutes</u>
Methyl Chloride <sup>1</sup>	50 ppm <sup>a</sup>		100 ppm	15
Methyl Iodide <sup>2</sup>	2 ppm			
Mercury, Inorganic		0.05 mg/m <sup>3</sup> b		
Sulfuric Acid <sup>4</sup>		1.0 mg/m <sup>3</sup>		
Hydrogen Sulfide <sup>5</sup>			10 ppm	10
Selenium <sup>6</sup>	0.2 mg/m <sup>3</sup>			

a) ppm - parts of a vapor or gas per million parts of contaminated air.

b) mg/m<sup>3</sup> - milligrams of contaminant per cubic meter of air.

1. Proposed TLV by ACGIH (1979). The Hawaii DOSH standard is 100 ppm as an 8-hour TWA.
2. Proposed TLV recommended by ACGIH (1979). The Hawaii Dosh standard is 5 ppm as an 8-hour TWA.
3. NIOSH Criteria Document (1973). The Hawaii DOSH standard is .1 mg/m<sup>3</sup> as a ceiling concentration
4. NIOSH Criteria Document (1974). The Hawaii DOSH standard is 1.0 mg/m<sup>3</sup>.
5. NIOSH Criteria Document (1977). The Hawaii DOSH standard is 20 ppm as the ceiling concentration.
6. The TLV recommended by the ACGIH (1979). The Hawaii DOSH standard is 0.2 mg/m<sup>3</sup>.

## B. Toxicological Effects

Since the chemicals evaluated were well below the evaluation criteria used, a comprehensive toxicological discussion is not warranted. However, a table has been prepared with a brief toxicological review of each chemical detected during environmental air sampling.

TABLE B  
CHEMICAL TOXICITY DATA

<u>Substance</u>	<u>Primary Health Effects</u>
Methyl Chloride	Percutaneous absorption may produce signs and symptoms of chronic exposure which include staggering gait, difficulty in speech, nausea, headache, dizziness and blurred vision. Acute symptoms are similar to chronic exposure except that the latency period is shorter and the effects are more severe.
Sulfur Dioxide (SO <sub>2</sub> )	Gaseous SO <sub>2</sub> is irritating to mucous membranes of the upper respiratory tract. Chronic effects include rhinitis, dryness of the throat, and cough.

## VI. RESULTS AND DISCUSSION

No measureable levels of methyl iodide, mercury, sulfuric acid, hydrogen sulfide, selenium or other metals were detected using the appropriate sampling methods.

Two airborne contaminants (methyl chloride and sulfur dioxide) were identified during this survey. The concentrations of methyl chloride which ranged from 0.02 - 0.08 ppm were well below the threshold limit value recommended by the ACGIH.

The airborne concentrations of sulfur dioxide ranged from 0.30 - 0.50 ppm. One sample was at the NIOSH recommended criterion of 0.50 ppm. However, based on the number of hours the personnel work at the observatory site and the uniqueness of this uncontrolled periodic exposure, a health hazard condition did not exist at the time of this survey.

Employees were queried whether or not they experienced discomfort or irritation when working at the observatory. Only one worker indicated that he had experienced mild eye irritation several years ago when the volcano was

fuming. No other incidents were reported.

It is impossible to predict future exposure to effluents, because exposures are dependent on volcanic fuming and downslope winds. The National Oceanographic and Atmospheric Administration (NOAA) is performing meteorological monitoring at their laboratory which is located at the Mauna Loa Observatory site. It is doubtful that worker exposures will exceed the NIOSH time weighted average criteria, unless volcanic fuming occurs.

VII - RECOMMENDATIONS

1. Should volcanic fuming occur, it is recommended that NOAA's air monitoring data be obtained to determine potential worker exposure.
2. If worker exposures become excessive either an evacuation plan should be implemented or employees should be issued proper respiratory protection.
3. A respiratory program should include proper equipment selection, worker fit testing, periodic training and equipment maintenance as described in OSHA requirements outlined in 29 CFR Part 1910.134.

VIII - AUTHORSHIP AND ACKNOWLEDGEMENTS

REPORT PREPARED BY:

Pierre L. Belanger  
Industrial Hygienist  
NIOSH - Region IX  
San Francisco, CA

ORIGINATING OFFICE:

Hazards Evaluations and Technical  
Assistance Branch  
Cincinnati, Ohio

ACKNOWLEDGEMENTS:

Analytical Laboratory Services  
Measurement Support Branch  
Cincinnati, Ohio

REPORT TYPED BY:

Noel Ryan  
NIOSH, Region IX

IX - REFERENCES

1. NIOSH Manual of Sampling Data Sheets, DHEW (NIOSH) Publication No. 77-158
2. NIOSH Manual of Sampling Data Sheets, Supplement to 1977 ed., DHEW (NIOSH) Publication No. 78-189.
3. NIOSH Manual of Analytical Methods, DHEW (NIOSH) Publication No. 78-175.
4. NIOSH Manual of Analytical Methods, DHEW (NIOSH) Publication No. 77-157B.
5. American Conference of Governmental Industrial Hygienists: TLV's - Threshold Limit Values of Chemical Substances and Physical Agents in the Workroom Air, Ed 3, 1971, Cincinnati, ACGIH, 1976.
6. Patty, F.A. Industrial Hygiene and Toxicology, Second Revision Ed., Vol II Interscience Publishers, New York, 1976.
7. Criteria for a Recommended Standard...Occupational Exposure to Sulfur Dioxide, 1974 and Revised Recommendations, 1978.
8. Criteria for a Recommended Standard...Occupational Exposure to Sulfuric Acid, (1974) NIOSH Pub. No. 74-128.
9. Criteria for a Recommended Standard...Occupational Exposure to Inorganic Mercury, (1973) NIOSH Pub. No. 73-11024.
10. Criteria for a Recommended Standard...Occupational Exposure to Hydrogen Sulfide, (1977), NIOSH Pub. No. 77-158.

X. - DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of the 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 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. University Corporation for Atmospheric Research
2. U. S. Department of Labor - Region IX.
3. Hawaii - Division of Occupational Safety and Health.

For the purpose of informing the approximately eight "affected employees," the employer shall promptly "post" for a period of 30 calendar days, this Determination Report in a prominent place(s) near where exposed employees work.

TABLE I

Area Samples Collected on Charcoal  
Tubes for Analysis of Methyl Chloride  
Mauna Loa Observatory  
Hilo, Hawaii

September 1979

<u>Date</u>	<u>Sample Number</u>	<u>Location</u>	<u>Sample Volume (liters)</u>	<u>Period</u>	<u>Methyl Chloride Concentration<sup>1</sup> - PPM</u>
9/24	1	Telescope Control Room	70	1240-1450	0.05
9/25	3	Telescope Control Room	81	0930-1200	0.08
9/25	7	Telescope Control Room	87	1200-1440	0.04
9/26	9	Telescope Dome	65	1030-1230	0.02
9/26	11	Telescope Control Room	57	1230-1415	0.05

1. PPM - Parts of a gas or vapor per million parts of contaminated air by volume.

Limit of Detection - 0.002 milligram

Federal OSHA Standard - 100 ppm

TABLE II

Personal and Area Samples Collected  
for Sulfur Dioxide

Mauna Loa Observatory  
Hilo, Hawaii

September, 1979

<u>Date</u>	<u>Sample Number</u>	<u>Type Sample</u>	<u>Location</u>	<u>Sample Volume (liters)</u>	<u>Period</u>	<u>Sulfur Dioxide Concentration - PPM<sup>1</sup></u>
9/24	S-1	A <sup>2</sup>	Telescope Control Room	21	1305-1450	0.44
9/25	S-2	P <sup>3</sup>	Telescope Control Room	28	0920-1430	0.42
9/25	S-3	P	Control Room and Dome	37	0920-1425	0.30
9/26	S-4	P	Telescope Control Room	25	1030-1445	0.42
9/26	S-5	P	Telescope Control Room	22	1045-1430	0.50

1. PPM - Parts of a gas or vapor per million parts of contaminated air by volume

2. A - Area samples

3. P - Personal Samples

Limit of Detection - 10 Microgram  
NIOSH Criteria - 0.5 ppm