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

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 78-54-518

FMC CORPORATION
BROOMFIELD, COLORADO

AUGUST 1978

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) on April 11, 1978, at the FMC Corporation in Broomfield, Colorado. At the time of this evaluation, breathing zone air samples were taken for Freon-11^{R}, hydrofluoric acid, nitric acid, and acetone. All workers using these chemicals were interviewed using the NIOSH Health Hazard Employee Interview form. Based on the extremely low concentrations of air contaminants and the absence of either complaints or symptoms from all workers, a health hazard did not exist at the time of this evaluation.

II. DISTRIBUTION AND AVAILABILITY

Copies of this determination report are currently available upon request from NIOSH, Division of Technical Services, Information 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. FMC Corporation
2. U.S. Department of Labor/OSHA - Region VIII
3. NIOSH - Region VIII

For the purpose of informing approximately 25 affected employees, a copy of this report shall be posted in a prominent place accessible to the workers for a period of 30 calendar days.

III. INTRODUCTION

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 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.

NIOSH received such a request from plant management at FMC Corporation, Broomfield, Colorado, to evaluate the potential hazards associated with exposures to Freon-11^{R}, hydrofluoric acid, nitric acid, and acetone during the etching and polishing of component parts to be used in assembly of semi-conductors.

IV. HEALTH HAZARD EVALUATION

A. Process Evaluated

The FMC Corporation, Broomfield, Colorado, produces semi-conductors. There are several processes involved in the preparation of the conductors. Processes evaluated during this evaluation included:

Etching and Polishing Areas--in this area small parts are etched with hydrochloric acid and nitric acid and are cleaned with acetone. All employees were well informed regarding the proper use of these acids and solvents. All were being used with the proper precautions and under well-ventilated hoods.

Polishing, Mounting, and Assembling Areas--Freon-11^{R} and nitric acid were used throughout this area during the assembly of semi-conductors. Proper protective clothing and proper use of these substances was being practiced at the time of this evaluation. A health hazard evaluation was performed by NIOSH at this facility in 1976, HHE Report No. 76-101-376. Both health hazard evaluations were requested by plant management and covered the same work areas. Therefore certain areas were not monitored that had been found free of contaminants during the 1976 evaluation. This Health Hazard Evaluation request, 78-54, was directed at exposures related to polishing, etching, and coating. Chemicals used in this area consisted of Freon-11^{R}, hydrofluoric acid, nitric acid, and acetone.

B. Evaluation Design and Methods

There was a total of 10 workers involved in this determination. Breathing zone air samples were taken to determine the concentrations of Freon-11^{R}, hydrofluoric acid, nitric acid, and acetone during the etching and coating of components and parts to be used in assembling semi-conductors.

Freon-11[R] and acetone samples were collected on charcoal tubes using vacuum pumps operated at 0.05 liters per minute and were analyzed by gas chromotography according to NIOSH method #127.

Hydrofluoric and nitric acid samples were collected in 0.1 Normal sodium hydroxide using vacuum pumps operated at 1.5 liters per minute. Hydrofluoric acid samples were analyzed using a specific ion electrode. Nitric acid samples were analyzed colorimetrically using a standard method as outlined in Standard Methods for the Examination of Water and Wastewater, 14th edition, 1976.

C. Criteria for Assessing Workroom Concentrations of Air Contaminants

Three sources of criteria generally used to assess workroom concentrations of air contaminants are: (1) the NIOSH criteria for recommended standards; (2) recommended threshold limit values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienist (ACGIH)(1977); and (3) Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910.1000), January 1976. NIOSH criteria and ACGIH TLV's represent the most recent and relevant recommendations and are given prominence in this report.

	Permissible Exposures 8-Hour Time-Weighted Exposure Basis (mg/M^3)		
Substance	NIOSH Criteria	TLV's	Current OSHA Standard
Freon-11[R]	-	5600	5600
Hydrofluoric Acid	2.5^C *	2	2
Nitric Acid	5	5	5
Acetone	-	2400	2400

* NIOSH Recommended Ceiling Value 5.0 mg/M^3 - 15 minutes.

Occupational health standards are established at levels designed to protect individuals occupationally exposed to individual toxic substances on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

D. Toxicology

Freon-11[R]--mild central nervous system depression may occur in cases of exposure to very high concentrations of Freons. Symptoms from acute exposure may manifest themselves in occasional tremor and incoordination.[1] Freon-11[R] exposures often cause a shallow rapid pulse. Liver and kidney damage have been reported.[2]

Hydrofluoric Acid--causes intolerable sensations to the nose, throat, eyes, and mouth. It has a marked effect on the skin and underlying tissue. On the skin it causes chemical burns, while subcutaneously its destructive action causes necrosis of tissue and blood vessels and may even penetrate to the bone. It is a potent protoplasmic poison. Inhalation of hydrofluoric acid vapors may cause lung edema which can lead to death.[3]

Nitric Acid--chronic exposure to nitric acid may result in bronchitis, and high exposures may result in a chemical pneumonitis. Vapors from nitric acid also erode the teeth. The irritating effect of nitric acid is similar to all strong acids. It irritates the body upon contact. Exposures of 5 mg/M^3 should protect the body from any physiological damage.[4]

Acetone--maintaining worker exposure below 2400 mg/M^3 will prevent the narcotic action and eliminate any organic injury. The major problem when using acetone is its volatility. It should be considered as one of the least toxic of the common solvents but presents an extremely high fire risk.[5]

E. Evaluation Results

Breathing zone air samples for Freon-11^R, hydrofluoric acid, nitric acid, and acetone were all well within the most recent evaluation criteria. Confidential employee interviews showed neither complaints nor symptoms. This plant was very clean from an occupational health or industrial hygiene viewpoint. The relatively high exposure to Freon-11^R found during the survey performed in 1976 had been corrected.

F. Recommendations

1. Since hydrofluoric acid is used in this facility, adequate protection should be provided for workers who accidentally become exposed. Magnesium oxide ointment should be kept in the dispensary to treat the hydrofluoric acid burns, since the magnesium oxide will precipitate the fluoride ion and prevent nerve and blood vessel damage.

2. All hoods should be checked frequently to ensure proper amount of air flow.

V. REFERENCES

1. Industrial Hygiene and Toxicology, second edition, Frank Patty (editor), Interscience Publishers, 1967, Vol. II, page 1035.

2. Occupational Disease - A Guide to Their Recognition, revised edition, June 1977, U.S.G.P.O., Washington, D.C. DHEW (NIOSH) Publication No. 77-181, page 203.

3. NIOSH Criteria for a Recommended Standard . . . Occupational Exposure to Hydrogen Fluoride, HEW Publication No. (NIOSH) 76-143, 1976.

4. American Conference of Governmental Industrial Hygienists: Documentation of the Threshold Limit Values for Substances in Workroom Air, third edition, 1971, page 181.

5. Ibid, page 3.

VI. AUTHORSHIP

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TABLE I

BREATHING ZONE AIR CONCENTRATIONS OF
FREON-11[R]

FMC Corporation
April 11, 1978

Sample Number	Location	Job Classification	Time of Sample	Freon-11[R] mg/M[3]
01	Phosphate Etch	Screen Print	8:04 - 10:00	13
02	Assembly	Assembler	7:59 - 9:45	*
03	Assembly	Assembler	7:56 - 9:48	2
05	Assembly	Assembler	9:46 - 11:00	1036
06	Assembly	Assembler	9:55 - 11:05	*
07	Assembly	Assembler	9:49 - 11:07	*
08	Assembly	Assembler	9:52 - 11:15	1.0
		EVALUATION CRITERIA		7600
		LABORATORY LIMIT OF DETECTION		0.01 mg/sample

* Below 0.01 mg/sample

TABLE II

BREATHING ZONE AIR CONCENTRATIONS OF
HYDROFLUORIC ACID (HF)

FMC Corporation
April 11, 1978

Sample Number	Location	Job Classification	Time of Sample	HF mg/M^3
1	Polish Etch	Etcher	7:30 - 12:00	0.005
2	Oxidation-Etching	Oxidation	7:46 - 1:08	*
3	Etching	Etcher	7:45 - 1:00	*
		EVALUATION CRITERIA		2
		LABORATORY LIMIT OF DETECTION		0.002 mg/sample

* Below 0.002 mg/sample

TABLE III

BREATHING ZONE AIR CONCENTRATIONS OF
NITRIC ACID (HNO_3)

FMC Corporation
April 11, 1978

Sample Number	Location	Job Classification	Time of Sample	Nitric Acid mg/M^3
4	Etch	Etcher	7:45 - 1:00	0.004
5	Etch	Etcher	7:45 - 1:00	0.006
		EVALUATION CRITERIA		5
		LABORATORY LIMIT OF DETECTION		.0002 mg/sample

TABLE IV

BREATHING ZONE AIR CONCENTRATIONS OF
ACETONE

FMC Corporation
April 11, 1978

Sample Number	Location	Job Classification	Time of Sample	Acetone mg/M^3
4	Assembly	Assembler	8:20 - 10:40	*
7	Assembly	Assembler	8:20 - 10:40	*
			EVALUATION CRITERIA	2400
			LABORATORY LIMIT OF DETECTION	0.01 mg/sample

*Below 0.01 mg/sample