U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 75-5-238

GENERAL ELECTRIC COPRORATION
EVENDALE, OHIO

DECEMBER 1975

I. TOXICITY DETERMINATION

It has been determined that the exposure of the machine operators and maintenance personnel of the Electrochemical Drilling Unit to mist of sulfuric acid and aqueous hydrogen chloride were not toxic at the concentrations measured on April 30 and May 1, 1975. However, a toxic exposure may exist, manifested by severe irritation to conjunctiva and the epithelium of the upper respiratory tract, during the occasional episodes of acid mist exposure resulting from ruptured electrolyte transporting lines or ventilation duct displacement during pressure vessel depressurization.

This determination is based on measured concentrations of sulfuric acid and aqueous hydrogen chloride; interviews with exposed employees; observation of work practices; and available literature on the toxicity of the substances investigated.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) General Electric Corporation, Evendale, Ohio
b) Authorized Representatives of Employees
c) U.S. Department of Labor - Region V
d) NIOSH Regional Consultant - Region V

For purposes of informing the approximately 90 "affected employees" the employer will promptly "post" the Determination Report in a prominent place(s) near where affected employees work 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.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of employees regarding exposure of production workers to sulfuric acid mist and aqueous hydrogen chloride (hereafter referred to as hydrochloric acid) in the electrochemical drilling operations at the General Electric Corporation plant in Evendale, Ohio. The request alleged that the symptoms experienced by the workers were "burning of eyes, throat and skin irritation, congestion of the lungs, loss of breath and headache".

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

The Electrochemical Drilling Unit has been in operation for about 10 years. The unit is principally composed of Electro-Stream and Stem machinery used for drilling air-cooling and weight reduction holes in turbo jet engine components. The Electro-Stream operations drill exclusively circular holes, while a variety of cross-sectional hole shapes are possible by the Stem process.

The components to be drilled are mounted on the worktable of the drilling machine. The controls are set and the drilling proceeds automatically in a ventilated enclosure. The holes are generated by controlled deplating of an electrically conductive workpiece in an electrolytic cell, i.e. an acid electrolyte is forced through an electrode under pressure impinging on a workpiece deplating the metal ions, thus drilling a hole.

There are 44 Electro-Stem drilling machines, all of which employ 10 per cent sulfuric acid as the electrolyte. There are 64 Electro-Stream operations of which 60 use 10 per cent sulfuric acid. The remaining 4 machines use 10 per cent hydrochloric acid as the electrolyte.

Approximately 98 persons are directly affected by the alleged hazard. This includes 94 machine operators and 4 maintenance employees.

B. Evaluation Design

An Initial Observational Survey of the General Electric Corporation was completed by NIOSH investigators, Jerome P. Flesch and John R. Kominsky on March 31, 1975. Two potential health hazards were identified: (1) exposure to mist of sulfuric acid by employees operating stem and stream drilling machines using sulfuric acid as the electrolyte, and (2) exposure to mist of hydrochloric acid by employees operating stream drilling machines using hydrochloric acid as the electrolyte. Other employees "directly affected" by the alleged hazards were the maintenance personnel. Subsequently, a follow-up environmental survey was conducted by Messrs: G. Edward Burroughs and John R. Kominsky on April 30 and May 1, 1975. Workroom air sampling coupled with medical interviews were completed during normal operating conditions.

C. Evaluation Methods

1. Environmental

Employee exposures to mists of sulfuric or hydrochloric acid were evaluated by obtaining air samples from the breathing zones of machine operators and maintenance employees by use of personnel monitoring equipment. Additionally, work area samples were collected to determine the workroom concentrations. The work area sampling device was placed adjacent to the operators normal work stations.

The samples for hydrochloric acid were collected by using a battery-operated vacuum pump, at flow rates of 1 liter per minute, with midget impingers containing 15 milliliters of 0.5 N sodium acetate as the absorbing solution. The impingers were later returned to NIOSH analytical laboratories where the amount of chloride ion was measured by an ion specific electrode method.[1] All sulfuric acid samples were collected using a battery-operated vacuum pump, at flow rates of 2 liters per minute with a 0.8 micrometer nominal pore size cellulose membrane filter mounted into a closed faced 3-piece filter cassette. The total sulfate concentration of each sample was measured turbidimetrically.[2]

2. Medical

Medical questionnaires were completed on fourteen employees representative of the Stream and Stem machine operators, and maintenance personnel. Each interview was begun in a non-directed manner to elicit any symptoms or medical problems of sufficient magnitude to come spontaneously to mind. Subsequently, a directed questionnaire was completed for each interviewee. The employees were asked if they had experienced common symptoms of sulfuric or hycrochloric acid mist overexposure in the past and/or during the day of the investigation, i.e. irritation to the mucous membranes of the eyes and upper respiratory tract, skin, or nose bleeds.

D. Evaluation Criteria

1. Environmental Criteria

The Occupational Health Standards, as promulgated by the U.S. Department of Labor (Title 29 Code of Federal Regulations, Chapter XVII, Part 1910, Subpart G, Section .93, Table G-1, entitled "Air Contaminants"), applicable to the individual substances of this evaluation are as follows:

Substance	Standard	
	8-hour time-weighted average	Acceptable ceiling concentration
Hydrogen Chloride		7 mg/M^3 [a]
Sulfuric Acid	1 mg/M^3	

[a] mg/M^3 = milligrams of substance per cubic meter of air sampled

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.

2. Medical Criteria

The following is a brief review of the toxicological effects that may occur upon toxic exposure to the substances of this evaluation.

a. Sulfuric Acid

Exposure to mist of sulfuric acid in humans have been reported to cause irritant effects on the mucous membranes, including those of the eyes, but principally those of the upper respiratory tract. Rapid shallow respiration may occur following exposure to low concentrations of sulfuric acid mist below the taste-odor irritation threshold.[3] A single overexposure to high concentrations may lead acutely to laryngeal, tracheobronchial and even pulmonary edema.[4]

b. Hydrochloric Acid

Intoxication from inhalation is rare, since hydrochloric acid is highly irritating in low concentrations, and prolonged exposure is intolerable. Inhalation of excessive concentrations immediately produces severe irritation of the upper respiratory tract, resulting in cough, burning of the throat, and a choking sensation. Prolonged exposure to low concentrations may cause erosion of teeth, bleeding of the nose and gums, and skin tenderness.[5]

E. Evaluation Results

1. Environmental Sampling Results

The airborne concentrations of hydrochloric and sulfuric acid are tabulated in Tables I and II, respectively, for all personal breathing-zone and work area samples collected in the Electrochemical Drilling Unit during April 30 and May 1, 1975.

Due to the limited number of operational Electro-Stream machines which used hydrochloric acid as the electrolyte, only one of these four machines could be evaluated. The exposure concentration of the employee operating Electro-Stream machine No. 16016, the numerical identification referring to the maintenance number, was measured on two consecutive days. On both days the measured concentrations were 12% or less of the established standard of 7 mg/M^3, as promulgated by the U.S. Department of Labor.

Exposure to mist of sulfuric acid by the Electro-Stream and Stem operators was measured at seventeen representatively selected drilling operations. This included four work area and thirteen personal samples. Additionally, personnel monitoring devices were worn by three maintanance employees to measure their exposure concentrations.

The measured sulfuric acid levels, with one notable exception, were determined to be quite low. The personal and work area exposures were 19% or less of the established federal standard of 1 mg/M^3, with 86% of the samples below 0.1 mg/M^3. The notable exception is a 1.27 mg/M^3 8-hour time-weighted-average (TWA) breathing zone exposure concentration by a maintenance employee on April 30, 1975, which exceeded the current accepted standard by 27%. This employee was also sampled on May 1, 1975, at which time was exposed to 0.19 mg/M^3 8-hour TWA. The exposure data indicates that a significant fluctuation in the airborne levels of sulfuric acid mist can occur from day to day. Suggesting that airborne concentrations of sulfuric acid experienced by maintenance personnel may reach potentially toxic levels on certain days, thus corresponding measures should be instituted to elucidate this possibility (see Part IV, Section F of this determination report). Based on (1) the medical questionnaire of the maintenance employee exposed to 1.27 mg/M^3 8-hour TWA, which did not disclose any symptomatology suggestive of a toxic exposure, and (2) on a toxicity study (Bushtueva, 1957) of exposures to low concentrations of sulfuric acid (exposure range - 0.6 to 6.0 mg/M^3) in humans under experimental conditions, it is the opinion of the environmental investigator in considering the above reasons that the employee was not exposed to a toxic concentration of sulfuric acid mist on April 30, 1975.

2. Medical Results

A total of fourteen non-directed and directed questionnaires were completed on employees working in the Electrochemical Drilling Unit. The interviewees included operators of both the Electro-Stream and Stem machinery and maintenance personnel. The survey interviews were reviewed by Dr. Robert Rostand of the Medical Services Branch of NIOSH.

Review of the survey questionnaires revealed that under normal operating conditions a toxic situation does not exist, even though occasional mild irritation to conjunctiva and mucous membranes of the upper respiratory are experienced. However, under certain abnormal operating conditions some employees may be exposed to toxic concentrations of acid mist with resultant effects as described in Part IV, Section D of this Determination Report. Abnormal conditions have resulted from local exhaust duct displacement and/or rupture of electrolyte transporting lines during pressure vessel depressurization. NIOSH personnel (2) experienced extreme irritation to conjunctiva and epithelium of the upper respiratory tract on March 31, 1975 which resulted from exhaust duct displacement during pressure vessel depressurization at Electro-Stream work station No. 42254. The exposure period of the affected persons was synonymous with the time needed to evacuate the area, being less than two minutes. A representative of the General Electric Corporation commented that the frequence of such episodes was low, totaling less than four over the past year.

On July 9, 1975 Dr. Robert Rostand contacted Dr. John Mindrin, occupational physician at the Evendale plant of General Electric Corporation, to discuss the medical records of the employees mentioned during the medical interviews or in the survey request form to have been transferred out of the drilling unit for medical reasons that were related to acid mist. The communication revealed that no persons mentioned by name in the request form or in the interviews had been transferred from the drilling

unit as a result of medical injury or illness resulting from exposure to acids "under normal or abnormal operating conditions". Persons who were transferred moved for a variety of other reasons which occasionally included medical reasons, relating to other medical problems.

F. Conclusions and Recommendations

Based on the environmental air sampling results, medical interviews and current literature, it has been determined, under conditions found on April 30 and May 1, 1975, concentrations of aqueous hydrogen chloride and sulfuric acid were not toxic, and did not constitute a hazard to the health of the workers in the Electrochemical Drilling Unit. However, in view of the indicated potential for a significant variation in daily exposure of maintenance personnel to sulfuric acid mist, it is recommended that appropriate assessment procedures be instituted to determine if an inhalation hazard does exist on certain days. These procedures should include:

a. Environmental Monitoring

Part I, Section 7 of the NIOSH criteria document for Sulfuric Acid should be used as a guide for the environmental monitoring.

b. Medical

A medical questionnaire should be developed to include questions relative to the irritant effects of sulfuric acid. Particular attention should be focused on complaints of mucous membrane irritation and cough. This questionnaire should be completed on each employee monitored by methods described in Part I, Section 7, of the NIOSH criteria document for Sulfuric Acid.

It has also been determined that a toxic exposure to sulfuric acid or aqueous hydrogen chloride may exist, manifested by severe irritation to conjunctiva and the epithelium of the upper respiratory tract, during the occasional episodes of acid mist exposure resulting from ruptured electrolyte transporting lines or ventilation duct displacement during pressure vessel depressurization. This is based on an episode which occurred on March 31, 1975 resulting from exhaust duct displacement with resultant effects of extreme mucous membrane irritation experienced by NIOSH personnel (2) requiring the immediate evacuation of the area. The following may aid in eliminating such episodes of acute exposure to acid mist during vessel depressurization.

1. The existing mechanical ventilation system should be properly maintained <u>at all times</u>. This may be accomplished by:

a. Installation of visible gauges or audible alarm or pressure activated devices to indicate or insure that the required air velocity is maintained. Displacement of a local exhaust duct would

be detected by such devices, thus alerting the affected employees. Institution of an inspection program involving scheduled checks of the local exhaust ducts to determine if the duct is properly positioned and not displaced.

b. Establishment of a preventive maintenance program involving scheduled replacement of electrolyte transporting lines.

V. REFERENCES

1. PICA Method No. 115, NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH) 75-121, 1974.

2. Standard Methods for Examination of Water and Waste Water, American Public Health Association, 13th Edition, Method 156C, pg. 334-335, 1971.

3. Amdur, M.D., Silverman, L. and Drinker, P., Inhalation of Sulfuric Acid Mist by Human Subjects. Arch. Ind. Hyg. Occup. Med. 6:305-13, 1952.

4. Goldman, A. and Hill, W.T., Chronic Bronchopulmonary Disease Due to Inhalation of Sulfuric Acid Fumes. A.M.A. Arch. Indust. Hyg. & Occup. Med. 8:205, 1953.

5. Quieries and Menor Notes: Effects of Hydrochloric Acid Fumes. J. Amer. Med. Assoc. 131:1182, 1946.

6. Bushtueva, K.A., The determination of the limit of allowable concentration of sulfuric acid in atmospheric air, in limits of Allowable Concentrations of Atmospheric Pollutants, Bk 3. BS Levine (transl), U.S. Department of Commerce, 1957, pp 20-36.

7. Criteria Document: Recommendations for an Occupational Exposure Standard for Sulfuric Acid, HEW Publication No. (NIOSH) 74-128, National Institute for Occupational Safety and Health, 1974.

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TABLE I

*HYDROCHLORIC ACID CONCENTRATIONS

GENERAL ELECTRIC CORPORATION
EVENDALE, OHIO

April 30 to May 1, 1975

Sample Date	Machine Type and No.	Job Classification	(a) Type of Sample	Sampling Period-Hours	Sample Vol. M^3	(b) Concentration mg/M^3
4/30/75	Stream 16016	Operator	BZ	7.45	0.894	0.03
4/30/75	Stream 16016	--	WA	7.43	0.992	0.83
5/1/75	Stream 16016	Operator	BZ	7.80	0.936	0.09

(a) BZ = Breathing Zone; WA = Work Area

(b) mg/M^3= milligrams of substance per cubic meter of air sampled.

* Aqueous hydrogen chloride

TABLE II

SULFURIC ACID CONCENTRATIONS

GENERAL ELECTRIC CORPORATION
EVENDALE, OHIO

April 30 to May 1, 1975

Sample Date	Machine Type and Number	Job Classification	(a) Type of Sample	Sampling Period Hours	Sample Volume M^3	(b) Concentration mg/M^3
4-30-75	Stream 16134	Operator	BZ	6.95	0.834	<0.1
4-30-75	Stream 16837	Operator	BZ	6.40	0.768	<0.1
4-30-75	Stream 15761	Operator	BZ	5.95	0.714	<0.1
4-30-75	Stem 15917	Operator	BZ	5.78	0.694	0.12
4-30-75	Stem 15833	Operator	BZ	5.90	0.708	<0.1
4-30-75	Stream 16137	Operator	BZ	5.68	0.682	<0.1
4-30-75	Stream 15795	--	WA	7.00	0.840	<0.1
4-30-75	Stream 16226	--	WA	3.27	0.392	<0.1
4-30-75	Stem 16361	--	WA	5.37	0.644	<0.1
4-30-75	--	Maintenance	BZ	6.38	0.766	1.27
4-30-75	--	Maintenance	BZ	5.88	0.706	<0.1
5-1-75	Stream 16222	Operator	BZ	7.00	0.840	<0.1
5-1-75	Stream 15760	Operator	BZ	6.40	0.768	<0.1
5-1-75	Stream 16134	Operator	BZ	6.65	0.798	<0.1
5-1-75	Stream 16837	Operator	BZ	7.27	0.872	<0.1
5-1-75	Stem 16913	Operator	BZ	5.95	0.714	<0.1
5-1-75	Stem 16414	Operator	BZ	6.53	0.784	<0.1
5-1-75	Stem 16319	Operator	BZ	5.25	0.630	<0.1
5-1-75	Stream 16226	--	WA	7.5	0.902	<0.1
5-1-75	--	Maintenance	BZ	7.02	0.842	<0.1
5-1-75	--	Maintenance	BZ	6.35	0.762	0.19

(a) BZ = Breathing Zone; WA = Work Area.

(b) mg/M^3 - Milligrams of substance per cubic meter of air sampled.