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. 76-42-407

SIBLEY ENGINEERING AND MANUFACTURING COMPANY
SULPHUR SPRINGS, ARKANSAS

JULY 1977

I. TOXICITY DETERMINATION

It has been determined that employees performing duties in the automatic screw machine area at Sibley Engineering and Manufacturing Company, Sulphur Springs, Arkansas were not exposed to toxic concentrations of 1,1,1 trichloroethane, oil mist, chlorine and phosgene.

Medical interviews conducted of ten (10) persons employed in the automatic screw machine area failed to produce evidence which would indicate medical problems resulting from the use and/or generation of the above-listed chemicals.

These determinations are based on data collected during medical interviews conducted on April 7, 1976, an environmental survey conducted on June 15, 1976, and a review of available literature.

Various environmental/medical recommendations were made to management for possible improvement of existing conditions in the applicable work area and are presented herein.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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 ninety (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, Ohio, address. Copies have been sent to:

a) Sibley Engineering and Manufacturing Company
b) U. S. Department of Labor, Region VI
c) NIOSH, Region VI

For the purpose of informing the approximately thirty-nine (39) "affected employees", the employer shall promptly "post" the Determination Report in a prominent place(s) near where exposed employees work, for a period of thirty (30) calendar days.

INTRODUCTION

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

The National Institute for Occupational Safety and Health (NIOSH) received such a request from the employer regarding the exposure of workers to 1,1,1 trichloroethane, oil mist, chlorine and phosgene in the automatic screw machine area.

IV. HEALTH HAZARD EVALUATION

A. Description of Process - Conditions of Use

This plant, commencing operations in 1945, currently employs a total of fifty-five (55) persons. Primarily, its activities relate to those of a "job shop", the majority of its production directed toward the output of precision parts for aircraft and missiles. As part of a planned plant expansion, the screw machine area, or specific area of request, was added in the latter part of 1973.

B. Evaluation Design

1. Preliminary Survey

On April 7, 1976, an initial walk-through survey was conducted of the facility. No environmental sampling was conducted at that time; considerable information was, however, gathered on the characterization of substances and conditions of their use. Areas where possible exposure to 1,1,1 trichloroethane (vapor degreaser) and cutting oil mist (screw machines) might occur were identified.

Workers in the screw machine area, where the use of cutting oils/fluids is typical, were privately interviewed in a non-directed manner concerning any health problems which they felt to be related to their specific jobs at the plant.

2. Follow-up Environmental Survey

In order to more fully evaluate employee exposure to chemicals mentioned in the earlier portion of this report, it was deemed appropriate and necessary to collect air samples in the automatic screw machine. This follow-up environmental survey was conducted on June 15, 1976. No further medical evaluation was made at that time.

(Note: Consideration was given to the possible presence of phosgene and chlorine vapors as decomposition products resulting from the contact of liquid or vapor 1,1,1 trichloroethane with open flames, red-hot surfaces, or welding operations).

C. Evaluation Methods

1. 1,1,1 Trichloroethane

Personal breathing-zone and area samples were collected by using low-flow SIPIN, Model SP-1 personal sampling pumps with standard charcoal tubes at a sampling rate of approximately 0.05 liters per minute. Samples were analyzed by gas chromatography at a lower detection limit of 0.01 milligram/tube.

2. Oil Mist

General area samples were collected by using MSA, Model G battery-operated vacuum pumps with AA 0.8μ pore density cellulose membrane filters at sampling rates of 1.7 liters per minute. Samples were analyzed by fluorescence spectroscopy at a lower limit of detection of 0.01 milligram/filter.

3. Chlorine

General area samples were collected by using a MSA Universal Sampling Pump with appropriate chlorine detector tubes (Part #460225, Range 0.5-20.0 parts per million).

4. Phosgene

General area samples were collected by using a MSA Universal Sampling Pump with appropriate phosgene detector tubes (Part #89890, Range 0.1-10.0 parts per million).

D. Evaluation Criteria

1. Environmental Standards or Criteria

The evaluation standards and criteria considered to be applicable to this evaluation are as follows:

The Occupational Health Standards as promulgated by the U. S. Department of Labor, Federal Register, May 28, 1975, Title 29, Chapter XVII, Subpart G, Table Z-1. (29CFR Part 1910.1000)

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) for Chemical Sub-

stances and Physical Agents in the Workroom Environment for 1976, and

NIOSH Criteria Documents recommending occupational standards.

The recommended TLV's as promulgated by the ACGIH, and applicable to the principal individual substances used in this evaluation, are as follows:

Substance	8-hr time-weighted average concentration ACGIH, TLV Committee		Comparable OSHA Standard	
	(mg/M^3)	(p.p.m.)	mg/M^3	(p.p.m.)
1,1,1 Trichloroethane	1,900	350	1,900	350
Oil Mist (mineral)	5	-	5	-
Chlorine	3	1	3	1
Phosgene	0.4	0.1	0.4	0.1

Occupational health exposure limits for individual substances have been generally established at levels designed to protect workers occupationally exposued on an eight (8) hours per day, forth (40) hours per week basis over a normal working lifetime.

2. Toxic effects

a. 1,1,1 Trichloroethane

1,1,1 Trichloroethane vapor is a narcotic, and repeated exposure of animals to concentrations of 1,000 to 10,000 parts per million (p.p.m.) caused liver and lung changes in some species. In dogs, cardiac sensitization to epinephrine occurs at concentrations of 5,000 to 10,000 p.p.m.

A number of human fatalities related to industrial exposure in closed spaces have been reported. A five (5) minute exposure to 5,000 p.p.m. can be expected to produce marked incoordination and anesthesia. Prolonged exposure at this concentration may cause coma and death. Exposure to concentrations in excess of 1,000 p.p.m. for fifteen (15) minutes, or 2,000 p.p.m. for five (5) minutes, can be expected to produce a disturbance of equilibrium in the majority of adults.[1]

Above 1700 p.p.m. minor disturbances of equilibrium have been observed, with complaints of headache and lassitude. In controlled human exposures to 500 p.p.m., no effects other than slight, transient eye irritation were noted; at 1,000 p.p.m. and

above, mild eye irritation was experienced by all subjects and some became dizzy. Following exposure, most of the compound is eliminated unchanged via the lungs--chiefly within 48 hours. Dermatitis may result from repeated skin contact with the liquid. [2]

b. Oil Mist

The changes in the skin due to the use of cutting oils take several forms and have been called oil boils, folliculitis, dermatitis and acne. This skin condition due to cutting oils is one of the most common forms of industrial dermatitis, and can cause extensive medical problems and loss of work. The boils occur more frequently on the backs of the forearms and the hands where the hair is located, and will also occur on the thighs--wherever the oil comes in contact directly or through oil-soaked clothing. [3]

The base of the hair becomes plugged with the oil and this forms blackheads (comidones). When the base of the hair follicle becomes infected, then boils, and perhaps carbuncles, can develop. The metal slivers in the cutting oil are also a cause of irritation and infection of the skin; therefore boils develop and extensive swelling of the tissues can occur.

The reaction and effect on the skin depend on the types of cutting oil, whether "insoluble" or "soluble", the chemical composition of the oils, the chemicals which may be added to the oils, the working conditions of the machine operators, the extent of proper protective clothing/washing facilities, and the type of skin.

c. Chlorine

Chlorine vapor irritates the mucous membranes, the respiratory system, and the skin. Strong concentrations irritate the eyes and cause coughing and labored breathing. If a person is exposed to a large dose, he will become generally excited, as shown by his becoming restless, having an irritated throat, sneezing, and salivating excessively. Symptoms of high exposure are retching and vomiting, followed by difficult breathing.[4]

Chlorine vapor has such an intense smell that concentrations of 3-5 p.p.m. in air are easily noticed; however, men rapidly lose their ability to detect the odor of chlorine in small concentrations. Higher concentrations are so severly irritating that no

one will remain in a chlorine-contaminated area unless he is either unconscious or trapped.

Chlorine produces no known systemic effect. All symptoms and signs result directly or indirectly from the local irritant action. Low concentrations of chlorine gas in the air may have a minor irritating effect or may produce slight symptoms after several hours exposure, but careful examination of persons repeatedly exposed by such conditions reportedly have shown no chronic effect.[5]

d. Phosgene

Phosgene gas is a severe respiratory irritant. Three (3) p.p.m. is claimed to be the least concentration capable of causing immediate irritation of the human throat; four (4) p.p.m. causes immediate irritation of the eyes; five (5) p.p.m. causes cough; brief exposure to 50 p.p.m. may be rapidly fatal. With moderate exposure, the presenting symptoms are often a dryness or a burning sensation of the throat, vomiting, pain in the chest, and dyspnea. The onset of symptoms of severe respiratory distress may be delayed for up to 72 hours, the latent interval depending upon the concentration and duration of exposure.

The delayed onset of pulmonary edema is characterized by cough, abundant quantities of foamy sputum, progressive dyspnea, and severe cyanosis. Pulmonary edema may progress to pneumonia, and cardiac failure may intervene. The gas in concentrations of 1 to 2 p.p.m. causes eye discomfort, and higher concentrations are likely to cause lacrimation and conjunctivitis.[6]

E. Evaluation Results and Discussion

1. Environmental

The results of ninety-one (91) air samples (17-1,1,1 trichloroethane; 6-oil mist; 34-chlorine; 34-phosgene) collected during the June 15, 1976, survey are shown in Tables 1 through 4.

Table 1 reveals that all seventeen (17) 1,1,1 trichloroethane samples were less than one-third of both the ACGIH TLV and the OSHA standard. Table 2 similarly indicates that the six (6) samples analyzed for oil mist were approximately one-fifth of the accepted ACGIH and OSHA

values. Tables 3 and 4 reveal that no chlorine and/or phosgene were detected during the evaluation.

Appropriate laboratory analyses also revealed the presence of nitrosamines in the water-soluble cutting fluids currently being used within the plant. Historically nitrosamines have been regarded as one of the most potent families of animal carcinogens. Although nitrosamines are suspected to be human carcinogens, their carcinogen potential in man has not been proven.

2. Medical

A review of the information obtained from the ten (10) worker interviews revealed three (3) employees had, at one time or another, witnessed minor eye irritation; one (1) employee reported a one-time instance of rash on his feet; and one (1) employee had, at one time, reported an occassional bleeding of his nose. None of the employees were under the care of a physician for a possible job related condition.

F. Conclusions

The following conclusions are based upon the previously discussed environmental and medical findings:

1. No excessive concentrations of 1,1,1 trichloroethane, oil mist, chlorine vapor or phosgene were present in the work atmosphere of the plant in question.

2. Medical interviews conducted of ten (10) persons employed in the automatic screw machine area failed to produce evidence which would indicate medical problems resulting from the use and/or generation of the above-mentioned chemicals.

V. RECOMMENDATIONS

1. Although airborne concentrations of 1,1,1 trichloroethane were well below existing standards and/or recommended levels, it is suggested that those persons receiving continuous exposure to said chemical be given:

a. Preplacement initial or interim medical and work histories.

b. Preplacement physical examinations, giving attention to at least the neurological, cardiovascular and liver functions, and skin condition.

c. Periodic examinations on an annual basis or at some other frequency to be determined by the responsible physician.

d. Medical records should be maintained for all persons employed in work involving exposure to 1,1,1 trichloroethane.

2. Areas in which small spills of 1,1,1 trichloroethane may occur should be evacuated and well-ventilated. Small, portable fans may be used in confined areas where local exhaust ventilation is not feasible. Workers should not return to any work area if the odor of 1,1,1 trichloroethane is still perceptible without the concentration being determined first.

3. Where an emergency may develop that could result in employee injury from overexposure to 1,1,1 trichloroethane, respiratory protection should be provided as listed in Table 5.

4. The following warning sign should be affixed in a readily visible location on applicable equipment and on 1,1,1-trichloroethane storage tanks or containers:

> 1,1,1, TRICHLOROETHANE
>
> Breathing vapor may be hazardous to health
>
> May generate toxic gases on contact with open flame, hot surfaces, or other heat-producing conditions.
>
> Keep containers closed when not in use.
>
> Use only with adequate ventilation.
>
> Avoid breathing of vapor.
>
> Avoid contact with skin.

5. Based on the fact that nitrosamines were found to exist in the water-soluble cutting fluids, NIOSH has suggested various industrial hygiene practices which are intended to minimize dermal and respiratory exposure to cutting fluids. (See Table 6).

VI REFERENCES

1. American Conference of Governmental Industrial Hygienists: "Methyl Chloroform (1,1,1 Trichloroethane", Documentation of the Threshold Limit Values for Substances in Workroom Air (3d Ed., 2d. Printing), Cincinnati, 1974, pp. 161-162.

2. Patty, Frank A.: Industrial Hygiene and Toxicology, Vol. II. Toxicology (2d Ed., Revised), Interscience Publishing Company, New York, 1963, pp. 1287-1290.

3. Mancuso, Thomas F.: Help for the Waling Wounded, "Cutting Oils", International Association of Machinists and Aerospace Workers, 1976, pp. 49-50.

4. National Safety Council: "Chlorine" (Data Sheet 207, Revised), 1966, pp. 7-8.

5. Manufacturing Chemists Association: "Chlorine" (Chemical Safety Data Sheet SD-80, Revised), 1970, pp. 23-24.

6. American Conference of Governmental Industrial Hygienists: "Phosgene", Documentation of the Threshold Limit Values for Substances in Workroom Air (3d Ed., 2d Printing), Cincinnati, 1974, pp. 208-209.

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Table 1
1,1,1 Trichloroethane Concentrations
Sibley Engineering and Manufacturing Company
Sulphur Springs, Arkansas
June 15, 1976

Sample Number	Operation	*Type of Sample	Sample Volume (liters)	**Concentration (mg/M^3)
C-1	Quality Control Shipping (A)	P	12	410
C-2	Quality Control Shipping (B)	P	13	349
C-3	Quality Control Shipping (C)	P	12	431
C-4	Screw Machine Operator (A)	P	15	400
C-5	Screw Machine Operator (B)	P	14	457
C-6	Screw Machine Operator (C)	P	8	545
C-7	Numerical Control Mill Operator (A)	P	11	384
C-8	Numerical Control Mill Operator (B)	P	16	393
C-9	Numerical Control Mill Operator (C)	P	15	345
C-10	Wire Forming Machinist	P	13	113
C-11	Tool Crib Attendant	P	14	390
C-12	Machinist-Mill Department	P	12	188
C-13	Assistant Supervisor	P	10	355
C-14	Lathe Operator	P	12	121
C-15	Attic-Adjacent to Lunch Room	GA	13	199
C-	Desk-Office Area	GA	11	66
C-	Above Vapor Degreaser	GA	11	402

American Conference of Governmental Industrial Hygienists
Threshold Limit Value Committee.....1900

* P - Personal; GA - General Area
**mg/M^3 = milligrams of substance per cubic meter of air sampled.

Table 2
Oil Mist Concentrations
Sibley Engineering and Manufacturing Company
Sulphur Springs, Arkansas
June 15, 1976

Sample Number	Operation	*Type of Sample	Sample Volume (liters)	**Concentration (mg/M^3)
OM-1	HES-Numerical Control Lathe	GA	328	(a)
OM-2	Screw Machine #112	GA	325	0.62
OM-3	Screw Machine #112	GA	140	(a)
OM-4	Screw Machine #118	GA	318	1.23
OM-5	1 5/8" Spindle Screw Machine	GA	308	0.52
OM-6	Above Clean-o-matic Pts. Cleaner	GA	308	0.52
OM-7	Tape Mills	GA	306	(2)
OM-8	Center of Mill Dept.--Old Bldg.	GA	303	0.33
OM-9	Center of Lathe Dept. - Old Bldg.	GA	303	0.50
OM-10	Center of Grinding Dept. - Old Bldg.	GA	304	(a)

can Conference of Governmental Industrial Hygienists,
...shold Limit Value Committee.....5.0

* GA - General Area
** mg/M^3 - milligrams of substance per cubic meter of air sampled
(a) - invalid sample

Table 3
Chlorine Concentrations
Sibley Engineering and Manufacturing Company
Sulphur Springs, Arkansas
June 15, 1976

Operation	Time of Sample	*Concentration (p.p.m.)
HES Numerical Control Lathe	9:30A;11:30A;1:30P;3:30P	ND**
Screw Machine #112	"	ND
Screw Machine #118	"	ND
1 5/8" Spindle Screw Machine	"	ND
Above Clean-o-matic Pts. Cleaner	"	ND
Center of Mill Dept. - Old. Bldg.	"	ND
Center of Lathe Dept. - Old Bldg.	"	ND
Center of Grinding Dept. - Old Bldg.	"	ND
Tape Mills	9:30A; 1:30P	ND

American Conference of Governmental Industrial Hygienists,
Threshold Limit Value Committee.....3.0

p.p.m. - parts of vapor or gas per million parts of contaminated air
ND - none detected at lower limit of detection

Note: Evaluation(s) conducted by using Mine Safety Appliance Universal Sampling Pump (Part No. 83499) and appropriate chlorine detector tubes (Part No. 460225), range 0.5-20.0 p.p.m.

Table 4
Phosgene Concentrations
Sibley Engineering and Manufacturing Company
Sulphur Springs, Arkansas
June 15, 1976

Operation	Time of Samples	*Concentration (p.p.m.)
HES - Numerical Control Lathe	9:30A;11:30A;1:30P;3:30P	ND
Screw Machine	"	ND
Screw Machine	"	ND
1 5/8" Spindle Screw Machine	"	ND
Above Clean-o-matic Pts. Cleaner	"	ND
Center of Mill Dept.-Old Bldg.	"	ND
Center of Lathe Dept. - Old. Bldg.	"	ND
Center of Grinding Dept. - Old. Bldg.	"	ND
Pipe Mills	9:30A; 1:30P	ND

American Conference of Governmental Industrial Hygienists,
Threshold Limit Value Committee.....0.4

p.p.m. - parts of vapor or gas per million parts of contaminated air
ND none detected at lower limit of detection.

Note: Evaluation(s) conducted by using Mine Safety Appliance Universal Sampling Pump (Part No. 83499) and appropriate phosgene detector tubes (Part No. 460225), range 0.1 - 10.0 p.p.m.

Table 5

Respiratory Protection
For 1,1,1-Trichloroethane

Condition Vapor Concentration	Respirator Type
500 ppm or less	A chemical cartridge respirator with organic vapor cartridge(s), maximum service life of 5 hours; chemical cartridges should be changed after each day of use.
	A self-contained breathing apparatus
1000 ppm or less	A chemical cartridge respirator with a full facepiece and organic vapor cartridge(s), maximum service life of 2 hours.
	A gas mask with a chin-style or a front-or back-mounted organic vapor canister.
	A supplied-air respirator with a full facepiece, helmet or hood.
	A self-contained breathing apparatus with a full facepiece.
Greater than 1000 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
	A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure demand or other positive pressure mode.
Escape	A gas mask providing protection against organic vapors.
	An escape self-contained breathing apparatus.

Table 6
Industrial Hygiene Practices to Minimize
Dermal and Respiratory Exposure to Cutting Fluids

The following are suggested as good industrial hygiene practices which can assist in minimizing exposure to cutting fluids. The recent detection of nitrosamines in certain cutting fluids has compounded the recognized problem of cutting oil control.

1. Engineering Control. The most effective control of any contaminant is control at the source of generation. Effective engineering measures include the use of local exhaust ventilation, with a suitable collector, or the use of electrostatic precipitator.

2. Substitution. The substitution of a cutting fluid that does not contain either nitrosamine contaminated amines, or the necessary ingredients (amines and nitrites) for nitrosamine formation, is another possible control measure. Since many of the proprietary ingredients of cutting fluids have not undergone complete toxicological evaluation, caution should be used when contemplating any change from one cutting fluid formulation to another, giving full consideration to the potential hazards of the substitute.

3. Respirators. Personal respiratory protective devices should only be used as an interim measure while engineering controls are being installed, for non-routine use and during emergencies. Considering the carcinogenic potential and the lack of a standard for nitrosamines as a group, the only available personal respiratory protective measure is the use of a positive pressure supplied air respirator or a positive pressure self-contained breathing apparatus.

4. Protective clothing. Impervious clothing should be provided and should be replaced or repaired as necessary. Non-impervious clothing is not suggested, but if used, it should be removed and laundered frequently to remove all traces of cutting fluids before being reworn. (Laundry personnel should be made aware of the potential hazard from handling contaminated clothing.)

5. Personal cleanliness. All exposed areas of the body and any area that becomes wet with cutting fluids should be washed with soap or mild detergent. Frequent showering is recommended.

6. Isolation. Where possible, any operations involved with cutting fluids should be placed in an isolated area to reduce exposure to employees not directly concerned with the operations.

7. Barrier creams. Barrier creams may provide protection against dermal irritation and skin absorption, however, the barrier cream should not contain secondary or tertiary amines (which may react to form nitrosamines in the presence of nitrites).