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. 76-99-397

REDFIELD COMPANY
DENVER, COLORADO

MAY, 1977

I. TOXICITY DETERMINATION

A health hazard evaluation was conducted by the National Institute for Occupational Safety and Health (NIOSH) at the Redfield Company in Denver, Colorado. An initial survey was conducted on July 29-30, 1976. At the time of the initial survey, breathing zone samples were taken for acetone, methyl ethyl ketone (MEK), 1,1,1,-Trichloroethane, and oil mist. Concentrations of MEK and oil mist were below the most recent evaluation criteria. With one exception (the laborer in the Buffing Area), concentrations of 1,1,1, Trichloroethane were also below the most recent evaluation criteria. Two-hour breathing zone samples of some scope assemblers were approximately 50% of the criteria for acetone. During the initial survey in July, 1976, confidential employee interviews were conducted by the NIOSH industrial hygienist. At that time employees reported symptoms consistent with overexposure to acetone. During the initial survey, acetone was being used in open containers. The NIOSH industrial hygienist recommended that closed containers be used to eliminate exposures.

Because of the reported symptoms and the elevated concentrations of acetone during the initial survey, a follow-up environmental and medical evaluation was conducted on November 9-12, 1976. At the time of the follow-up evaluation, eight-hour breathing zone samples were taken for acetone, MEK and 1,1,1, Trichloroethane. All concentrations were below the most recent evaluation criteria in November, 1976. Based on the earlier recommendation of the NIOSH industrial hygienist, Redfield Company began using closed containers. A medical evaluation consisting of a medical questionnaire, blood and urine samples and pulmonary function tests were done on the employees in the Scope Assembly and Scope Tube Preparation areas. The results of the biological tests were all within the acceptable range.

Environmental and medical data obtained in November, 1976 indicated that a toxic situation did not exist during this follow-up investigation.

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:

Redfield Company
United Steelworkers Union, Local 5550, Denver
U.S. Department of Labor - Region VIII
NIOSH - Region VIII

For the purpose of informing the 100 affected employees, copies of the report shall be posted in a prominent place accessible to the employees 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 the United Steelworkers Union, Local 5550, Denver, Colorado, to evaluate potential hazards associated with exposures to acetone, MEK, 1,1,1-trichloroethane, and oil mist during the manufacture of rifle scopes. The request was precipitated by employees concerned with the possible relationship of such symptoms as headache, stomach disorders, dermatitis, difficult breathing, muscle cramps, and nervous conditions with occupational exposure.

IV. HEALTH HAZARD EVALUATION

A. Process Evaluated (Scope Assembly Area)

The Redfield Company, Denver, Colorado, produces rifle scopes. The following two areas were monitored during this evaluation.

Scope Assembly--acetone was used during scope assembly to clean lenses and scope tubes. MEK was the solvent in the glue that was used in the assembly of the scopes. The only ventilation present in this area was general room ventilation.

Scope Tube Preparation--the only other processes evaluated were the vapor degreasers using 1,1,1-trichloroethane and the two cutting machines that were using cutting oil. There was no local or general ventilation in this area of the plant except for roof fans.

B. Environmental and Medical Evaluation Design and Methods

1. Environmental

During the follow-up evaluation, breathing zone samples were taken on 29 workers in the scope assembly and on 3 workers operating the vapor degreasers. Acetone, MEK, and 1,1,1-trichloroethane were collected on organic vapor charcoal sampling tubes, using Sipin pumps operating on approximately 50 cubic centimeters (cc) per minute. The acetone, MEK, 1,1,1-trichloroethane were analyzed by gas chromatography.

During the initial survey in July, 1976, oil mist samples were collected on two workers. Oil mist samples were taken on pre-weighed filters using MSA Model G pumps operating at 1.5 liters per minute. The samples were analyzed by fluorescence spectroscopy. Because oil mist was not a problem on this plant, oil mist samples were not collected during the follow-up evaluation in November, 1976.

2. Medical

Forty-three workers were interviewed. Informed consent was obtained from each worker. A questionnaire containing identification data, smoking history, occupational history, and medical history of complaints related to work was completed.

The employees were divided into the following groups:

Those exposed only to acetone

Those exposed to acetone and MEK

Those exposed only to 1,1,1-trichloroethane

Control group

Because oil mist was not a problem, the employees exposed to oil mist were not included in the medical evaluation

Pre- and post-shift pulmonary function tests were performed on those workers exposed to 1,1,1-trichloroethane because of an alleged high incidence of respiratory symptomatology in this group and also on a control group. Pre- and post-shift urines for trichloroacetic acid and trichlorocompounds analysis were also collected on the above group. Post-shift blood samples were collected for ketone analysis for all interviewed employees--both exposed and controls.

3. Method of Analysis of Biological Samples

Pulmonary function testing was performed on the "Vitalograph" single breath instrument. FEV_1/FVC ratios were calculated from Nomogram figures provided in the Nomogram table by Kamburoff and Woitowitz[1] for the predicted values. The results were interpreted by the Chief of the Medical Section, Hazard Evaluation and Technical Assistance Branch.

Spot urine samples were frozen upon arrival in the NIOSH Cincinnati Laboratory and maintained in that state until they could be analyzed Urine samples were analyzed for trichloroacetic acid (TCA) and total trichlorocompounds (TTC) by the method of Tanaka and Ikeda,[2] a colorimetric procedure based on the alkaline-pyridine Fujiwara reaction. TTC-TCA is assumed to be trichloroethanol (TCE). Urine specific gravity and creatinine were also determined, the former by hydrometer, the latter by standard Auto Analyzer methodology and uncorrected data are shown in Table I. Corrected data are shown in Table II.

Spot urine specimens may not be representative of "normal" urine with respect to concentration. There are two established ways to "normalize" urines. One is the correction to a constant standard specific gravity of 1.024. The other way which is the method the author used in reporting, requires the separate determination of urine creatinine and an expression of the metabolite concentration as mg metabolite per gram of creatinine, a type of "specific activity" used when working with isotopes.

Blood was collected at the end of the shift using the standard venapuncture technique. Blood specimens were centrifuged to sediment red cells and the serum transferred to "hypo vials," small 6 ml vials with teflon-lined serum tearaway seals. The serums were refrigerated until analysis.

Serum for 1,1,1-trichloroethane was analyzed by gas-liquid chromatography using a 10% Carbowax 20M on 80/100 mesh Supelcoport 6' x 1/4" (4mm ID) glass column. Two ul of serum were injected directly on-column using the same column conditions as above except temperature programming was for 4 min. at 70° followed by a 12°/min. rise to 210°. 1,1,1-trichloroethane had a retention time of approximately two minutes. Limits of detection were 0.05 mg/dl serum.

Serum samples for acetone and MEK analysis were analyzed by gas solid chromatography on a porous polymer packing. Two ul of serum were injected directly onto a 6' x 14/" (4mm ID glass column containing Chromosorb 101 (80-100 mesh). Conditions were: Unjector 160, detector 160, column temperature was 4 min. at 100° then programmed at 12°/min. to 210°, helium carrier 35 ml/min. The FID detector used 30 ml/min. of helium and 300 ml/min. air. Retention times for acetone and MEK were approximately 7 and 10 minutes, respectively. Limits of detection were 0.05 mg acetone or MEK per dl serum.

C. Criteria for Assessing Workroom Concentrations of Air Contaminants

The two sources of criteria used to assess workroom concentrations of air contaminants in this evaluation are:

(1) NIOSH recommended criteria for occupational exposures

(2) Recommended threshold limit values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienist (ACGIH) (1976).

	Permissible Exposures 8-hour Time-Weighted Exposure Basis			
Substance	1976 TLV's		NIOSH Criteria	
	mg/M^3	ppm	mg/M^3	ppm
Acetone	2400	1000	----	---
Methyl Ethyl Ketone (2-Butanone) .	590	200	----	---
1,1,1-Trichloroethane (Methyl Chloroform)	1900	350	"C" 1900	"C" 350
Oil Mist Particulate	5	----	----	---

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mg/M^3 = approximate milligrams of substance per cubic meter of air

"C" = ceiling concentration which should never be exceeded.

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

1. Acetone

Acetone is one of the least hazardous of the volatile solvents. Eye, nose and throat irritation occur only after very high exposures such as in tanks and closed compartments. Narcotic (anesthetic) effects with headache, drowsiness and incoordination should not occur under usual conditions.

Acetone is not known to produce chronic or accumulative systemic effects. Repeated and prolonged skin contact with the liquid can cause dryness and mild irritation of the skin.[3]

The 1000 ppm threshold limit is well below a concentration capable of producing narcotic symptoms or mucous membrane irritation. It is practically devoid of inhalation hazard.[4]

2. 1,1,1,-Trichloroethane

1,1,1,-Trichloroethane vapors may produce narcosis. A five-minute exposure to 5000 ppm can be expected to produce marked incoordination and anesthesia. Exposure to concentrations in excess of 1000 ppm for 15 minutes, or 2000 ppm for 5 minutes, can be expected to produce a disturbance of equilibrium in the majority of adults. Above 1700 ppm minor disturbances of equilibrium have been observed, with complaints of headache and lassitude. In controlled human exposures to 500 ppm no effects other than slight transient eye irritation were noted; at 1000 ppm and above, mild eye irritation and some dizziness were noted. 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. Cardiac arrhythmias have been reported following ingestion.[5]

3. Methyl Ethyl Ketone (MEK)

Prolonged exposure to MEK may result in mucous membrane irritation, nausea, vomiting, dermatitis, headache and paresthesias.[6]

E. Medical and Environmental Results and Discussion

1. Environmental

Environmental data collected during the initial survey on July 29-30, 1976 indicated exposure to 1,1,1-trichloroethane and acetone. Concentrations of MEK and oil mist were below the most recent evaluation criteria. Results of the environmental samples taken during the initial survey in July, 1976 may be reviewed in Tables III through V.

At the time of the follow-up environmental-medical evaluation on November 9-12, 1976, concentrations of acetone, MEK and 1,1,1,-trichloroethane were far below the most recent evaluation criteria. Samples for oil mist were not taken during the follow-up evaluation. Environmental data collected on November 9-12, 1976 indicated concentrations of all chemicals measured were well below any level that would cause a health hazard. Results of the environmental data collected on November 9-12, 1976 may be reviewed in Tables VI and VII.

2. Medical

A. Demographic Data

The exposed group at Redfield Company consisted of 4 (12.5%) males and 28 (87.5%) females. The mean age was 36.8 years with a range from 19 to 58 years. The control group consisted of 2 (18.2%) males and 9 (81.8%) females. The mean age of the control group was 27.6 years with a range of 22 to 45 years.

The average length of employment in the exposed group was three years with a range from 1.5 months to 31 years. In the control group the average length of employment was one year with a range from one week to 2.5 years.

Thirteen (40.6%) of the exposed group are smokers, 17 (53.1%) are non-smokers and 2 (6.3%) are ex-smokers. In the control group 4 (36.4%) are smokers, 4 (36.4%) are non-smokers and 3 (27.2%) are ex-smokers.

B. Pulmonary Function Test Results

Results of pulmonary function tests for both the exposed and the control group were within normal limits and no changes were observed during the course of the shift.

C. Biological Results

1. Urine Test Results

Urine data expressed as mg. metabolite/g creatinine, for those workers exposed to 1,1,1,-trichloroethane and the control group are shown in Table VIII.

Comparison data for workers exposed to 1,1,1,-trichloroethane (TRI) are available in the NIOSH, 1,1,1,-Trichloroethane Criteria Document.[7] The Table below shows these comparisons with data from this study shown as ppm for comparison.

Exposure	Blood TRI, ppm	Serum TRI, ppm
250 ppm	1.4-4.4 (page 164)	-
500 ppm	1.5-6.5 (page 39)	-
955 ppm	1-10 (page 39)	-
Fatal	60-720 (page 40)	-
HHE	-	1.3-2.7

It can be seen that our data are consistent with low exposure to TRI. See Table IX.

Comparison data for urine metabolites has also been shown and reported in the criteria document and is shown below for comparison expressed as mg/liter corrected to a specific gravity (page 53).

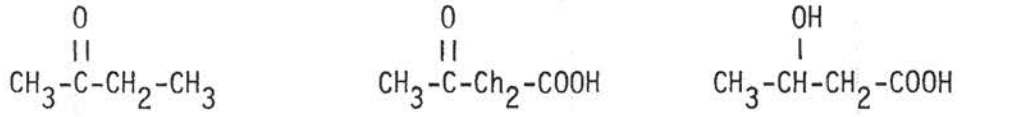
Exposure	TCA mg/liter	TCE mg/liter
4 ppm	0.6	1.2
25 ppm	2.4	5.5
53 ppm	3.6	9.9
HHE	4	12
Controls	2	2

Again, the data are consistent with serum data and indicates low exposure to TRI.

2. Blood Test Results

Ketones are a normal constituent of the blood. Slight increases may be due to diet and/or disease (e.g. diabetes). In the exposed group the average length of time since the last meal was 3.4 hours with a range from 1 to 4 hours. The average length of time since the last meal in the control group was 6.3 hours with a range from one-half hour to 15.5 hours. One exposed employee is a diabetic and takes insulin.

Data on normal serum levels of acetone and MEK are not readily available but may be found by a rather extensive literature evaluation. The data shown in Table X and XI show the levels found in "controls" and "exposed" workers collected after seven hours on the job. Acetone levels show a statistically elevated level, but the physiological meaning of this is not clear. Exposures do not seem to be extensive from this data. Although the MEK levels in serum are low, both in controls and exposed, there is an indication of exposure to MEK. MEK, one might think, should not be a normal metabolite in man. However, an examination of the structure shows a close relationship between acetoacetate and B-hydroxy-butyrate as shown.



A linear regression analysis of the acetone data, although not significant, does seem to indicate a dose-response trend. (See Figure I) Attempts to plot the MEK and trichloroethane data were not successful due to the small numbers.

3. Questionnaire Results

When asked directly, "During the course of the shift today, did you develop any of the following symptoms?", 24 (75%) of the exposed employees reported one or more symptoms. Table XII shows the frequency of symptoms reported as they relate to the specific exposures. Eight (25%) employees denied any symptoms.

In humans, the teratogenic effect of 1,1,1,-trichloroethane has not yet been determined. Employees exposed to this substance were asked if they or their wives had nay miscarriages or if they had any children with congenital abnormalities. The three exposed employees denied miscarriages or children with congenital abnormalities.

4. Discussion

Urine data show the presence of TCA and TCE, indicating absorption of trichlorocompounds. These metabolites are also produced by trichloro-ethylene and perchloroethylene, so they cannot be used for definite identification of the exposure agent. Only a trace of MEK was found. Based on serum data, there appears to be exposure to acetone. However, acetone is the least toxic of the solvents involved in this health hazard evaluation, and the environmental levels in this study are below the 8 hour TWA TLV of 2400 mg/M^3.

V. CONCLUSIONS

Evaluation of the combined environmental-medical data indicates that environmental levels would have to be considerably higher than measured on the days of the NIOSH visit to account for the symptoms. The most frequently reported symptoms (sleepiness, burning or itchy eyes and headaches) may be due to the tedious nature of the work. Also, coming out of a controlled environment into the pollution in the Denver area may account for the reported eye irritation.

The biomedical and environmental values observed indicate a toxic situation did not exist at this plant during the follow-up evaluation.

VI. RECOMMENDATIONS

1. That Management should make every effort to continue to provide a healthy and safe environment. The use of covered containers for solvents seems to have reduced the environmental levels of the solvents since the first NIOSH visit.

2. That employees should aid in ensuring their own health by:

   a. Wearing gloves when possible
   b. Not smoking, eating or drinking in the immediate work environment.
   c. Washing hands before smoking, eating, or drinking.

3. When vapor degreasers are cleaned, NIOSH-approved respirators should be worn by the person performing this operation to avoid any accidental overexposure.

4. Employee education should be attempted, namely, to acquaint the worker with the chemical nature and toxicity of each substance used at the work site.

VII. REFERENCES

1. Kamburoff, P.L., and Woitowitz, H.J., & R.N. "Prediction of Spriometric Indices," Brit J. of Disease of Chest (1972).

2. Tanaka and Ikeda, Brit. J. Ind. Med. 25:214 (1968)

3. Acetone Chemical Safety Data Sheet

4. Acetone, 2 Hygienic Guide

5. NIOSH - 1,1,1,-Trichloroethane Standards Completion Project

6. Patty, Frank A., Ed., Industrial Hygiene and Toxicology, Vol. II, 1963.

7. NIOSH - 1,1,1,-Trichloroethane Criteria Document

VIII. AUTHORSHIP

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TABLE I

REDFIELD COMPANY
DENVER, COLORADO
NOVEMBER 8-11, 1976

Urine Metabolites of 1,1,1-Trichloroethane

Sample	TCA mg/liter	TCE mg/liter	Sp. Gravity	Creatinine mg/liter
01	<2	15	1.035	3.13
02	6	11	1.020	1.28
03	5	8	1.022	1.13
04	3	<2	1.022	1.95
05	4	7	1.031	2.05
06	6	16	1.027	1.83
07	8	22	1.030	3.13
08	<2	<2	1.028	1.35
09	6	<2	1.027	3.13
10	7	2	1.031	3.50
C_1	<2	<2	1.007	0.53
C_2	<2	<2	1.025	2.33
C_3	<2	<2	1.027	1.88

Lower limit of detection is 2 mg metabolite/liter;
C_1, C_2, C_3 collected from NIOSH Laboratory Personnel.

TABLE II

REDFIELD COMPANY
DENVER, COLORADO
NOVEMBER 8-11, 1976

Urine Metabolite Data Expressed as Mg Metabolite Per Liter of Urine Corrected to a Specific Gravity of 1.024

Exposed	TCA	TCE
01 Pre	<2	10
05 Post	3	5
02 Pre	7	13
06 Post	5	14
03 Pre	5	9
07 Post	6	18
Controls		
04 Pre	3	<2
08 Post	<2	<2
09 Pre	5	<2
10 Post	5	<2
C_1	<2	<2
C_2	<2	<2
C_3	<2	<2

Mean, Exposed	TCA	TCE
Pre	4 (<2-7)	11 (9-13)
Post	5 (3-6)	12 (5-18)
Mean, Controls	2 (<2-5)	<2

TABLE III

ATMOSPHERIC CONCENTRATIONS OF ACETONE AND METHYL ETHYL KETONE

REDFIELD COMPANY
July 29-30, 1976

Sample Number	Location	Job Classification	Time of Sample	Atmospheric Concentrations (mg/M^3) Acetone	Methyl Ethyl Ketone	Type of Sample
1	Scope Assembly	Scope Assembler	12:00 - 2:15	1027	19	BZ
2	Scope Assembly	Scope Assembler	12:00 - 2:15	1550	68	BZ
3	Scope Assembly	Scope Assembler	12:10 - 2:15	1066	3	BZ
4	Scope Assembly	Scope Assembler	12:06 - 2:15	1540	*	BZ
5	Scope Assembly	Scope Assembler	12:11 - 2:15	937	3	BZ
6	Scope Assembly	Scope Assembler	12:05 - 2:17	1269	2	BZ
7	Scope Assembly	Scope Assembler	10:43 - 11:17	1441	*	BZ
8	Scope Assembly	Scope Assembler	10:45 - 11:20	1014	3	BZ
9	Scope Assembly	Scope Assembler	12:50 - 2:10	1071	6	BZ
10	Scope Assembly	Scope Assembler	12:50 - 2:00	1143	5	BZ
11	Scope Assembly	Scope Assembler	7:34 - 10:30	1333	*	BZ
12	Scope Assembly	Scope Assembler	7:47 - 10:35	716	12	BZ
13	Scope Assembly	Scope Assembler	7:45 - 10:35	725	3	BZ
14	Scope Assembly	Scope Assembler	7:55 - 10:40	699	2	BZ
15	Scope Assembly	Scope Assembler	7:52 - 11:25	906	*	BZ
16	Scope Assembly	Scope Assembler	7:45 - 10:35	811	*	BZ
17	Scope Assembly	Scope Assembler	7:45 - 10:35	625	1	BZ
18	Scope Assembly	Scope Assembler	7:40 - 10:25	989	*	BZ
19	Scope Assembly	Scope Assembler	7:30 - 10:30	813	*	BZ
20	Scope Assembly	Scope Assembler	7:31 - 10:25	1292	*	BZ

(CONTINUED)

TABLE III (continued)

Redfield Company
July 29-30, 1976

Sample Number	Location	Job Classification	Time of Sample	Atmospheric Concentrations Acetone (mg/M^3)	Methyl Ethyl Ketone (mg/M^3)	Type of Sample
25	Scope Assembly	Scope Assembler	12:00 - 3:17	1000	5	BZ
26	Scope Assembly	Scope Assembler	12:05 - 3:30	823	3	BZ
27	Scope Assembly	Scope Assembler	12:05 - 3:30	863	3	BZ
28	Scope Assembly	Scope Assembler	12:10 - 3:40	1000	6	BZ
29	Scope Assembly	Scope Assembler	12:17 - 3:30	871	4	BZ
30	Scope Assembly	Scope Assembler	12:00 - 3:30	845	4	BZ
37	Scope Assembly	Scope Assembler	7:45 - 9:45	1209	3	BZ
38	Scope Assembly	Scope Assembler	7:25 - 10:00	700	3	BZ
39	Scope Assembly	Scope Assembler	7:45 - 9:45	885	6	BZ
45	Scope Assembly	Scope Assembler	7:30 - 10:00	795	2	BZ
42	Scope Assembly	Scope Assembler	7:38 - 10:00	639	2	BZ
43	Scope Assembly	Scope Assembler	7:35 - 10:00	1134	2	BZ
44	Scope Assembly	Scope Assembler	7:39 - 10:00	672	2	BZ
			EVALUATION CRITERIA	2400	590	
			NIOSH LIMIT OF DETECTION	0.01	0.01	

mg/M^3=approximate milligrams of substance per cubic meter of air

BZ=breathing zone

*=below the NIOSH lower limit of detection

TABLE IV

ATMOSPHERIC CONCENTRATIONS OF OIL MIST

REDFIELD COMPANY
July 29-30, 1976

Sample Number	Location	Job Class.	Time of Sample	Oil Mist (mg/M^3)	Type of Sample
47	Screw Machine Area	Machinist	8:15 - 1:30	0.3	BZ
48	Screw Machine Area	Machinist	8:15 - 1:30	0.3	BZ
23	Screw Machine Area	Machinist	8:15 - 2:17	1.0	BZ
			EVALUATION CRITERIA	5.0	
			NIOSH LIMIT OF DETECTION	0.05	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

TABLE V

ATMOSPHERIC CONCENTRATIONS OF 1,1,1-TRICHLOROETHANE

REDFIELD COMPANY
July 29, 1976

Sample Number	Location	Job Classification	Time of Sample	1,1,1-Trichloroethane (mg/M^3)	Type of Sample
21	Deburring	Laborer	8:05 - 11:15	523	BZ
22	Buffing	Laborer	8:01 - 11:15	367	BZ
41	Cold Wash	Laborer	8:00 - 10:00	364	BZ
36	Vapor Degreaser	Laborer	12:40 - 3:45	90	BZ
33	Punch Press	Laborer	12:40 - 3:40	154	BZ
34	Deburring	Laborer	12:45 - 3:15	52	BZ
32	Deburring	Laborer	12:45 - 3:15	48	BZ
31	Deburring	Laborer	12:45 - 3:15	42	BZ
35	General Room	---	12:50 - 3:40	567	General Room
40	Buffing	Laborer	7:50 - 9:45	2608	BZ
			EVALUATION CRITERIA	1900	
			NIOSH LIMIT OF DETECTION	0.01 µg/sample	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

µg = micrograms

TABLE VI

ATMOSPHERIC CONCENTRATIONS OF ACETONE AND METHYL ETHYL KETONE (MEK)

Redfield Company
November 9-12, 1976

Sample Number	Location	Job Classification	Time of Sample	Atmospheric Concentrations Time-Weighted Average mg/M^3 ACETONE	MEK	Type of Sample
1	Scope Assembly	First Clean	7:30- 3:30	511	*	BZ
2	Scope Assembly	First Clean	7:30- 1:30	316	*	BZ
3	Scope Assembly	First Clean	7:30- 3:30	457	*	BZ
4	Scope Assembly	Collimator	7:30- 3:30	167	*	BZ
5	Scope Assembly	Collimator	7:30- 1:30	554	*	BZ
6	Scope Assembly	Collimator	7:10- 3:10	597	121	BZ
7	Scope Assembly	Collimator	7:30- 3:30	309	6	BZ
8	Scope Assembly	Final Clean	7:50-11:50	407	32	BZ
9	Scope Assembly	Final Clean	7:45- 3:30	351	6	BZ
10	Scope Assembly	Clean and Fill	7:25- 3:30	520	*	BZ
11	Scope Assembly	Clean and Fill	7:25- 3:30	402	5.6	BZ
12	Scope Assembly	Clean and Fill	7:30- 3:30	685	*	BZ
13	Scope Assembly	Eye Piece Assembly	7:30- 3:30	539	*	BZ
14	Scope Assembly	Shell Assembly	7:35- 3:35	535	*	BZ
15	Scope Assembly	Minor Assembly	7:40- 3:40	365	1.4	BZ
16	Scope Assembly	Pressure Tester	7:48- 3:50	1677	2.4	BZ
17	Scope Assembly	Assembly	7:45- 3:30	284	3	BZ
18	Scope Assembly	Clean and Fill	7:55- 3:30	744	*	BZ
19	Scope Assembly	Turret Bushings	7:45- 3:30	501	*	BZ
20	Scope Assembly	Guide Tube Assembly	6:58- 3:00	406	*	BZ

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Table VI (continued)

Redfield Company
November 9-12, 1976

Sample Number	Location	Job Classification	Time of Sample	Atmospheric Concentrations Time-Weighted Average mg/M^3 ACETONE	MEK	Type of Sample
21	Scope Assembly	Guide Tube Assembly	7:00- 3:00	391	*	BZ
22	Scope Assembly	Guide Tube Assembly	7:00- 3:00	382	*	BZ
23	Scope Assembly	Reticule Assembly	7:00- 3:00	325	*	BZ
24	Scope Assembly	Rework Line	7:00- 3:00	338	*	BZ
25	Scope Repair	Repair	7:30- 3:30	213	*	BZ
26	Scope Repair	Repair	7:25- 2:30	191	*	BZ
27	Scope Repair	Repair	7:25- 2:30	208	*	BZ
28	Scope Repair	Repair	7:25- 2:30	94	*	BZ
29	Scope Assembly	Erector Assembly	7:25- 3:30	405	*	BZ
		EVALUATION CRITERIA		2400	590	
		NIOSH LIMIT OF DETECTION		0.01	0.01	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

* = below the NIOSH lower limit of detection

TABLE VII

ATMOSPHERIC CONCENTRATIONS OF 1,1,1-TRICHLOROETHANE

Redfield Company
November 9-12, 1976

Sample Number	Location	Job Classification	Time of Sample	Atmospheric Concentrations Time-Weighted Average 1,1,1-TRICHLOROETHANE mg/M^3	Type of Sample
22	Ultrasonic Cleaner	Vapor Degreasing	7:25-10:40	244	BZ
23	Machine Shop	Vapor Degreasing	7:30- 2:30	866	BZ
24	Machine Shop	Vapor Degreasing	7:30- 2:30	198	BZ
		EVALUATION CRITERIA		1900	
		NIOSH LIMIT OF DETECTION		0.01 µg/sample	

mg/M^3 = approximate milligrams of substance per cubic meter of air

BZ = breathing zone

µg = micrograms

TABLE VIII

REDFIELD COMPANY
DENVER, COLORADO
NOVEMBER 8-11, 1976

Urine Metabolite Data Expressed as Mg Metabolite/g Creatinine

Exposed	TCA	TCE
01 Pre	<2	5
05 Post	2	3
02 Pre	5	9
06 Post	3	9
03 Pre	4	7
07 Post	3	7
Controls		
04 Pre	2	<2
08 Post	<2	<2
09 Pre	2	<2
10 Post	2	<2
C_1	<2	<2
C_2	<2	<2
C_3	<2	<2

Mean, Exposed	TCA	TCE
Pre	3 (<2-5)	7 (5-9)
Post	3 (2-3)	6 (3-9)
Mean, Controls		
	<2 (<2-2)	<2

TABLE IX

REDFIELD COMPANY
DENVER, COLORADO
NOVEMBER 8-11, 1976

1,1,1-Trichloroethane in Serum

Control	1,1,1-Tri (mg/dl)		
100	<0.05		
Exposed			
112	0.13	mean	0.18 mg/dl
120	0.15	SD	0.08
121	0.27	range	0.13-0.27

TABLE X

REDFIELD COMPANY
DENVER, COLORADO
NOVEMBER 8-11, 1976

Acetone and MEK in Serum

Controls	Acetone (mg/dl)	MEK (mg/dl)
101	1.0	0.86
102	0.6	<0.05
103	0.8	0.64
104	1.0	0.86
105	0.5	<0.05
106	0.6	<0.05
107	1.0	<0.05
108	2.9	2.0
109	1.0	1.1
122	1.8	0.86
Exposed		
110	2.4	2.0
111	4.0	0.64
113	2.8	0.80
114	5.6	0.64
115	4.4	1.1
116	4.2	1.3
117	3.4	1.1
118	3.6	1.3
119	4.2	1.1
123	1.3	<0.05
124	2.0	0.20
125	1.4	<0.05
126	1.4	0.20
127	2.0	No MEK Exposure
128	2.0	-
129	3.6	-
130	1.8	-
131	2.4	-
132	2.6	-
133	3.5	-
134	3.1	-
135	4.8	-
136	3.2	-
137	3.8	-
138	3.6	-
139	3.3	-
140	3.2	-
141	3.8	-
142	2.4	-

Limits of detection are 0.05 mg/dl serum for both acetone and MEK.

TABLE XI

REDFIELD COMPANY
DENVER, COLORADO
NOVEMBER 8-11, 1976

Evaluation of Serum Data

	Acetone	MEK*
Controls		
n	10	10
mean	1.12 mg/dl serum	0.65 mg/dl serum
SD	0.72 mg/dl serum	0.63 mg/dl serum
range	0.5-2.9 mg/dl serum	<0.05-2.0 mg/dl serum
Exposed		
n	29	13
mean	3.10 mg/dl serum	0.81 mg/dl serum
SD	1.07 mg/dl serum	0.58 mg/dl serum
range	1.3-4.8 mg/dl serum	<0.05-2.0 mg/dl serum

* Data for MEK included values <0.05, the limit of detection which were included as 0.05 in this evaluation. This tends to introduce a bias on the high side for controls and exposed.

Limits of detection are [illegible]

TABLE XII

REDFIELD COMPANY
DENVER, COLORADO
NOVEMBER 8-11, 1976

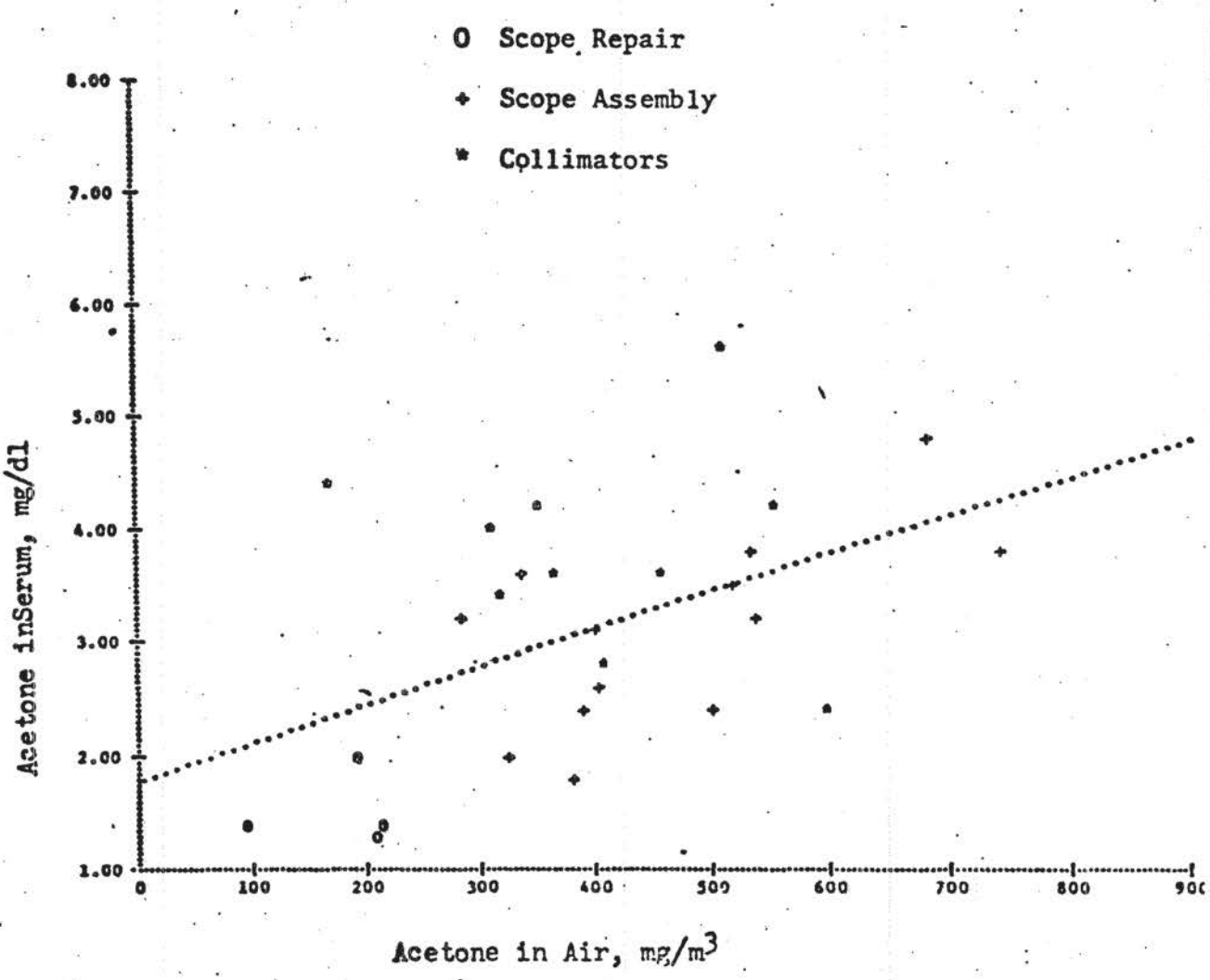
FREQUENCY OF SYMPTOMS RELATED TO SPECIFIC EXPOSURES

SYMPTOMS	1,1,1 Trichloroethane	Acetone only	MEK/Acetone	Total
Sleepiness	0	6	10	16
Burning or itchy eyes	0	4	11	15
Headache	1	4	8	13
Dry or sore throat	0	5	3	8
Nasal irritation	0	3	0	3
Tearing of eyes	0	4	1	5
Wheezing in chest	0	2	2	4
Nasal discharge	0	3	0	3
Difficulty breathing	0	2	1	3
Nausea/vomiting	0	1	2	3
Dizziness	0	2	1	3
"Drunk" feeling	0	1	2	3
Heart flutter or irriegular rhythm	0	1	2	3
Cough	0	2	0	2
Skin irritation	0	2	0	2
Pins & needles sensation in fingers & toes	0	2	0	2

Figure I

REDFIELD COMPANY
DENVER, COLORADO
NOVEMBER 8-11, 1976

Acetone in Serum vs Acetone in Air, 8 hr. TWA



Y = 1.801162 + 0.003323 X

CORRELATION COEFFICIENT = 0.479869