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 75-79-331
HEATH ENGINEERING COMPANY
FORT COLLINS, COLORADO

SEPTEMBER 1976

I. TOXICITY DETERMINATION

It has been determined that employees at Heath Engineering Company in Fort Collins, Colorado, were exposed to toxic concentrations of toluene, cadmium, iron oxide fumes, and combined exposures to isopropanol, methyl ethyl ketone (MEK), and methyl isobutyl ketone (MIBK). This determination is based on environmental data collected on May 14 and June 24, 1975, and January 20, 1976. The medical evaluation conducted on January 20 showed that employees frequently complained of burning, itching, and tearing of the eyes. Dry and sore throats were also found among many of the workers; all of these symptoms are typical of exposures to ketones such as MEK and MIBK. All blood tests were within the normal range. One worker had dermatitis about the face.

II. DISTRIBUTION AND AVAILABILITY

Copies of this hazard evaluation determination report are available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. Copies have been sent to:

(a) Heath Engineering Company
(b) U.S. Department of Labor - Region VIII
(c) NIOSH - Region VIII

For the purpose of informing 70 affected employees, copies of the report shall be provided to these employees or 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 plant management at the Heath Engineering Company, Fort Collins, Colorado, to evaluate the potential hazards associated with spray paint booths, welding operations, and various other fabrication operations performed during the manufacture of flame cutting machinery.

HEALTH HAZARD EVALUATION

A. Plant Process

The Heath Engineering Company produces flame cutting machines of the automatic variety, primarily using optical scanning techniques. The company fabricates everything from steel parts to electrical scanning components. Various parts of the finished product are spray painted. Welding and soldering also are performed at this plant. The principal air contaminants of concern in this evaluation include welding fumes and contaminants coming from the paint booths and painting rooms. Workers exposed during these operations include welders, flame cutters, spray painters, and assembly line workers.

B. Environmental Design and Methods

A preliminary observational and environmental study was conducted on May 14, 1975, by a team of two NIOSH industrial hygienists. Breathing zone and general area samples were obtained in the painting rooms on painters and painter helpers. General room samples were also collected. These samples were analyzed for isopropanol, MEK, MIBK, and toluene. The painter's exposure time varies from one to eight hours per day. Some days a painter will work continuously for eight hours, whereas other days he may only work for one hour or less. Periodic ventilation measurements were taken on the two paint booths in operation at this time. The face velocity was never below 200 linear feet per minute. All samples were collected using Sipin pumps (with flow rates of approximately 50 cubic centimeters per minute) and organic vapor sampling tubes.

The exposures of flame cutters and welders to iron oxide fumes, lead, and cadmium were also monitored. Sampling times ranged from 51 to 304 minutes. Samples were collected on AA filters using MSA Model G pumps and flow rates of 1.5 to 2.0 liters per minute.

The exposure of the metal electroplater to cadmium was also monitored. The worker performing the electroplating only stayed in the metal electroplating room for short periods. Sampling times ranged from 143 to 230 minutes. General room samples were taken in order to establish what the maximum exposure would be if a person stayed in the room continuously. The metal electroplating room has been closed since August 1, 1975. All samples were taken on AA filters using MSA Model G pumps and flow rates of 1.5 to 2.0 liters per minute.

There was one person operating a cleaning tank containing Stoddard solvent. A personal sample and a general room sample were taken using organic vapor sampling tubes and Sipin pumps with flow rates of approximately 50 cubic centimeters per minute, with sampling times of 185 and 178 minutes.

On June 24, 1975, exposures of painters to methanol were monitored. Samples were taken using a Sipin pump with flow rates of approximately 50 cubic centimeters per minute and silica gel sampling tubes. Sampling times were 180 and 178 minutes.

On January 20, 1976, a medical evaluation was scheduled; therefore, the NIOSH industrial hygienist did limited sampling of painters, welders, and flame cutters. Welders and flame cutters were monitored for exposures to iron oxide fumes and lead using methods identical to those used on May 14, 1975.

Exposures of painters to isopropanol and MEK were monitored using sampling methods identical to those used on May 14, 1975.

All breathing zone and general room samples collected for iron oxide fumes, lead, and cadmium were collected on AA filters and analyzed by atomic absorption spectroscopy. All breathing zone and general room samples collected for isopropanol, MEK, MIBK, toluene, and Stoddard solvent were collected on organic vapor sampling tubes and analyzed by gas chromatography.

C. Medical Design and Methods

A nondirected and directed medical questionnaire was administered by the NIOSH medical officer to randomly selected workers. Twenty workers were selected. Age of the cohort varied from 18 to 62 years, with a mean of 30 years. The blood of 20 workers was examined as follows in an effort to determine any changes related to the toxic substances.

1. Hematology, white blood cells, red blood cells, hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hematocrit, blood cell differential.

2. Chemistry, blood lead.

3. Urine--in this study 20 urine specimens were analyzed for protein, glucose, creatine, total hippuric acid, and cadmium.

The Personnel Department provided the shift schedule and personnel roster by job description of the production workers and administrative personnel who work in the production area. Utilizing sectional random sampling techniques, 20 workers were chosen to include all of the production procedures.

The NIOSH medical officer performed a short physical examination, emphasizing examination of the skin, auscultation of the lungs, and examination of mucous membranes of the eyes, throat, and nose.

Two 10 cc tubes of blood were collected from each worker utilizing oxylated vacuum tubes. The blood was refrigerated and sent to the National Health Laboratories, Englewood, Colorado, to perform the procedures previously described. No sample controls were used, as the normal range for these procedures are well known.

Urine specimens were collected. Each worker in the cohort was given a 125 ml specimen bottle and asked to collect the urine and return it immediately to the medical officer. This was refrigerated for transportation to NIOSH laboratories in Cincinnati, Ohio. All specimens were identified by consecutive numbers only. The NIOSH medical officer performed Ames Dipstick Test for urobilinogen. This study was performed in the field at the time of the urine collection. At the time of the visit, the cadmium plating process had been discontinued at the Heath Engineering Company plant; however, due to the delayed reaction potential of cadmium, urine cadmium levels were performed at the NIOSH laboratories.

D. Evaluation Criteria

The three sources of criteria used to assess workroom concentrations of air contaminants in this evaluation are: (1) The NIOSH criteria for recommended standards; (2) recommended and proposed threshold limit values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH) (1975); and (3) Occupational Safety and Health Standards (29 CFR 1910.1000), U.S. Department of Labor, as of January 1, 1976.

In the following tabulation of criteria, the most appropriate value is presented with its reference and other information footnoted.

Substance	Permissible Exposures 8-Hour Time-Weighted Exposure Basis	
[1]Methanol	200 ppm	
[1]Isopropanol	400 ppm	
[2]MEK	200 ppm	
[2]MIBK	100 ppm	
[3]Toluene	100 ppm	
[4]Stoddard Solvent	200 ppm	
[4]Iron Oxide Fumes	5 mg/M^3	
[3]Lead	0.15 mg/M^3	
[4]Cadmium	0.05 mg/M^3	"C"

ppm = parts per million
mg/M^3 = approximate milligrams of substance per cubic meter of air
"C" = ceiling concentration and should never be exceeded

[1]Reference: NIOSH criteria for recommended standards; recommended and proposed TLV's and their supporting documentation as set forth by the ACGIH (1975); and Occupational Safety and Health Standards (29 CFR 1910.1000) as of January 1, 1976.

[2]Reference: Recommended and proposed TLV's and their supporting documentation as set forth by the ACGIH (1975); Occupational Safety and Health Standards (29 CFR 1910.1000) as of January 1, 1976.

[3]Reference: NIOSH criteria for recommended standards; recommended and proposed TLV's and their supporting documentation as set forth by the ACGIH (1975).

[4]Reference: Recommended and proposed TLV's and their supporting documentation as set forth by the ACGIH (1975).

E. Toxic Effects of Substances

Cadmium

Cadmium is a silver-white, blue-tinged, lustrous, malleable and very ductile metal. It volatilizes and burns with a bright flame when heated in air, producing a brownish-yellow fume. The operations in which cadmium plated or cadmium containing metal parts are subject to heat treatment, welding or soldering are dangerous. Some silver solders contain 20% cadmium. Cadmium fumes have no pronounced odor or immediate irritating effect at concentrations which are sufficient to cause fatal injuries. Symptomatology following exposure may include irritation of the throat and lungs, shortness of breath, and chest tightness. Chronic exposure may cause proteinuria, glycosuria, emphysema, and elevated urine cadmium levels.[1] The present evidence indicates that serious chronic effects following exposure to cadmium can occur.

Iron Oxide

Prolonged excessive exposure to this agent gives rise to "iron pigmentation" of the lungs known as "siderosis," which is considered a benign pneumoconiosis at the present time in that it does not lead to progressive pulmonary fibrosis "scarring" or predisposes to lung cancer and tuberculosis as do asbestosis and silicosis, respectively. This type of dust or fume is found in a number of occupations such as welding, iron ore mining, foundry work, and fettling operations. Regarding the systemic absorption of iron from iron oxide inhalation, no evidence of systemic disease has been noted. With regard to local effects, mucous membrane irritation of the upper respiratory tract and sinuses have been known to occur with excessive exposure to this agent.[2]

Toluene

Toluene is a colorless, flammable liquid with an odor similar to benzene. Although toluene resembles benzene in many of its physical and chemical properties, it does not produce the chronic blood disease characteristic of benzene absorption. Toluene has a strong narcotic action, and dermatitis may result from repeated skin contact. Toluene is used extensively as a solvent for a wide variety of gum resins and fats.[3] It is also used as a diluent in cellulose ester lacquers.

Methyl Ethyl Ketone (MEK)

Methyl Ethyl Ketone is a colorless liquid with a characteristic ketonic odor. This chemical is widely used as a solvent for resins and lacquers. It can be recognized by its characteristic odor which is similar to acetone but more irritating. It is this irritant property of the vapor that limits the possibility of volunteer exposure to high concentrations. It may cause drying and irritation of the skin as well as irritation of the eyes and nasal passages.[4]

Methyl Isobutyl Ketone: (MIBK):

Methyl isobutyl ketone (MIBK) is widely used as a solvent for lacquers, cellulose, esters, vinyl polymers and copolymers and for natural and synthetic resins. MIBK does not present a serious inhalation hazard under normal industrial applications. The vapor can be irritating to the eyes, nose and throat. Workmen exposed to MIBK often complained of headache and nausea and with a tolerance developing. Repeated or prolonged exposure to the skin will cause defatting.[5] Exposure to high vapor concentractions require installation of adequate ventilation. Until ventilation is installed, approved respiratory protection must be used.

Isopropanol:

Isopropanol is an "exempt solvent" under Los Angeles "Rule 66" and San Francisco "Bay Area Three" air pollution regulations. Extensive use of it is made in reformulating solvents and thinners to meet these regulations. Isopropanol is an ingredient in several approved ethanol-based special industrial solvents. Isopropanol is an effective germicide. It is used as a rubbing compound for massage and in lotions, liniments, liquid soaps and antiseptic solutions.

Isopropanol is not classed as a highly toxic material. It does not penetrate the skin in harmful amounts nor is it a skin irritant. Contact with the eyes causes irritation comparable to liquid hand soap. The breathing of high vapor concentrations should be avoided.[6]

Stoddard Solvent:

Relatively few data are available on industrial exposures to stoddard solvent. Based on the projected toxicities of its major aliphatic components and the limited data on aromatic components present in the amount of 15%, a threshold limit for stoddard solvent of 150 or 200 parts per million is recommended to prevent narcotic and irritant responses. As a first approximation for toxicological purposes, stoddard solvent may be considered to consist of a mixture of 85% noname and isodecane and about 15% trimethylbenzene. If a TLV of 35 parts per million is assumed for trimethylbenzene, the stoddard solvent value would be 131 parts per million. This reasoning is in general agreement with the statement that heavy benzene is one and one-half times as toxic as light benzene although the data indicate a twofold ratio of toxicity or even more if concentration is based on parts per million rather than milligrams per liter.

Methyl Alcohol (Methanol)

Based on human experience and animal experimentation, the recommended maximal atmospheric concentration for eight hours of methanol is 200 parts of vapor per million parts of air by volume (ppm). Inhalation of very high concentrations produces central nervous system depression and optical nerve damage. Recovery is slow and delayed death may occur. These more serious effects and death following inhalation are reported chiefly in the older literature. Lower concentrations may cause headache, dizziness, weakness, or fatigue, gastrointestinal or visual disturbances. Many deaths or permanent eye damage have been reported from ingestion. An amount in the neighborhood of three to four ounces may be fatal, and methanol may be absorbed through the skin. Methanol has wide use as a solvent, especially in the paint and varnish, dye manufacturing, printing, photographic, and plastic industries. However, odor and irritation occur only at high concentrations. Methanol is slowly eliminated from the body, hence repeated exposures result in an increase in concentration in the blood and tissues. Headaches and blurred vision are reportedly frequent symptoms of exposure. Other manifestations include conjunctivitis, giddiness, insomnia, and gastric disturbances.[8]

Lead

NIOSH recommends that occupational exposures to inorganic lead be controlled so that workers shall not be exposed to a concentration greather than 0.15 milligrams per cubic meter of air determined as a time-weighted average exposure for an 8-hour workday.[9] Lead presents a moderate health hazard for brief exposure and a high health hazard for prolonged exposure. Lead dust and the dust and fumes of most insoluble lead compounds are readily absorbed on inhalation but to a lesser degree after ingestion. Lead and its inorganic compounds are usually not absorbed through the skin. High exposure to lead may immediately cause loss of appetitie, metallic taste in the mouth, constipation, anemia, pallor, malaise, weakness, insomnia, headache, nervous irritability, muscle and joint pains, fine tremors, encephalopathy, and colic. For the workers who repeatedly are overexposed and develop lead colic over many years, there is a tendency toward the occurrence of weakness of extensor muscle groups. This weakness may progress to palsy, often observed as a characteristic "wrist drop" or "foot drop."[10]

F. Environmental Results and Discussion

The results of environmental sampling are presented in Tables I through VII.

Concentrations of toluene measured in the painting rooms at the Heath Engineering Company ranged from 1 to 391 parts per million. Two out of ten painters' breathing zone samples exceeded the most recent evaluation criteria (samples 23 and 24 in Table I). These high values were perhaps due to improper use of spray paint booths, since the face velocity of these booths exceeded 200 linear feet per minute, and other samples taken in the same area were well below evaluation criteria. Combined exposures to isopropanol, MEK, and MIBK exceeded the most recent evaluation criteria (samples 23 and 24 in Table I). Excessive levels of these chemicals may produce burning, itching, and tearing of the eyes as well as upper respiratory irritation, which were found during the medical evaluation. All other environmental samples taken for isopropanol, MEK, and MIBK were well below the most recent evaluation criteria.

Flame cutters and welders were monitored for iron oxide fumes, lead, and cadmium (Table II). All lead and cadmium samples were below NIOSH detection limits with the exception of one cadmium sample which was 0.01 milligrams per cubic meter, which is well below the evaluation criteria of 0.05 milligrams per cubic meter. Iron oxide fume samples ranged from 0.2 milligrams per cubic meter to 13.3 milligrams per cubic meter with a mean of 4.6 milligrams per cubic meter. Two out of ten breathing zone samples grossly exceeded the most recent evaluation criteria of 5.0 milligrams per cubic meter.

Stoddard solvent concentrations were well below the most recent evaluation criteria (Table III).

Cadmium concentrations in the metal electroplating room ranged from 0.002 to 0.16 milligrams per cubic meter on May 14, 1975. Only one out of six samples exceeded the most recent evaluation criteria of 0.05 milligrams per cubic meter (Table IV). As previously mentioned, the metal electroplating shop is now closed.

Concentrations of methanol posed no health hazard. The highest concentration was 13.0 milligrams per cubic meter, and the evaluation criteria for an 8-hour exposure is 260.0 milligrams per cubic meter (Table V). On January 20, 1976, workers were monitored for iron oxide fumes, lead, isopropanol, and MEK. All environmental levels were well below the most recent evaluation criteria (Tables VI and VII).

G. Medical Results and Discussion

In this study 20 urine specimens collected from workers in the survey were analyzed for protein using the glucose oxidase oxygen rate method (Beckman Glucose Analyzer); creatine by the standard Jaffee Auto Analyzer method; total hippuric acid by the spectrophotometric method. (Tomokuni-K-Ogata, M. Clin. Chemistry, Vol. 18, p 349)

All urine test results for protein and glucose are within normal limits. The urobilinogen in the second column of Table VIII was performed by the Ames Dipstick Test in the field.

The 20 urine samples were also examined for micrograms of cadmium per ml of urine, utilizing the nitric acid ash solvent extraction method (ABDC/MIBK). For purposes of verification, the test results were compared by the direct extraction technique as well (Table IX).

Table X presents the results of blood morphology and of blood lead for those workers on which it was performed. It is noted that the mean for each column falls within the accepted normal limits. One worker had a high normal blood lead; however, it was still within acceptable limits.

Symptom complaints were given to the NIOSH medical investigator by 45% of the sample. Table XI gives the percentage response by symptom. The frequency distribution indicates burning, itching, or tearing of the eyes and dry or sore throat as the most common complaints, followed by headaches and stuffy or runny nose and subsequent coughing up of phlegm. With one exception, the dermatologic complaint seems not to be related to work practices. One worker experienced an acne-form reaction about the face.

It is interesting to note that only 40% of the work sample smoke an average of one pack of cigarettes per day (mean 18.6) for an average of 8-1/2 years (mean 8.5).

Table XII indicates upon physical examination 90-95% of the cohort were judged normal. Two workers had inflamed nasal mucosa; two workers had inflamed conjunctiva; two workers had rales in their lungs; and one worker had dermatitis as previously mentioned. One worker had pharyngitis. The respiratory symptoms were judged to be probably due to combined exposures to MEK and MIBK.

Medical and Environmental Conclusions

A medical survey at Heath Engineering Company, Fort Collins, Colorado, was concluded on January 19-21, 1976. The entire production department was seen. A sample of 20 workers were interviewed--divided among two shifts. Frequent complaints regarding burning, itching, and tearing of the eyes and dry or sore throat were found. These medical findings are consistent with over-exposures to toluene, MEK, and MIBK. All blood tests were determined to be within the normal range of mean or accounted for. One worker had dermatitis about the face.

RECOMMENDATIONS

1. Proper use of spray paint booths should be taught to all spray painters, since all paint booths had a face velocity of at least 200 linear feet per minute. Even though a spray paint booth may be operating properly with adequate ventilation, a worker will still receive excessive exposures if he stands between the part being painted and the exhaust fans.

2. In situations where the painter has to paint equipment without adequate ventilation, he should be provided with a NIOSH-approved respirator.

3. All workers new to production, and all presently employed workers in this department, should receive preplacement and periodic medical examinations consisting minimally of dermatologic examination, lung auscultation and x-ray, examination of nasal mucosa, conjunctiva, and pharynx. A complete CBC and differential should be accomplished on a routine basis. Certain workers, especially solderers, should have periodic blood lead determinations. Periodic urine examinations for proteinuria, urobilinogen, glucose, creatine, and hippuric acid should be performed on all workers using solvents, lacquers, or spray paint and all workers in adjacent exposed work areas.

4. An accurate log should be maintained on the actual work performed on a shift basis for each worker. The present practice of work rotation is desirable, but the inability to pinpoint exposure time of individual workers should be corrected.

5. The practice of hand-dipping metal parts in solvents should be discouraged. Until such time as engineering changes can be accomplished, workers should be required to wear approved gloves.

V. REFERENCES

1. Zena, Carl (ed): Occupational Medicine--Principles & Practical Applications, pp. 636-643, Year Book Medical Publishers, Chicago (1975).

2. American Conference of Governmental Industrial Hygienists: Documentation of the Threshold Limit Values for Substances in Workroom Air, third edition (1971), p. 136.

3. Ibid, p. 259.

4. Ibid, p. 165.

5. Ibid, pp. 787-788.

6. Patty, Frank (ed): Industrial Hygiene and Toxicology, Volume II, pp. 1436-1440, Interscience Publishers, New York (1963).

7. American Conference of Governmental Industrial Hygienists: Documentation of the Threshold Limit Values for Substances in Workroom Air, third edition (1971), pp. 233-235.

8. Ibid, p. 155.

9. National Institute for Occupational Safety and Health: Occupational Exposure to Inorganic Lead...Criteria for a Recommended Standard, p. I-1 (1972).

10. Ibid, p. III-3.

VI. AUTHORSHIP AND ACKNOWLEDGMENT

Report Prepared By:

Bobby J. Gunter, Ph.D.
Regional Industrial Hygienist
NIOSH - Region VIII
Denver, Colorado

Loren Hatch, M.D., Ph.D.
Medical Officer
NIOSH - Cincinnati, Ohio

Originating Office:

Jerome P. Flesch, Acting Chief
Hazard Evaluation and Technical Assistance Branch
NIOSH - Cincinnati, Ohio

The authors would like to express their appreciation to Mr. Ray Hoglund, Heath Production Manager, for his cooperation during the entire evaluation.

TABLE I

ATMOSPHERIC CONCENTRATIONS OF ISOPROPANOL, MEK, MIBK, AND TOLUENE

Heath Engineering Company
May 14, 1975

Sample Number	Location	Time of Sample (min.)	Atmospheric Concentrations Isopropanol (ppm)	MEK (ppm)	MIBK (ppm)	Combined Exposures to Isopropanol, MEK, MIBK (ppm)	Toluene (ppm)	Type of Sample
4	Waterfall Paint Booth	95	8.4	8.0	5.4		25.2	PBZ
5	Waterfall Paint Booth	96	< 0.2	15.9	3.4		17.3	PBZ
6	Painting Room	129	< 0.2	3.2	0.3		1.1	General Room
7	Waterfall Paint Booth	142	9.4	7.6	7.0		32.7	PBZ
8	Waterfall Paint Booth	142	6.3	9.5	3.3		18.0	PBZ
9	Painting Room	48	< 0.2	6.6	0.5		19.8	PBZ
20	Painting Room	103	7.5	11.9	6.3		33.3	PBZ
21	Painting Room	129	< 0.2	< 0.2	1.4		4.4	PBZ
22	Painting Room	117	7.6	9.0	5.7		28.1	PBZ
23	Painting Room	48	105.4	131.3	66.6	1.6	391.5	PBZ
24	Painting Room	58	85.5	118.9	23.4	1.0	143.3	PBZ
	EVALUATION CRITERIA		400.0	200.0	100.0	1.0	100.0	

PBZ = Painter's Breathing Zone

Lower limit of detection for all of the above chemical agents is 0.2 ppm.

TABLE II

ATMOSPHERIC CONCENTRATIONS OF Fe_2O_3, LEAD, AND CADMIUM

Heath Engineering Company
May 14, 1975

Sample Number	Location	Time of Sample (min.)	Atmospheric Concentrations			Type of Sample
			Fe_2O_3	Lead (mg/M^3)	Cadmium	
100	Flame Cutting	304	2.7	*	*	OBZ
101	Welder	268	0.2	*	0.01	WBZ
102	Welder	168	4.9	*	*	WBZ
104	Welder	51	12.6	*	*	WBZ
106	Welder	69	13.3	*	*	WBZ
203	Welder	149	2.1	*	*	WBZ
204	Welder	150	0.2	*	*	WBZ
205	Welder	58	4.8	*	*	WBZ
207	Flame Cutting	135	1.7	*	*	OBZ
208	Welder	90	3.7	*	*	WBZ
	EVALUATION CRITERIA		5.0	0.15	"C" 0.05	

"C" = Ceiling concentration and should never be exceeded

OBZ = Operator's Breathing Zone

WBZ = Welder's Breathing Zone

* = Lower limit of detection for lead is .006 mg per sample; for cadmium it is .002 mg per sample.

TABLE III

ATMOSPHERIC CONCENTRATIONS OF STODDARD SOLVENT

Heath Engineering Company
May 14, 1975

Sample Number	Location	Time of Sample (min.)	Atmospheric Concentrations Stoddard Solvent (mg/M^3)	Type of Sample
2	Cleaning Area	185	103.2	OBZ
3	Cleaning Area	178	< 0.1	General Room
		EVALUATION CRITERIA	575.0	

OBZ = Operator's Breathing Zone

TABLE IV

ATMOSPHERIC CONCENTRATIONS OF CADMIUM

Heath Engineering Company
May 14, 1975

Sample Number	Location	Time of Sample (min.)	Atmospheric Concentrations Cadmium (mg/M^3)	Type of Sample
103	Metal Electroplating	230	< 0.002	General Room
200	Metal Electroplating	146	< 0.002	OBZ
202	Metal Electroplating	153	0.01	General Room
206	Metal Electroplating	143	0.16	OBZ
1	Metal Electroplating	178	0.03	OBZ
2	Metal Electroplating	173	0.002	OBZ
	EVALUATION CRITERIA		0.05	

OBZ = Operator's Breathing Zone

The lower limit of detection for cadmium is 0.002 mg.

TABLE V

ATMOSPHERIC CONCENTRATIONS OF METHANOL

Heath Engineering Company
June 24, 1975

Sample Number	Location	Time of Sample (min.)	Atmospheric Concentrations Methanol (mg/M^3)	Type of Sample
1	Waterfall Paint Booth	180	7.0	OBZ
2	Waterfall Paint Booth	178	13.0	OBZ
		EVALUATION CRITERIA	260.0	

OBZ = Operator's Breathing Zone

TABLE VI

ATMOSPHERIC CONCENTRATIONS OF IRON OXIDE FUMES AND LEAD

Heath Engineering Company
January 20, 1976

Sample Number	Location	Time of Sample (min.)	Atmospheric Concentrations		Type of Sample
			Iron Oxide Fumes (mg/M^3)	Lead (mg)	
1	Pedestal Welding	155	1.31	< 0.006	WBZ
2	Pedestal Welding	155	0.84	< 0.006	WBZ
3	Flame Cutting	155	0.16	< 0.006	WBZ
4	Flame Cutting	155	0.24	< 0.006	WBZ
	EVALUATION CRITERIA		5.0	0.15	

WBZ = Welder's Breathing Zone

Lower limit of detection for iron oxide is 0.001 mg per sample; for lead it is 0.006 mg per sample.

TABLE VII

ATMOSPHERIC CONCENTRATIONS OF ISOPROPANOL AND MEK

Heath Engineering Company
January 20, 1976

Sample Number	Location	Time of Sample (min.)	Isopropanol (ppm)	MEK (ppm)	Type of Sample
2887	Painting Room	170	*	*	PBZ
2889	Painting Room	168	*	*	PBZ
		EVALUATION CRITERIA	400	200	

PBZ = Painter's Breathing Zone

* = All samples were below 0.01 mg per sample, which is the lower limit of detection by the most recent analytical methods.

TABLE VIII

Urine Examination Results

Heath Manufacturing Company

Name	Protein in mg/dl	Urobilinogen	Glucose in mg/dl	Creatinne in mg/dl	Hippuric acid mg/ml	mg Hippuric per mg/Creat.
1	0	0	5	20	0.40	2.00
2	4	0	10	208	5.33	2.56
3	2	1	7	148	0.63	0.43
4	9	0	8	183	0.70	0.38
5	4	1	7	190	3.87	2.04
6	0	0	6	88	0.30	0.34
7	4	1	4	163	0.47	0.29
8	4	1	5	43	0.53	1.23
9	4	0	6	190	0.23	0.12
10	4	1	9	178	0.50	0.28
11	4	.5	5	148	0.57	0.39
12	4	.5	6	238	0.90	0.38
13	13	1	14	203	3.13	1.54
14	2	1	7	233	2.10	0.90
15	2	1	4	63	0.87	1.38
16	4	1	6	180	3.50	1.94
17	2	.5	5	163	1.13	0.69
18	2	0	4	88	1.27	1.44
19	2	.5	6	128	0.60	0.47
20	0	0	5	48	0.53	1.10
Mean	3.50	.55	6.45	140.2	1.38	1.00
Std. Dev.	3.02	.46	2.39	65.6	1.44	.73

TABLE IX

Heath Manufacturing Company
Ft. Collins, Colorado

Microgram Cadium/ml Urine
(0 → .0004)

1	.0002
2	.0011
3	.0004
4	.0009
5	.0002
6	.0003
7	.0004
8	.0005
9	.0018
10	.0004
11	.0029
12	.0006
13	.0005
14	.0012
15	.0006
16	.0032
17	.0004
18	.0012
19	.0006
20	.0006

TABLE

Heath Manufac. ..g Company
Ft. Collins, Colorado

Blood Examination Results

Men and Women	(4.8-10.8) WBC x 10^3	(4.2-6.2) RBC x 10^6	(12-8) Hgb gm	(37-52) HCT %	(79-97) MCV uu	(27-31) MCH uug	(32-36) MCHC %	(40-65%) Polys %	(20-40%) Lymph %	(4-8%) Mono %	(1-3%) EOS %	(0-30 Lead ug
1	6.5	4.70	15.2	42.4	87.	31.4	35.6	41	57	0	2	
2	5.8	4.90	15.7	42.3	84.	31.1	36.7	45	54	0	1	
3	6.7	5.54	16.5	46.1	81.	28.9	35.4	52	41	3	4	
4	8.2	5.40	15.3	42.1	76.	27.5	36.0	85	15	0	0	
5	7.2	5.23	14.6	40.3	75.	27.1	35.8	47	50	0	3	
6	7.9	5.18	16.8	45.7	86.	31.4	36.3	39	58	2	1	
7	9.3	5.32	16.5	46.9	86.	30.1	34.8	59	40	1	0	
8	6.7	5.07	15.7	44.7	86.	30.2	34.8	48	50	0	2	
9	6.8	5.09	15.3	43.4	83.	29.2	34.8	80	19	0	1	
10	6.4	5.28	15.1	42.0	78.	27.8	35.6	67	33	0	0	17
11	10.8	4.79	15.3	44.4	90	31.0	34.1	71	27	2	0	
12	8.1	5.91	18.1	51.8	86.	29.6	34.4	79	21	0	0	12
13	8.0	5.06	15.4	44.4	85.	29.6	34.4	66	33	0	1	
14	7.2	5.21	16.3	45.5	85.	30.4	35.4	84	16	0	0	12
15	7.7	4.96	15.1	43.7	86.	29.6	34.1	60	32	1	7	7
16	12.1	5.06	15.1	42.4	82.	28.9	35.1	71	26	0	3	
17	7.0	4.77	14.4	41.7	85.	29.3	34.2	47	51	0	2	
18	9.0	5.04	15.1	43.5	84.	29.2	34.4	69	29	2	0	
19	5.0	4.69	14.1	41.0	85.	29.2	34.1	40	60	0	0	
20	6.8	5.04	15.9	45.2	87.	30.8	34.8	89	11	0	0	25
Mean	7.66	5.11	15.6	44.0	83.9	29.6	35.0	62.0	36.2	.6	1.4	14.6
Std. Dev.	1.66	.30	.9	2.57	3.8	1.2	.8	16.4	15.8	.9	1.8	6.8

TABLE XI

Heath Manufacturing Company
Ft. Collins, Colorado

System Complaints Related to Work

	Sometimes	Usually
Burning, itching and tearing of eyes	40%	5%
Dry or sore throat	35%	
Headaches	25%	5%
Stuffy, runny or sore nose	25%	5%
Itching of skin	20%	
Dryness of skin	15%	5%
Irritation of skin	15%	5%
Nasal irritation	15%	5%
Coughing and phlegm	15%	5%
Shortness of breath	10%	
Chest tightness, soreness and heaviness	10%	
Wheezing/whistling in chest	5%	

TABLE XII

Heath Manufacturing Company
Ft. Collins, Colorado

Physical Findings

	Percent	
	Positive	Negative
Inflamed Tubrinates	10	90
Conjunctiva	10	90
Pharyngitis	5	95
Lungs (auscultation)	10	90
Skin	5	95