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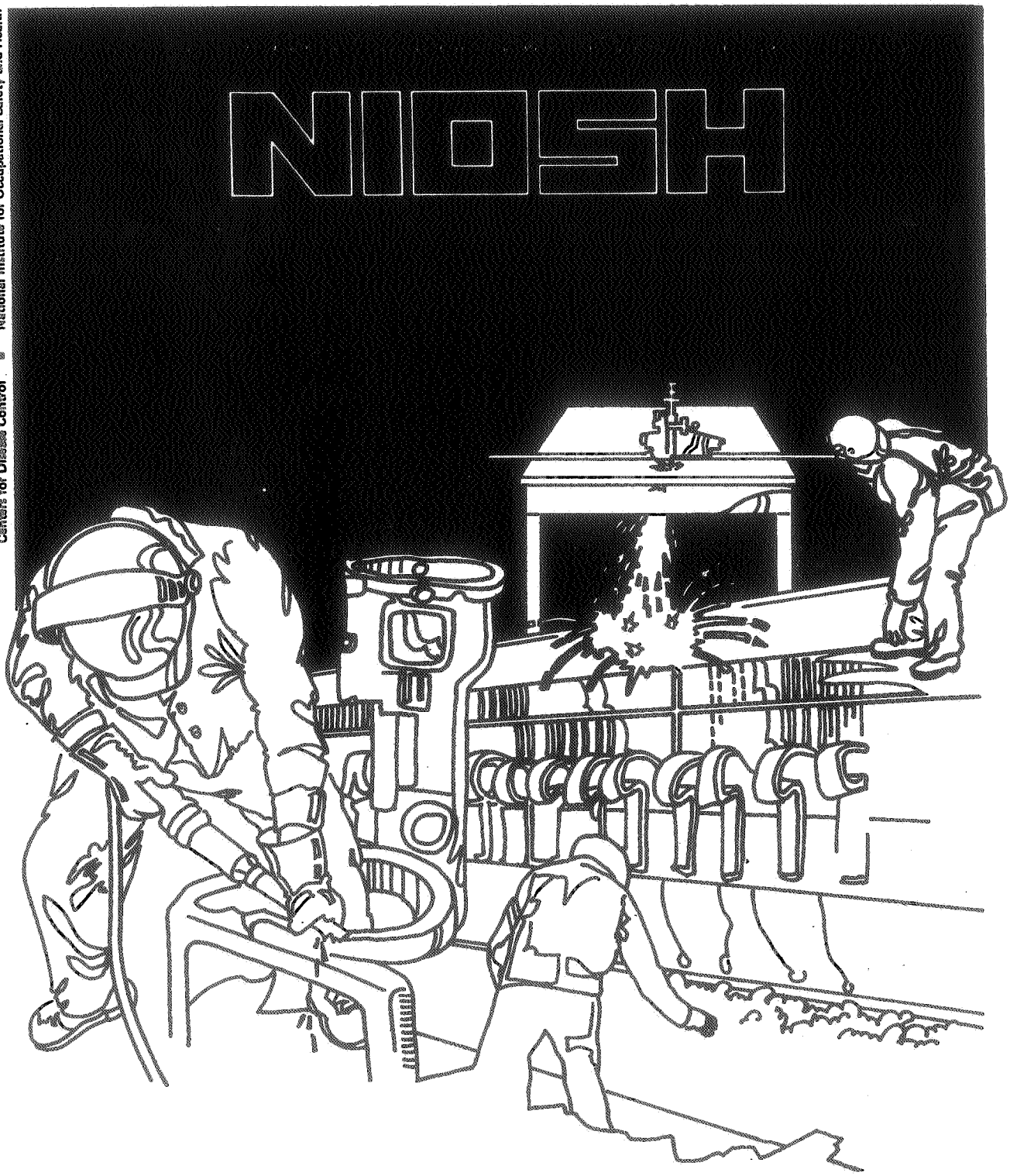
NIOSH



Health Hazard Evaluation Report

HETA 80-168-1204
ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from 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 Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 80-168-1204
OCTOBER 1982
ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA

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I. SUMMARY

In April 1980, the National Institute for Occupational Safety and Health (NIOSH) received a request from the local union to evaluate reports of various neurological and psychological problems among workers at Rola-Esmark, DuBois, Pennsylvania. At the time of the study, approximately 140 workers were employed at this plant in the manufacture of automobile stereo speakers.

On July 28-30, 1980, NIOSH investigators conducted industrial hygiene sampling and employee interviews at the plant. Personal breathing zone samples, primarily for measuring exposure to organic solvent vapors, were collected on activated charcoal and analyzed in accordance with NIOSH Method P&CAM 127. A medical interview was administered to 20 randomly selected workers who were employed or had been employed in areas where solvents and glues are used.

Workers were found to have low-level exposures to solvent vapor mixtures comprised of toluene, 1,1,1-trichloroethane, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), trichloroethylene, butyl acetate, ethanol, acetone, 1,1,2-trichloro - 1,2,2-trifluoroethane, and methyl methacrylate. Assuming additivity, combined exposure levels ranged from 1.0% to 38% of the recommended standards with a mean of 7% of the recommended standards. The major component of the higher exposures was trichloroethylene (TCE) in the Woofer-Tweeter Assembly Department where 8-hour average concentrations ranged from 0.3 to 8.0 ppm with a mean of 2.3 ppm. NIOSH recommends an 8-hour exposure limit of 25 ppm for TCE.

Environmental data also were collected by industrial hygiene consultants for Rola-Esmark shortly before the NIOSH study. The results are particularly useful because they offer a comparison between solvent vapor exposures that were present when the plant was operating at full capacity (356 workers) versus the exposures found by NIOSH during operations with a reduced workforce (140 workers). Average personal breathing zone concentrations of organic vapor mixtures were over twice those found by NIOSH, however, most were still well below the evaluation criteria. TCE concentrations were still the most significant individual environmental finding. Of the 49 workers who were sampled, two were overexposed to TCE at concentrations of 39 and 28 ppm.

A high proportion of the 19 women workers interviewed reported mucous membrane (eye, nose, and throat) irritation (84%), neurological (headaches, dizziness, tremor, fatigue) symptoms (79%), skin-related symptoms (58%) and depression (53%).

Based on the results of this evaluation, workers were exposed to solvents at concentrations well below current environmental criteria. However, a high prevalence of symptoms compatible with solvent exposure was found.

Recommendations for reducing solvent exposures are presented in Section IX of this report.

KEYWORDS: SIC 3651 (Radio Receiving Systems), speaker systems manufacturing, organic solvent mixtures, trichloroethylene, TCE, mucous membrane irritation, neurological effects, psycological effects.

II. INTRODUCTION

In April 1980, NIOSH received a request for a health hazard evaluation at the Rola-Esmark Company, DuBois, Pennsylvania. The request was submitted by the International Association of Machinists and Aerospace Workers who asked NIOSH to evaluate reports of the following health complaints among workers: headaches; dizziness; nausea; menstrual disorders; loss of hair; increased heartbeat; abdominal cramps; weakness of hands, eyes, and legs; and "high" and "low" feelings.

Environmental and medical results of the NIOSH survey were distributed as interim reports in August 1980, October 1980, and April 1981.

III. BACKGROUND

Rola-Esmark manufactures automobile stereo speakers by mass production on assembly lines. Two weeks prior to the NIOSH survey there were 350 production workers, but due to massive layoffs only 140 were still employed at the time of the survey. The three main assembly lines still in operation were the voice coil assembly, woofer and tweeter assembly, and the co-ax or tri-ax assembly.

The voice coil assembly involves a wire winding operation in which a solvent consisting mostly of ethyl alcohol is used to aid in the adhesion to the coil. The woofer and tweeter assembly contains 10-15 stations where various glues, cements, adhesives, and paints are applied either manually or automatically to speaker components. The co-ax or tri-ax assembly involves three stations where adhesives are applied and two stations where fine wiring is soldered with a lead-tin alloy. Other areas of the plant include some spray painting, cleaning with solvents, and faulty speaker tear down and parts salvaging.

IV. EVALUATION DESIGN AND METHODS

A. Environmental

NIOSH collected 30 personal breathing-zone air samples on July 29-30, 1980, to evaluate workers' exposure to organic vapor contaminants throughout the plant. The samples were collected on activated charcoal using calibrated sampling pumps operating at 50 cc/min over a seven hour sampling period. The samples were desorbed in carbon disulfide and analysed by gas chromatography according to NIOSH Method P&CAM 127.

One personal breathing zone and six area air samples for the measurement of benzoyl peroxide exposure were taken on mixed cellulose-ester filters at a flow rate of 1.5 liters/min. Analysis was by high pressure liquid chromatography according to NIOSH Method S-253.

Industrial hygiene data was also evaluated from previous OSHA investigations and studies done by industrial hygiene and toxicology consultants for Rola-Esmark.

B. Medical

On July 28, 1980, medical interviews were conducted with 20 randomly selected workers who were employed or had been employed in areas where solvents and glues are used. Information on health history, occupational history and prevalence of symptoms were obtained.

V. EVALUATION CRITERIA

Environmental evaluation criteria and the principal health effects of the substances evaluated in this study can be found in Table I. NIOSH recommended exposure limits were used as the evaluation criteria. The current ACGIH recommended threshold limit values (TLV) were used to evaluate those substances for which NIOSH has not yet developed a recommended standard. Current OSHA standards are also presented in Table I. A more detailed discussion of TCE is presented here since it was found to be the major single component of the higher solvent exposures.

Toxic Effects of Trichloroethylene

Acute exposure to trichloroethylene is known to cause drowsiness, dizziness, weakness, tremor, loss of coordination, and mental confusion.[1] Severe exposures can result in coma, heart rhythm disturbances, and death. Other toxic effects include respiratory tract irritation, nausea, vomiting, abdominal cramps, and liver abnormalities. Intolerance to alcohol has been reported, resulting in intoxication and skin flushing after ingestion of relatively small amounts.[2,3] Alcohol is known to make trichloroethylene more toxic to the liver in mice and to alter trichloroethylene metabolism in humans.[4,5]

Based on studies performed by the National Cancer Institute which found TCE to cause cancer in animals, NIOSH considers TCE to be a suspect human carcinogen.

NIOSH currently recommends that exposure to TCE be limited to 25 parts per million (ppm) as an 8-hour time-weighted average (TWA). The current OSHA standard for trichloroethylene is 100 ppm for an 8-hour TWA, 200 ppm as a 15-minute ceiling, and 300 ppm as a 5-minute ceiling within and 2-hour period.

Solvent Mixtures

When evaluating mixed exposure to substances, such as solvents, which affect the body in a similar fashion, their combined health effects should be given primary consideration. That is, if the sum of the following fractions, $\frac{\text{exposure level(1)}}{\text{evaluation criteria(1)}} + \frac{\text{exposure level(2)}}{\text{evaluation criteria(2)}} + \ldots + \frac{\text{exposure level(n)}}{\text{evaluation criteria(n)}}$ exceeds 1.0, then exposure to the mixture is considered excessive.[8]

VI. RESULTS AND DISCUSSION

A. Environmental

Organic Vapors

Thirty personal breathing-zone exposures to toluene, 1,1,1-trichloroethane, MEK, MIBK, trichloroethylene, butyl acetate, ethanol, acetone, 1,1,2-trichloro - 1,2,2-trifluoroethane, and methyl methacylate were identified and quantitated from the charcoal tube samples (Table II).

Trichloroethylene exposure in the Woofer-Tweeter Assembly Department was the single most significant environmental finding. Workers in that area were exposed to 8-hour TWA concentrations of TCE ranging from 0.3 to 8.0 ppm with a mean of 2.3 ppm. All other organic vapor exposures were further below the applicable criteria.

When considering the combined exposure to all of the organic vapor contaminants, workers throughout the plant were exposed to levels ranging from 1.0% to 38% with a mean of 7% of the evaluation criteria.

Data collected by the industrial hygiene consultants for Rola-Esmark in June 1980 (Table III) offers an interesting comparison between solvent vapor levels that were present when the plant was operating at full capacity (356 workers) versus the contaminant concentrations found by NIOSH during operations with a reduced workforce (140 workers). Personal breathing zone concentrations of TCE during part of the woofer-tweeter assembly (listed as Department 30 in Table III) ranged from 0.8 to 39 ppm with a mean of 10 ppm.

Combined exposures to solvent vapors throughout the plant ranged up to 49% with a mean of 15% of the evaluation criteria used in that study (ACGIH TLV's). When using NIOSH criteria, however, two workers were overexposed by about 180% and 130%. These overexposures were due primarily to TCE at concentrations of 39 and 28 ppm.

It could be argued that the NIOSH recommended exposure limit of 25 ppm for TCE should not be used for assuming additivity when combining solvent vapor exposures since the TCE exposure limit was lowered, in part, because of its suspected carcinogenic potential. However, considerable evidence was found by NIOSH to challenge the current Federal standard (100 ppm) based upon acute health effects alone. Narcotic, irritating, and behavioral effects have been documented at TCE levels of one-fourth to one half the OSHA limit. These effects are similar to those experienced from exposure to "typical" solvents and, therefore, should be considered additive.

Although benzene concentrations were too low to be quantitated during the NIOSH survey, low levels were found by the industrial hygiene consultants for Rola-Esmark. Workers were exposed to benzene concentrations ranging up to 1 ppm with a mean of 0.2 ppm. The industrial hygienist concluded that the benzene was probably present as an impurity in the aromatic hydrocarbon mixture used in one of the cements (#046-01376 black). Its use has since been discontinued.

It should be noted that the NIOSH recommended exposure limit of 1 ppm for benzene could not be used for assuming additivity when evaluating exposure to typical solvent mixtures. The recommended standard is based on blood changes caused by chronic exposure to benzene as opposed to the acutely irritating and narcotic effects that occur at much higher concentrations.

Benzoyl Peroxide

Benzoyl peroxide is used as an accelerator for polymerizing methyl methacrylate in one of the adhesive systems. The operator working with this material was exposed to 0.97 mg/M^3 during the NIOSH survey (Table IV). Area samples ranged from <0.03 mg/M^3 to 0.32 mg/M^3. The industrial hygiene consultants for Rola-Esmark found that workers were exposed to benzoyl peroxide concentrations ranging from <0.03 mg/M^3 to 0.11 mg/M^3 (Table V).

Tertiary Amines

One of the adhesives in the Head Assembly area contains 4% tertiary amines. Industrial hygiene consultants for Rola-Esmark collected 10 personal breathing zone samples for tertiary amines but none were detected (Table VI).

OSHA Sampling Results

OSHA sampling data from 1974 through 1978 is presented in Table VII. Generally, the same array of low-level organic vapors that were found by NIOSH and others also were documented by OSHA. In addition, lead, tin, and formaldehyde were sampled during soldering operations. Formaldehyde was found in one 8-hour air sample at a concentration of 0.028 ppm. No lead or tin was detected in air samples.

Ventilation

Extensive local exhaust ventilation has been installed at the assembly line stations. Most gluing, soldering and painting operations are exhausted. Ventilation measurements showed that capture velocities ranged from 300-600 feet per minute (fpm) at gluing stations, 50-200 fpm at the soldering hoods, and 200-400 fpm at the spray painting booths. Some general deficiencies in ventilation design such as imbalanced air flows and abrupt hood entries were noted. However, the worst problem with the ventilation system was observed to be caused by some of the 20-30 floor fans located all over the plant for worker comfort. Many of the assembly line stations had fans blowing 100-600 fpm across the capture zones of the local exhaust ventilation, thus severely affecting their capture efficiency.

B. Medical

A medical and mental health interview was administrated to 20 workers (19 female, 1 male). Results are summarized in Table VIII. The majority of female workers were over 30 years of age and had a high school education. They had worked at Rola-Esmark for 4.2 years on the average. A high proportion of these workers reported severe headaches (79%), dizziness (68%), balance problems (58%), tremor (47%), fatigue (79%), and depression (53%). Reports of skin problems and upper respiratory and eye irritation were also quite prevalent. Ten of the 19 women interviewed had abnormal scores on the Center for Epidemiological Studies Depression Scale. A semi-structured psychiatric diagnostic interview confirmed this finding and also noted other emotional problems in a high proportion of these workers.

VII. DISCUSSION

Workers were exposed to airborne contaminants at concentrations well below the evaluation criteria during the NIOSH investigation.

Even when the plant was operating at peak capacity, exposure to most contaminants were below the evaluation criteria except for trichloroethylene which was found to exceed the more recent NIOSH recommended standard of 25 ppm in two workers' breathing zones. The industrial hygiene and toxicology consultants who conducted that study concluded: "all [contaminant concentrations] were so far below the accepted exposure limits [based on ACGIH TLV's] that effect on the health of the workers cannot be anticipated."

These types of conclusions have been voiced ever since Pennsylvania state officials began documenting "no excessive exposures" at the Rola plant in 1965. Unfortunately, such findings have always fallen short of elucidating the complaints of health problems and their causes. A high proportion of workers still appear to experience neurological and psycological problems consistent with the effects of solvent exposure despite extensive installation of ventilation controls and demonstrably low levels of exposure.

One possible explanation is that the "accepted" exposure limits are sometimes not adequate indicators of potential health hazards. Much of the past documentation for exposure to many substances is based, primarily, on studies of men exposed to a single compound. This workforce is comprised almost entirely of female workers exposed to mixtures of many compounds.

Women, having more fat per body weight (about 20% for women versus 10% for men), probably stand a greater risk from exposure to compounds which are fat soluble. Most organic solvents are fat soluble, particularly one important compound of this study, trichloroethylene. Because of their high affinity for fat, TCE and its metabolites have a fairly long half-life. The results of one study found this to be about 32 hours for men and 36 hours for women.[9] Several of the health hazard evaluations which helped prompt the reduction of the NIOSH recommended standard for TCE involved significant numbers of women in the workforces that were studied.[10]

Another important issue involves the assumption of additivity for evaluating mixtures of organic solvents. Some mixtures are more toxic than exposures to the individual compounds added together. A good pair of examples mentioned earlier would be trichloroethylene and ethyl alcohol. Because of the difficulty involved in studying complex mixtures, most research in joint toxicity has considered only the effects of two compounds at a time. This evaluation must consider exposures to several compounds simultaneously.

Scandinavian researchers have recently expended considerable epidemiological effort on the effects of multiple solvent mixtures, particularly behavioral and psycological effects, which they consider to be the early warning signs of later neurological disease.[11] For instance, one study of 168 Finnish workers with a history of exposure to TCE, tetrachloroethylene, toluene, and xylene found that the workers performed worse than the controls on most psycomotor and intelligence tests and tests of visual accuracy.[12]

The most extensive epidemiological study of solvents that is relevant to this evaluation has been one of Finnish car painters in 1976-1980. Exposures were to a mixture of toluene, xylene, butyl acetate and white spirits for a mean duration of 15 years. Average combined exposures were less than 32% of ACGIH TLV's. When matched with railroad engineers as controls, researchers found more memory disturbances, decreased vigilence and more absent mindedness among the car painters. Visual intelligence and verbal memory were the most affected. The authors concluded that car painters, although not ill in the clinical sense, showed clear signs of central and peripheral nervous system lesions more often than members of the control group.[13,14,15,16]

VIII. RECOMMENDATIONS

In view of the increasing amount of literature citing adverse health effects associated with low-level exposure to solvent mixtures, it would be prudent to control exposures to the lowest feasible levels. Specifically, the reduction of TCE exposure in the Woofer-Tweeter assembly area would be the most beneficial in terms of the evaluation criteria used in this study.

It may be feasible to substitute some of the currently used adhesives for those that contain little or no TCE. The local exhaust ventilation at those few work stations that use products containing large amounts of TCE could also be improved. More efficient hood designs should be used for increasing capture efficiency. Cross drafts from portable floor fans and open windows also have been shown to interfere with many of the local exhaust systems. These interferences should be controlled as much as possible.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Rola-Esmark Company, DuBois, Pennsylvania
2. International Association of Machinists and Aerospace Workers
3. NIOSH, Region III
4. OSHA, Region III

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

EVALUATION CRITERIA FOR HAZARDOUS SUBSTANCES

ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA
HETA 80-168

Contaminant	OSHA Permissible Exposure Limit	ACGIH Threshold Limit Value	NIOSH Recommended Standard	Principle Health Effects
Toluene	200 ppm	100 ppm	100 ppm	fatigue, weakness, confusion, euphoria, dizziness, headache, dilated pupils, lacrimation (watering of the eyes), nervousness, muscular fatigue, insomnia, paresthesias (abnormal sensations)
Xylene	100 ppm	100 ppm	100 ppm	irritation of the eyes, mucous membranes and skin; in high concentrations dizziness, excitement, drowsiness, incoordination, staggering gait, loss of appetite, nausea, vomiting, abdominal pain.
MIBK	100 ppm	100 ppm	50 ppm	dermatitis; irritation of the eyes, nose and throat; nausea; headache; in high concentrations drowsiness, weakness, dizziness, and staggering gait.
MEK	200 ppm	200 ppm	200 ppm	dermatitis of exposed skin; irritation of the eyes, nose and throat at lower concentrations (100-200 ppm); headache, nausea, light headedness, vomiting, dizziness and incoordination at higher concentrations.
Isopropanol	400 ppm	400 ppm	400 ppm	irritation of eyes, nose, and throat; in high concentrations dizziness, drowsiness, and incoordination.
1,1,1-Trichloroethane	350 ppm	350 ppm	350 ppm 15 min. exposure limit	dermatitis; irritation to eyes, skin, and respiratory tract; nausea, fatigue weakness, sleepiness, lightheadedness.
Acetone	1,000 ppm	750 ppm	250 ppm	irritation of the eyes, nose, throat, and skin; nausea; headache; in high concentrations drowsiness, weakness, dizziness, and staggering gait.

TABLE I (continued)

EVALUATION CRITERIA FOR HAZARDOUS SUBSTANCES

Contaminant	OSHA Permissible Exposure Limit	ACGIH Threshold Limit Value	NIOSH Recommended Standard	Principle Health Effects
Trichloroethylene	100 ppm	100 ppm	25 ppm	drowsiness, dizziness, weakness, mental confusion, respiratory irritation; carcinogenic to rodents at very high concentrations.
Butyl Acetate	150 ppm	150 ppm	-	irritating to the eyes, mucous membranes and skin; in high concentrations dizziness, drowsiness, weakness.
Ethanol	1000 ppm	1000 ppm	-	in very high concentrations irritation of the eyes and respiratory tract, headache, drowsiness.
1,1,2-Trichloro-1,2,2-Trifluoro-ethane	1000 ppm	1000 ppm	-	in very high concentrations irritation of the eyes and respiratory tract, headache, drowsiness.
Methyl Methacrylete	100 ppm	100 ppm		irritation of the eyes, mucous membranes and skin; in high concentrations dizziness, drowsiness, nausea, incoordination.
Benzene	10 ppm	10 ppm	1.0 ppm Ceiling	irritation of skin, eyes, and respiratory tract; in high concentrations dizziness, headaches, and nausea; chronic exposure may cause blood changes including leukemia.
Benzoyl Peroxide	5 mg/M^3	5 mg/M^3	5 mg/M^3	irritation of skin, eyes, and respiratory tract

TABLE II

NIOSH
PERSONAL AIR SAMPLES FOR ORGANIC VAPORS (ppm)

ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA
HETA 80-168
July 29-30, 1980

Location	Sampling Time	Toluene	1,1,1-Trichloro Ethane	Methyl Ethyl Ketone	Methyl Isobutyl Ketone	Trichloro-Ethylene	Butyl Acetate	Ethanol	Acetone	1,1,2-Trichloro-1,2,2-Trifluoro-Ethane	Methyl Methacrylate	Combined Exposure Ratio
Painting Department	7:05-14:40	1.6	2.8	0.3	N.D.*	0.2	0.6	-**	-	-	-	0.04
"	7:05-14:40	0.6	4.1	0.2	N.D.	N.D.	0.2	-	-	-	-	0.02
"	7:10-14:40	1.6	4.2	0.3	0.1	0.1	0.5	-	-	-	-	0.04
"	7:10-14:40	0.8	15	0.3	N.D.	0.2	0.9	-	-	-	-	0.07
"	7:50-15:15	1.1	7.6	0.3	N.D.	0.2	0.6	-	-	-	-	0.05
Coil Winding Department	7:20-14:40	-	-	0.3	N.D.	N.D.	-	4.0	1.5	1.6	-	0.03
"	7:20-15:00	-	-	0.7	0.3	N.D.	-	28	1.4	1.5	-	0.06
"	7:25-15:00	-	-	N.D.	N.D.	N.D.	-	0.8	2.8	2.4	-	0.02
"	7:25-15:15	-	-	0.3	0.3	0.1	-	13	2.9	1.3	-	0.05
Woofer-Tweeter Assembly	7:30-15:00	N.D.	N.D.	N.D.	1.3	2.2	-	-	-	1.1	1.3	0.13
"	7:30-15:00	0.4	N.D.	0.5	0.8	1.3	-	-	-	5.4	N.D.	0.08
"	7:30-15:00	0.2	N.D.	0.2	1.0	1.9	-	-	-	0.6	N.D.	0.10
"	7:40-15:00	0.2	N.D.	0.2	0.3	0.4	-	-	-	3.3	N.D.	0.03
"	7:30-15:15	0.2	N.D.	0.4	0.3	0.3	-	-	-	6.7	N.D.	0.04
"	7:30-15:15	0.4	0.3	0.2	3.5	6.5	-	-	-	0.4	N.D.	0.34
"	7:35-15:15	0.4	0.3	0.2	3.5	8.0	-	-	-	0.4	N.D.	0.39
"	7:40-15:15	0.3	0.5	0.5	0.5	0.6	-	-	-	0.8	N.D.	0.04
"	7:45-15:15	0.3	0.7	0.5	0.3	0.4	-	-	-	0.6	N.D.	0.03
"	7:45-15:15	0.4	0.4	0.5	1.3	1.4	-	-	-	0.4	N.D.	0.09
Woofer-Tweeter Finishing	7:40-15:10	0.2	N.D.	0.9	0.2	0.4	-	-	-	4.6	N.D.	0.03
"	7:45-15:15	1.0	0.1	0.4	0.2	1.3	-	-	-	0.8	N.D.	0.07
"	7:45-15:20	0.2	0.1	0.2	N.D.	0.2	-	-	-	0.6	N.D.	0.01
"	7:15-15:15	0.8	0.4	1.9	0.3	0.3	-	-	-	0.9	N.D.	0.03
Co-Ax, Tri-Ax Assembly	7:55-15:15	0.4	0.9	0.4	N.D.	0.6	-	-	-	0.2	N.D.	0.03
"	7:55-15:15	0.4	0.5	0.4	N.D.	0.6	-	-	-	0.2	N.D.	0.03
"	8:00-15:15	0.4	0.5	0.4	N.D.	0.4	-	-	-	0.2	N.D.	0.02
"	8:05-15:15	0.4	0.5	0.5	0.4	0.6	-	-	-	0.2	N.D.	0.04
"	8:10-15:15	0.4	0.5	0.5	0.4	0.6	-	-	-	0.2	N.D.	0.04
Hot-Plate Tear-Down Department	7:15-15:15	0.4	0.3	0.5	0.4	0.1	-	-	-	0.2	N.D.	0.02
"	7:15-15:15	0.4	0.3	0.5	0.4	0.1	-	-	-	0.2	N.D.	0.02
Evaluation Criteria		100	350	200	50	25	150	1000	250	1000	100	1.0

* N.D. = No Contaminant Detected
** - = Not Analysed

TABLE III

INDUSTRIAL HYGIENE ASSOCIATES, INC.
ORGANIC VAPOR CONCENTRATIONS EXPRESSED AS mg/M^3 FOR DEPARTMENT 30

ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA
HETA 80-168
June 19-20, 1980

Employee Number	Job Desc.	Date	Ethyl Alcohol	Isopropyl Alcohol	Methyl Alcohol	Ethyl Acetate	Methyl Acetone	Acetone	Benzene	Toluene	Xylene	Methyl Ethyl Ketone	Methyl Isobutyl Ketone	Methylene Chloride	Trichloro-ethylene	1,1,1 Trichlor Ethane
8175	Coil Winder	6/19	80.3	10.4	71.9	-	12.7	-	-	7.3	0.4	-	0.5	-	16.8	7.6
8011	Coil Winder	6/19	33.4	2.6				0.4		4.2	0.1		1.7		13.3	
8101	Coil Tray Off	6/20	10.8	-	39.5			-		4.2	0.5	-	1.7	-	7.7	
8185	Coil Heat Seal	6/20	3.8	-	26.8	-	-	-	-	0.9	0.1	-	0.3	-	4.5	16.3
8968	Cone Piercing	6/20	-	-	-	-	11.0	0.4	1.0	5.7	0.3	-	1.7	15.7	13.2	-
8326	Cementer	6/20	-	-	-	-	18.0	0.7	1.1	20.1	0.4	-	-	49.9	37.0	-
8217	Array Tester	6/19	-	-	-	-	-	0.3	2.3	47.5	0.4	-	-	28.9	148.6	6.2
8623	Array Tray Off	6/19	-	-	-	-	4.0	-	0.3	88.4	1.0	-	-	14.9	209.0	-
8651	Array Group Leader	6/20	-	-	-	-	11.9	0.4	3.2	16.1	0.3	-	2.4	65.9	40.8	-
Environmental Criteria	mg/M^3		1900	980	260	1400	610	2400	3.2C	375	435	590	100	350	134	1900

TABLE III (continued)

ORGANIC VAPOR CONCENTRATIONS EXPRESSED AS mg/M^3 FOR DEPARTMENT 40

Employee Number	Job Desc.	Date	Ethyl Alcohol	Isopropyl Alcohol	Methyl Alcohol	Ethyl Acetate	Methyl Acetone	Acetone	Benzene	Toluene	Xylene	Methyl Ethyl Ketone	Methyl Isobutyl Ketone	Methylene Chloride	Trichloro-ethylene	1,1,1 Trichlor Ethane
8093	Coning	6/19	-	-	-	3.2	15.6	-	0.5	4.1	0.1	33.6	0.7	-	3.6	-
8134	Coning Cementer	6/20	40.0	-	14.1	-	-	-	-	4.1	0.2	-	1.1	-	4.3	13.0
8998	Finish Cementer	6/19	26.7	-	15.2	-	18.2	-	-	3.4	0.1	-	0.7	3.3	4.6	-
8375	Rounder	6/19	15.9	0.9	11.2	-	16.9	-	-	2.6	-	-	0.5	-	4.1	30.0
8096	Riveter	6/20	39.5	-	-	-	-	-	1.3	7.6	0.4	-	2.6	-	7.7	61.2
9446	Magnet	6/20	18.8	-	13.1	-	-	-	-	2.5	0.1	-	3.1	-	1.5	17.2
9167	Finish Tray Off	6/19	17.6	1.9	10.8	-	-	-	-	4.0	0.1	-	0.6	-	3.4	10.2
8764	Tester	6/20	18.4	-	10.9	-	-	-	-	1.8	0.1	-	0.4	-	1.3	15.3
9176	Tray Off	6/20	-	-	-	-	14.2	-	0.9	3.1	0.1	38.4	0.8	-	2.2	8.0
Environmental Criteria		mg/M^3	1900	980	260	1400	610	2400	3.2C	375	435	590	410	700	134	1900

TABLE III (continued)

ORGANIC VAPOR CONCENTRATIONS EXPRESSED AS mg/M^3 FOR DEPARTMENT 70

Employee Number	Job Desc.	Date	Ethyl Alcohol	Isopropyl Alcohol	Methyl Alcohol	Ethyl Acetate	Methyl Acetone	Acetone	Benzene	Toluene	Xylene	Methyl Ethyl Ketone	Methyl Isobutyl Ketone	Methylene Chloride	Trichloro-ethylene	1,1,1 Trichlor Ethane
477	Tear Down	6/19	-	-	32.7	-	28.5	0.2	-	12.4	7.4	5.7	2.4	-	0.4	11.6
453	Tear Down	6/20	-	-	17.1	-	19.0	-	-	6.4	3.7	3.6	1.2	-	0.2	2.3
572	Tear Down	6/19	-	-	27.5	-	27.9	-	-	7.9	4.6	5.8	1.9	-	0.6	6.2
417	Tear Down	6/20	-	-	45.7	-	41.8	0.4	-	15.2	8.4	8.0	2.7	-	0.2	10.5
992	Gauge Cleaning Line Repair	6/19	-	-	16.0	-	11.9	0.4	1.0	6.6	3.8	11.4	2.9	-	3.2	151.3
951	Line Repair	6/19	-	-	-	-	9.7	0.7	0.7	5.9	0.6	12.1	1.8	-	4.0	17.3
036	Line Repair	6/19	-	-	-	-	14.4	0.5	0.5	4.3	0.2	7.1	1.1	-	1.5	8.9
348	Paint Conveyor Unloader	6/20	-	-	-	-	9.0	-	0.2	2.3	-	3.8	0.4	-	0.7	3.9
567	Spray Paint Touch Up	6/19	-	-	-	-	10.9	-	0.3	1.6	-	5.7	0.4	-	0.3	5.0
866	Paint Room Printing	6/20	-	-	-	-	-	-	0.2	2.3	-	3.8	0.4	-	0.7	3.9
036	Hot Plate	6/20	-	-	-	-	-	-	0.1	1.0	-	2.5	0.2	-	0.4	-
087	Gauge	6/20	-	-	-	-	-	-	0.3	3.3	0.2	6.4	0.4	-	2.7	-
Environmental Criteria	mg/M^3		1900	980	260	1400	610	2400	3.2C	375	435	590	410	700	134	1900

TABLE III (continued)

ORGANIC VAPOR CONCENTRATIONS EXPRESSED AS mg/M^3 FOR DEPARTMENT 80

Employee Number	Job Desc.	Date	Ethyl Alcohol	Isopropyl Alcohol	Methyl Alcohol	Ethyl Acetate	Methyl Acetone	Acetone	Benzene	Toluene	Xylene	Methyl Ethyl Ketone	Methyl Isobutyl Ketone	Methylene Chloride	Trichloro-ethylene	1,1,1 Trichlor Ethane
49	Line Repair	6/20	-	-	-	-	-	1.7	2.0	6.8	0.6	27.6	2.9	-	4.9	-
03	Pigtailing	6/19	-	-	-	2.5	-	3.5	1.5	5.8	0.6	18.4	2.6	-	6.9	-
99	Cementer	6/19	-	-	-	-	-	4.5	1.3	6.2	0.3	38.7	1.8	-	7.0	4.8
20	Material Handler	6/20	-	-	-	-	18.2	3.3	-	6.8	0.6	61.9	14.9	-	6.1	-
19	Gauger	6/19	11.4	-	16.1	-	-	7.9	-	1.3	-	-	0.6	-	1.2	-
11	Tester	6/19	13.5	-	15.4	-	-	5.5	-	1.4	-	-	0.3	-	0.2	-
34	Skid Off	6/19	27.4	-	40.9	-	-	12.1	-	6.5	-	-	2.8	-	5.8	-
Environmental Criteria		mg/M^3	1900	980	260	1400	610	2400	3.2C	375	435	590	410	700	134	1900

TABLE III (continued)

ORGANIC VAPOR CONCENTRATIONS EXPRESSED AS mg/M^3 FOR DEPARTMENT 90

Employee Number	Job Desc.	Date	Ethyl Alcohol	Isopropyl Alcohol	Methyl Alcohol	Ethyl Acetate	Methyl Acetone	Acetone	Benzene	Toluene	Xylene	Methyl Ethyl Ketone	Methyl Isobutyl Ketone	Methylene Chloride	Trichloro-ethylene	1,1,1 Trichlor Ethane
9162	Rounder	6/19	-	-	-	-	-	0.8	0.4	2.2	0.4	8.2	3.7	-	1.6	-
9229	Wrapper	6/20	-	-	-	-	-	0.3	0.3	3.4	0.3	14.4	1.0	-	1.9	-
8639	Material Handler	6/20	-	-	-	-	15.6	0.8	0.4	4.9	0.6	13.6	5.0	-	3.2	-
9790	Coner	6/19	-	-	-	2.7	15.9	0.4	0.6	6.4	0.8	16.2	2.8	-	4.6	-
9134	Magnet Activator	6/19	-	-	-	4.2	24.2	0.5	2.1	7.3	1.2	29.9	13.0	-	13.0	-
Environmental Criteria		mg/M^3	1900	980	260	1400	610	2400	3.2C	375	435	590	410	700	134	1900

TABLE III (continued)

ORGANIC VAPOR CONCENTRATIONS EXPRESSED AS mg/M^3 FOR DEPARTMENT 50

Employee Number	Job Desc.	Date	Ethyl Alcohol	Isopropyl Alcohol	Methyl Alcohol	Ethyl Acetate	Methyl Acetone	Acetone	Benzene	Toluene	Xylene	Methyl Ethyl Ketone	Methyl Isobutyl Ketone	Methylene Chloride	Trichloro-ethylene	1,1,1 Trichlor Ethane
9669	Stickers	6/20	-	-	-	-	-	-	0.7	5.1	0.2	12.4	0.9	-	7.4	-
9215	Lacing	6/19	-	-	-	1.9	6.4	-	0.4	6.6	0.5	9.9	1.6	-	8.2	-
9304	Touch Up Sprayer	6/19	-	-	-	-	-	-	0.2	3.2	0.1	3.8	0.3	-	5.1	-
9877	Capacitor Fitter	6/20	10.2	-	13.9	-	-	-	-	4.2	0.4	-	0.3	-	3.7	15.2
9518	Power Driver	6/20	15.4	-	15.2	-	-	-	-	3.5	0.3	-	0.7	-	4.0	16.6
8894	Gluer	6/20	18.5	-	14.4	-	-	-	-	8.0	0.3	-	0.5	-	17.9	-
8887	Clipper	6/20	20.9	-	24.4	-	-	-	-	4.5	0.3	-	2.0	-	6.3	4.4
Environmental Criteria		mg/M^3	1900	980	260	1400	610	2400	3.2C	375	435	590	410	700	134	1900

TABLE IV

NIOSH
PERSONAL AND AREA AIR SAMPLES FOR BENZOYL PEROXIDE

ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA
HETA 80-168
June 19-20, 1980

Location	Sampling Time	Concentration (mg/M^3)
Head Assembly Operator	8:13-15:00	0.97
Head Assembly Area Sample	8:28-15:00	0.002
Head Assembly Area Sample	8:29-15:00	0.11
Tear Down Area Sample	7:10-15:15	N.D.*
Tear Down Area Sample	7:18-15:15	N.D.
Head Assembly Area Sample	7:20-15:15	0.03
Head Assembly Area Sample	7:40-15:15	0.32
Evaluation Criteria		5.0

*N.D. = non detected

TABLE V

INDUSTRIAL HYGIENE ASSOCIATES, INC.
BENZOYL PEROXIDE CONCENTRATIONS EXPRESSED AS mg/M^3

ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA
HETA 80-168
June 19-20, 1980

Employee Number	Job Description	Department Number	Date	Benzoyl Peroxide mg/M^3
8097	Head	40	6/19	<0.03
8183	Activator	40	6/19	<0.04
8587	Hot Plate	70	6/20	<0.03
9791	Activator	80	6/19	0.11
9435	Head	80	6/19	0.06
8628	Gauger	80	6/19	<0.03
8774	Accelerator Applier	80	6/20	<0.05
9729	Stacking	80	6/20	<0.03
9269	Coning	90	6/19	<0.04
9613	Head	90	6/19	0.04
9925	Finish	90	6/19	<0.03
9964	Skid Off	90	6/20	<0.04
9931	Dust Cap	90	6/20	<0.04
9449	Accelerator Applier	90	6/20	<0.04
8936	Gauger	90	6/20	<0.04
9021	Gasket Loader	90	6/20	<0.03
9239	Cementer	90	6/20	<0.04

TABLE VI

INDUSTRIAL HYGIENE ASSOCIATES, INC.
TERTIARY AMINE CONCENTRATIONS EXPRESSED AS PPM

ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA
HETA 80-168
June 19-20, 1980

Employee Number	Job Description	Department Number	Date	Tertiary Amine Found PPM
8198	Head Blow Out	40	6/19	N.D.
9997	Head - Glue Cones	40	6/19	N.D.
9828	Activator	80	6/19	N.D.
9345	Skid Off	80	6/19	N.D.
9221	Coning	80	6/19	N.D.
9828	Magnet Activator	80	6/20	N.D.
9134	Magnet Activator	90	6/20	N.D.
9255	Loctite Applier	90	6/20	N.D.
8966	Coning	90	6/20	N.D.
8072	Tear Down	70	6/20	N.D.

TABLE VII

OSHA SAMPLING DATA

ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA
HETA 80-168
June 19-20, 1980

Date	Job Description	Contaminant	TWA	PEL
S1482/066				
10/10/74	Semi-auto voice coil lining	MEK	<1.0	200
10/10/74	Final assembly-line 10-coning	MEK	<1.0	200
10/10/74	(Blank)	MEK	(Blank --)	
S6988/066				
5/7/76	Department 100, assembly oper.	Freon TF	50.56	1000
5/7/76	Department 40, assembler	Freon TF	<19.2	1000
5/7/76	Department 60, assembler	Freon TF	<19.2	1000
5/7/76	Depart. 30, voice coil winding	MEK	ND	200
7/13/76	Department 70A, cementer	Acetone	<50	1000
		Toluene	<10	200
		Isopropanol	<20	400
		Methyl Ethyl Ketone	<10	200
		Butyl Acetate	<2	150
		2-Butoxy Ethanol	ND	50
		Isopropyl Acetate	ND	250
		Heptane	<25	500
7/13/76	Department 70A, cementer	Acetone	<50	1000
		Toluene	<10	200
		Isopropanol	<20	400
		Methyl Ethyl Ketone	<10	200
		Butyl Acetate	<2.5	150
		2-Butoxy Ethanol	ND	50
		Isopropyl Acetate	ND	250
		Heptane	<25	500
7/13/76	Department 10, 1st Floor Silk Screener	Acetone	<50	1000
		Toluene	20.4	200
		Isopropanol	<20	400
		Methyl Ethyl Ketone	ND	200
		Butyl Acetate	ND	150
		2-Butoxy Ethanol	ND	50
		Isopropyl Acetate	ND	250
		Heptane	ND	500

TABLE VII (continued)

Date	Job Description	Contaminant	TWA	PEL
7/13/76	Department 100, Parts Washer	Methyl Chloroform	155.3	350
	Department 40, Cementer	Acetate	<50	1000
		Toluene	<10	200
		Isopropanol	<20	400
		Methyl Ethyl Ketone	<10	200
		Butyl Acetate	ND	150
		2-Butoxy Ethanol	ND	50
		Isopropyl Acetate	ND	250
		Heptane	ND	500
S6988/092				
11/5/76	Department 40, Magnet Structure Group Leader	MDK	43.2	200
	Depart. 40, Magnet Structure General Assembly Worker	Methylene Chloride	48.3	500
		Acetone	16.3	1000
	Department 40, Materials Handler (1st & 2nd Floors)	MIBK	2.46	100
		MEK	84.4	200
	Department 30, Voice Coil Winder (2-hour sample)	MEK	51.8	200
	Department 40, Treating (5 1/2-hour sample)	MEK	104.9	200
	Department 802, Epoxy Mixer (7-hour sample)	Toluene	42.8	200
		Methyl Chloroform	55.4	350
		Methyl Acrylate	5.5	10
		MEK	21.8	200
		MIBK	11.8	100
	Department 80, Line Repair (7-hour)	Methyl Chloroform	10.5	350
	Department 601, Magnet Assy. (6 1/2-hour sample)	MEK	27	200
		Methylene Chloride	56.3	500
		Methyl Acrylate	2.3	10
2/16/77	Department 601, Magnet Assy.	MIBK	<4	100
		Methyl Chloroform	<13	350
		Methylene chloride	<23	500
	Depart. 40, Materials Handler	Acetone	<27.4	1000
		Methyl Chloroform	<9.3	350
	Department 40, Paint Spray (4-hour sample)	Methyl Chloroform	<8.5	350
		Ethanol	33.4	1000
		Toluene	17.1	200
		Acetone	<24	1000

TABLE VII (continued)

Date	Job Description	Contaminant	TWA	PEL
2/16/77	Depart. 80, General Assy - cleaning (6-hour sample)	Methyl Chloroform	89.7	350
	Department 802, Epoxy Mixer	Methyl Chloride	19.3	350
		Methyl Chloroform	136.8	350
		Ethanol	38.5	1000
		Toluene	7.7	200
L4980/031				
2/2/78	Soldering			
	2nd Floor-coning line	Formaldehyde	ND	3 ppm
	1st Floor-finishing line	Formaldehyde	ND	3 ppm
	1st Floor-co-axial assy.	Formaldehyde	ND	3ppm
2/28/78	Department 80, coning line (Employee applying Hughson activator)	Trichloroethylene	18.0	100
		Methyl isobutyl ketone	9.2	100
		Methyl methacrylate	<5	100
		Methyl acrylate	ND	10
		Ethyl acrylate	<1.25	25
	Department 60, coning line (Employee applying Hughson activator)	Methylene chloride	212.6	500
		Trichloroethylene	27.3	100
		Methyl isobutyl ketone	14.0	100
		Methyl methacrylate	<5.0	100
		Methyl acrylate	ND	10
		Ethyl acrylate	ND	25
	Department 80, coning line (Employee applying Hughson adhesive)	Methylene chloride	<25	500
		Trichloroethylene	<5	100
		Methyl isobutyl ketone	<5	100
		Methyl methacrylate	6.6	100
		Methyl acrylate	ND	10
		Ethyl acrylate	ND	25
2/28/78	Paint spraying, 1st floor	Acetone	<50	1000
		1,1,1 Trichloroethane	49	350

TABLE VIII

PREVALENCE OF REPORTED MEDICAL SYMPTOMS

ROLA-ESMARK COMPANY
DUBOIS, PENNSYLVANIA
HETA 80-168

	N	%
Neurological		
Severe headaches	15	79
A lot of headaches	12	63
Dizziness	13	68
Difficulty with balance	11	58
Difficulty walking	4	21
Feeling faint	11	58
Fainted	2	11
Tingling or numbness	9	47
Weakness of the muscles	7	37
Muscle pain	3	16
Tremor	9	47
Paralysis	0	0
Depression	10	53
Getting high	12	63
Poor memory	10	53
Worsening memory	10	53
Tiredness	13	79
Sleepiness	12	63
Sleep problems	4	21
Mental arithmetic	8	42
Deterioration in ability to do mental arithmetic	4	21
Difficulty	3	16
Skin		
Rash	11	58
Itch	10	53
Acne	11	58
Hair loss	4	21
Other skin problems	3	16
Mucous Membranes		
Runny nose	13	68
Nose irritation	11	58
Sneezing	13	68
Throat irritation	15	79
Choking	8	42
Laryngitis	5	26
Burning eyes	16	84
Sore eyes	11	58

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