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. 77-26-472

ROLA COMPANY, DIVISION OF PEMCOR, INC.
PUNXSUTAWNEY, PA
MARCH, 1978

I. TOXICITY DETERMINATION

A Health Hazard Evaluation has been conducted at the Rola Company, Division of Pemcor, Inc., Punxsutawney, PA to evaluate employees' exposure to organic vapors. It was determined that exposures to organic vapors were not toxic under the conditions of use noted over several visits. A number of possible explanations as to the cause of an incident on September 1, 1976 and the more general problems that followed are also discussed.

A review of available data has also indicated that a potential health hazard may exist regarding the number of non-therapeutic abortions and menstrual problems experienced by women in this plant. Recommendations for an additional evaluation regarding this matter and for maintaining records to aid in the evaluation are also made in the body of this report.

These determination are based upon review of available medical data, employee interviews, measurements of workplace concentrations of airborne chemicals, inspection of the work areas and materials used, and review of the current knowledge of the materials used.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this determination report are available upon request from NIOSH, Division of Technical Services, Information Resources 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 have been sent to:

a) Rola Company, Division of Pemcor, Inc.
b) Authorized Representative of Employees, United Steel Workers Local

c) Authorized Representative of Employees, United Steel Workers, 5 Gateway Center, Pittsburg, PA
d) U.S. Department of Labor
e) NIOSH - Region III

For the purpose of informing the approximately 300 "affected employees", the employer should promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) where affected employees work.

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 an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has a potentially toxic effect in such concentrations as used or found.

The National Institute for Occupational Safety and Health,(NIOSH) received a joint employer/employee request concerning the reported illness of employees working with adhesives.

IV. HEALTH HAZARD EVALUATION

A. Evaluation Background/Chronology

A joint union/management request for a Health Hazard Evaluation was submitted after an OSHA investigation found no excessive levels of airborne contaminants while complaints of illness continued.

On October 20, 1976, a plant visit was made to review conditions and procedures. During this visit, a history of past and present health complaints was discussed. Specific details were obtained regarding an incident that occured on September 1, 1976 and the subsequent and more wide spread reported illnesses that followed.

On December 8 and 9, 1976, an environmental follow-up visit was made to conduct air sampling to evaluate worker exposures to organic vapors.

A medical evaluation was subsequently planned and made on April 13 to 15, 1977 to review the available medical records and correlate medical and environmental data. As a result of the findings during the medical visit, a follow-up survey was conducted on June 20 and 21, 1977 to

evaluate employees exposures to tetramethyl thiourea (TMTU), a compound found to be both carcinogenic and capable of causing fetal malformations in rats and used in one of the adhesives.

B. Process Description

The Rola Company Division of Pemcor is a manufacturer of high fidelity speakers utilizing production line techniques. At the time of the initial visit the plant was capable of running seven production lines, which except for the size of the speaker produced were basically the same. Each production line starts with a magnet adhesive and activator application station. Two workers per line apply the activator which at the time of our visits used a flurocarbon solvent as the vehicle for the activator. After the activator magnets allowed to dry on peg boards placed in front of the workers. The adhesive is then applied to bond magnets to obtain the desired weight for various speakers. Bonded magnets are then placed on a circular conveyor refered to as a ferris wheel to allow the adhesive to set. Magnets and cones are then attached to metal frames using either organic or water soluable adhesives to form the basic speaker. The voice coil and associated parts are next installed along the assembly line and cemented. At this point speakers must presently be dry-banked - or stored over night to allow adhesives to dry insuring proper alignment. Depending on production rates stacks of speakers being dry banked are often placed between production lines when additional storage space becomes full. After drying over night speakers are returned to the production line for finale soldering sealing and in some cases a waterproofing treatment or coating. Each speaker is then audibly tested prior to packing. If the speaker does not function properly appropriate repairs are made or if repairs are impossible speakers are dismantled to salvage usable parts.

C. Evaluation Methods

1) Air Sampling

Employees considered to be at greatest risk were monitored for organic vapors using personal and area sampling methods. Air samples were collected using 150 milligrams (mg) activated charcoal tubes with Sipin* pumps operating at 50cc per minute. Samples were subsequently analyzed by gas chromatography for acetone, ethyl alcohol, methyl ethyl ketone, methyl isobutyl ketone, toluene, isopropanol, butyl acetate, isopropyl acetate, heptane, butyl cellosolve, 1,1,1 trifluoroethane, using NIOSH P & CA Method #127[1]. The lower limit of detection for this method was 0.01 mg per analyte per sample.

Air samples of TMTU obtained during the follow-up environmental survey of June 20-21, 1977 were collected using a number of different techniques

* Mention of company or product names is not to be considered as an endorsement by NIOSH.

because of the experimental nature of the technique. Samples were collected using methanol or distilled water with and without vinyl polychloride pre filters using a flow rate of between 1.0 and 1.5 liters per minute.

The analytical procedure for TMTU involved the preparation of an iron coordination complex - pentacyanoammonio ferrate - which is used to complex the TMTU forming a colored complex. Analyses were performed employing a recording U.V. - visible spectrophotometer, using the absorption maximum of the complex at 590 nanometers. To improve sensitivity, 5 cm sample cells were employed. Absorbance versus concentration plots of standard solutions of the TMTU complex in water were linear over the range of 15-150 micrograms/16.5 ml with a 0.9999 linear correlation coefficient.

2) Medical

Informed consent was obtained, and a directed medical questionnaire was administered to eighty-eight (88) workers out of a total of 300 (29%). All those interviewed were female. The employees were randomly selected from each of the production lines and surrounding areas in operation at the time of the evaluation. Medical records of fifty-four (54) employees attended to in the emergency room of Adrian Hospital were reviewed.

D. Evaluation Criteria

1) Occupational

Airborne exposure limits intended to protect the health of workers have been recommended or promulgated by several sources for a number of chemical substances. These limits are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime. For this investigation, the criteria used to assess the degree of health hazards to workers were selected from the following sources:

a) NIOSH Recommended Standards - airborne exposure limits which NIOSH has recommended to OSHA for occupational health standards

b) OSHA Standard - the air contaminants standards enforced by the U.S. Department of Labor as found in the Federal Register

c) ACGIH Threshold Limit Value and supporting documentation

Substances	8-Hour Time Weighted Average Concentration	Standard Source
Acetone	1,000 ppm*	OSHA Standard[2]
Ethyl Alcohol	1,000 ppm	" "
Methyl Ethyl Ketone (2-butanone)	200 ppm	" "
Methyl Isobutyl Ketone (hexone)	100 ppm	" "
Toluene	100 ppm	NIOSH Criteria[3]
Isopropyl Alcohol	400 ppm	" "
Butyl Acetate	150 ppm	OSHA Standard
Isopropyl Acetate	250 ppm	" "
Heptane	400 ppm	ACGIH[4]
Butyl Cellosolve (2-butoxyethanol)	50 ppm	OSHA Standard
1,1,2 Trichloro-1,2,2 trifluoroethane	1,000 ppm	" "
Methyl Chloroform (1,1,1-trichloroethane)	350 ppm	NIOSH Criteria[3]
Tetra Methyl Thiourea	XX	

* denotes parts per million

XX see discussion under toxic effects.

2) Toxic Effects

A review of current literature concerning health hazard associated with this evaluation indicated that most materials were capable of causing narcosis and mucous membrane irritation. More specific information on each follows:

Acetone (1,000 ppm) - cause slight eye, nose and throat irritation at levels less than 1,000 ppm during intermittent exposure. Beginning evidence of narcosis such as dulled sensibilities with increased accident proneness also occurs at this level.

Butyl acetate (150) - characteristic fruity odor at lower concentrations but disagreeable at higher concentrations. Throat irritation at 200 ppm, becoming severe at 300 ppm. Narcosis may be experienced at higher concentrations.

Butyl cellosolve (50 ppm, skin) - when used at room temperature, the slow evaporation rate results in low inhalation hazard. Repeated skin penetration, however, can permit sufficient absorption to cause chronic poisoning.

Ethyl alcohol (1,000 ppm) - some eye irritation at above 1,000 ppm. Vapors may be anesthetic and narcotic.

Heptane (500 ppm) - slight dizziness report at exposures of 1,000 ppm while exposure to 5,000 ppm for short periods produced complaints of nausea, loss of appetite and a gasoline taste. Narcosis may occur at higher concentrations.

Isopropyl acetate (250 ppm) - eye irritation has been reported at 200 ppm while nose and throat irritation occur at higher levels.

Isopropyl alcohol (400 ppm) - mild irritation of the eyes, nose and throat at 400 ppm, narcotic at higher concentrations.

Methyl chloroform (350 ppm) - one of the least toxic chlorinated solvents. Beginning narcosis occurs at twice the threshold limit value.

Methyl ethyl ketone (200 ppm) - slight throat irritation of unacclimated persons at half the threshold limit value. Eye irritation may occur at threshold limit, while nausea may occur at twice this level.

Methyl isobutyl ketone (100 ppm) - some eye irritation and objectionable odor at twice the threshold limit. High exposure may cause narcosis.

Toluene (100 ppm) - fatigue, weakness and confusion may occur at 100 ppm. Irritation of mucous membrances at 400 ppm. Higher exposures cause narcosis.

1,1,2 Trichloro - 1,2,2 trifluoroethane (1,000 ppm) - depression of the central nervous system and irritation of the respiratory tract at higher concentrations.

One additional compound was considered during this evaluation - Tetramethyl thiourea (TMTU). The following summary was provided to NIOSH by E. I. DuPont DeNemours & Company, Inc.[5]

Tetramethyl thiourea (TMTU) has been fed to male and female ChR-CD rats, starting with 28-day old animals, for two years at levels of 0, 30, and 300 ppm. Males and females receiving 30 ppm TMTU showed body weight curves and food consumption data that was inferior to that of the controls. Erythrocyte count, hemoglobin concentration, and hema-

tocrit were lower in the females, but not the males, receiving 300 ppm TMTU, and both males and females in this group excreted a larger volume of a more dilute urine than did the controls. Serum thyroxine concentrations were lower in the animals given 300 ppm than in the controls. The thyroid was the only organ that developed test compound-related histologic changes; these in time were indicative of a carcinogenic effect. TMTU caused tumors to develop in the thyroid after 18 months' feeding at 300 ppm; however, no compound-related changes were seen in the thyroids of either sex that were fed 30 ppm TMTU.

TMTU is not as potent a carcinogen in the rat as thiourea or ethylene-thiourea (ETU).

Also in a letter dated, July 9, 1976 to Honorable Morton Corn, then Assistant Secretary of Labor, C.F. Reinhardt, M.D., Director, Haskell Laboratory, indicated, ..." in a previous study, Haskell also found TMTU to produce fetal malformations in rats fed 2500 ppm in their diets."

E. Evaluation Results

The initial visit to the plant revealed a history of problems dating back to between December, 1965 and January, 1966. This problem was alledgedly related to the introduction of a "red cement" into production. Although no excessive exposures were found at the time by Pennsylvania State Officials, complaints continued. Problems were reported to have also occured in 1971 and again in 1974.

On September 1, 1976, the company instituted a production change in an adhesive system used to bind magnets. This change was initiated when the company was made aware that the present adhesive activator contained TMTU, a compound found to be carcinogenic and mutagenic in rats.

The replacement adhesive system appeared to have one additional significant difference. While the initial adhesive activator used 1,1,2 trichloro - 1,2,2, trifluoroethane as the vehicle, the replacement activator used methyl chloroform.

Workers first became ill on line #1 at about 7:30 on September 1, 1976. Illness seemed to spread to line #2 by about 10:00 and in both cases workers were in the area of the head of the line where the new adhesives were being used. By lunch, some 30 workers were affected and either went home or were taken to the Adrian Hospital. The new adhesive was removed from line #1 by 1:00 and line #2 by 3:30 but remained on lines #3 through #7. The new adhesive was removed from all lines by 9:30 on September 2, 1976, due to uncertainty as to cause of problem.

Although the adhesive containing methyl chloroform was not used after September 2, 1976, workers continued to become ill in a scattered and random pattern along all seven production lines.

Air samples collected by the Pittsburgh area office of OSHA indicated operating conditions using the adhesive were in compliance with present OSHA standards. OSHA was also unable to obtain information regarding airborne contaminant levels when the adhesive was used that contained methyl chloroform.

1) Environmental Results

Environmental samples collected for organic vapors by NIOSH on December 8 and 9 also indicated that exposures were well within the recognized limits as indicated in Table I. The highest levels found were for methyl ethyl ketone at about one half the evaluation criteria used here in the areas of lines 1 and 2. It should again be noted that throat irritation has been reported in the literature[6] to unacclimated workers at these levels. Because concentrations vary from day to day and area to area of the plant, workers may never really become fully acclimated to the effect of methyl ethyl ketone.

Personal and General Area

Environmental samples collected on June 20 and 21 indicated that 21 out of 42 samples showed detectable concentrations of TMTU (Table IV).

Several laboratory extraction studies of spiked VM-1 filters with TMTU indicated that TMTU cannot be extracted from filters, using water as solvent.

Methanol was then tested as the extraction solvent; results revealed that extraction of TMTU from filters is not possible below 45 ug. The calibration curve of TMTU standards in methanol is non-linear in contrast to that in water.

Organic solvents for extraction of TMTU from filters were not investigated because organic solvents extract the filters and plasticizers in the filter or even dissolve the filter. Because of the above extraction difficulties, the VM-1 field filter samples were not analyzed.

2) Medical Results

A total of eighty-eight (88) employees were studied during the medical portion of the evaluation. Table II shows a breakdown of the group according to job description.

The majority of complaints were of upper respiratory tract in nature and included burning, tearing eyes; burning runny nose; dry, sore throat; and cough, dizziness, sometimes to the point of syncope, nausea, headache, and numbness in extremities and face were also reported. Complaints reported at the time of the evaluation and their percentages are listed in Table III. The most frequent complaint was nasal irritation and congestion. This correlated well with physical findings at that time. (See Table III). Twelve (12) percent of those interviewed attributed their symptomatology to the colds they had at the time of evaluation.

Fifty-six (56%) percent of the employees interviewed stated that they had problems in September, 1976 when the adhesive had been changed. Prior to September, 1976 thirty-five percent (35%) had had problems. Since then, forty-eight percent (48%) have continued to experience symptomatology.

The medical records of fifty-six (56) employees attended to at Adrian Hospital Emergency Room during September and October, 1976 were reviewed. Two had been admitted, with a length of stay ranging between overnight and three days. The remainder visited the Emergency Room with similar complaints of headache, dizziness, numbness around the mouth, and in the extremities. Rates of respiration were recorded for each patient with an average of 25.3/minute, median of 22 and a range of 14 - 100/minute. Normal rates in resting adults range from 12 to 14/minute.

This increase in respiration rate is known as hyperventilation. During hyperventilation, the increased breathing rate blows off carbon dioxide more quickly, thereby raising the pH of the blood and resulting in respiratory alkalosis. Respiratory alkalosis produces a typical clinical syndrome in which the main symptoms are lightheadness, numbness and tingling in extremities, and numbness around the mouth. Carpopedal spasms, which are contractions of the hands and feet, can also occur in some individuals.

During the course of this evaluation, a worker experienced lightheadness, weakness, numbness in extremities and shaking. Her respiratory rate was 32/minute at that time. When she was removed from the workplace and allowed to rest quietly, her breathing rate and her symptomatology both decreased.

Nineteen (19) workers (22%) felt that there had been an improvement in conditions since September, 1976. Extensive ventilation changes were undertaken after September 1, 1976. However, the overall effecti-

veness of the changes in reducing concentrations and removing odors was found to be questionable due to poor design. Additional steps to redesign existing ventilation and balance air flows were subsequently undertaken. Floor fans which interfer with local exhaust ventilation were to be removed from use. Total solvent body burden for many workers was reduced by the elimination of open solvent and waste containers and the use of gloves especially in the adhesive preparation area.

One continuing complaint voiced by the majority of workers interviewed, related to the practice of dry banking (drying in stacks), speakers between work lines and often directly behind workers. While eliminating this practice in production areas would undoubtedly reduce exposures unless it is done in conjunction with improved ventilation to control vapors along the assembly line, associated complaints will not be eliminated.

Data provided by the union during the medical visit also indicated a number of menstral problems and five (5) reported cases of non-therapeutic abortions within the last six months. Medical releases were subsequently obtained on four of the reported cases in order to obtain additional data. The fifth was omitted when additional information was obtained indicating a complete pregnancy.

A review of union leave records for the period March, 1974 to April, 1977 indicated that actually 62 employees were on record as being on maternity leave or again approximately 20 (20.6) maternity leaves per year. These figures do not include those employees who may not have taken leave, when full term was not achieved or those who may have left employment of this company without providing notification that pregnancy was the reason.

No national rate on the number of non-therapeutic abortions is available. The rate of 8 to 15% has been used[7,8,9] and varies depending on how data is ascertained. Thus the occurrence of four non-therapeutic abortions in a six month period (4 out of 10 or 40%) appears unusually high and enough reason for concern and additional study of the problem.

V. CONCLUSIONS

While a number of health problems related to solvent vapors appear to have occurred in the past, there is no indication that a recognized solvent vapor health hazard existed at the time of this evaluation.

Since no environmental air samples were collected at the time of the September 1, 1976 incident, no factual determination can be made

regarding the events that took place. However, if the supposition is made that employee illness was related to the change in adhesives used, then the illness may have been due to either 1) excessive exposures to solvent vapors presumably methyl chloroform, which replaced the 1,1,2 trichloro-1,2,2 trifluoroethane previously used; or 2) respiratory alkalosis triggered by the much stronger odor and uncertainty associated with the new adhesive. The latter would also explain the well documented increase is respiratory rates of employees seen at the hospital.

The more widespread and varied symptomatology exibited by workers since September 1, 1976 appears to be the result of a combination respiratory alkalosis and exposure to marginal concentrations (100 ppm) of vapors, primarily methyl ethyl ketone to which employees never become acclimated.

During the April medical visit, the continuing use of the initial activator, (which contained TMTU) was questioned by the employee representative. Of special interest was the number of terminated pregnancies and menstrual problems being experienced by the workers. Preliminary data obtained during the medical visit and follow-up environmental survey indicated that there was an unusually high number of non-therapeutic abortion(s) and that detectable concentrations of TMTU were present in the work environment, (see Table IV) where the adhesive was being applied. In light of this information, the authors are of the opinion that a more detailed investigation of this problem should be made.

VI. RECOMMENDATIONS

A. Environmental

1) Execute plans to improve and install additional ventilation to control adhesive solvent vapors at the point of generation. Ventilation should be designed to meet criteria established by the American Conference of Governmental Industrial Hygienists, Ventilation Manual.[10]

2) Continue efforts to eliminate the practice of dry banking. Until such time that this can be accomplished, minimize dry banking in production areas between assembly lines. This would appear to be especially important when working with those adhesives that contain higher amounts of methyl ethyl ketone.

3) Establish a program to improve worker education concerning chemical substances in the work place.

B. Medical

1) Establish a program of pre-employment and perodic examinations of workers.

2) In order to facilitate future study of the potential problem associated with the use of TMTU, we recommend the following:

a) A registry be established and maintained thru an impartial third party, (i.e., local hospital or clinic) to record pregnancy and tumor data. Technical assistance in establishing such a register is available from NIOSH's Surveillance Branch, Illness Effects Section, Cincinnati, Ohio

b) Employees be educated as to the importance of prenatal counseling, and examination and of reporting pregnancy outcome

VII. REFERENCES

1) P & CA Methods #126, NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH) 75-121, 1974.

2) U.S. Department of Labor - OSHA, Federal Register, July 1, 1975, Volume 39, Title 29, Part 1910, Subpart 2, Section 1000.

3) Criteria for a Recommended Standard Occupational Exposure to: Tolune, HEW Publication No. (NIOSH) 73-11023
Isopropyl Alcohol, HEW Publication No. (NIOSH) 76-142
Methylchloroform, HEW Publication No. (NIOSH) 76-184

4) Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1976, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1976.

5) Personal communication and extracted from Haskell Laboratory Report No. 682-75, Medical Research Project No. 1567.

6) Nelson, K.W., Ege, J.F., Jr., Ross, M., Woodman, L.E., Silverman, L.J., Industrial Hygiene & Tox 25, 284 (1943).

7) Pharoah, et al Outcome of Pregnancy Among Woman Anaesthesiologist, Lancet Vol. 1, 34-36 (1977).

8) Knill, Jones et al Anaestectic Practice and Pregnancy, Lancet Vol. 12, 807-809 (1975).

9) Cohen, E.N., et al Occupational Disease Among Operating Room Personnel - A National Survey, Anesthesiology, Vol. 41, 321-339, (1974).

10) Industrial Ventilation, A Manual of Recommended Practices, American Conference of Governmental Industrial Hygienists, Tenth Edition, Lansing, Michigan 48900.

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HEALTH HAZARD EVALUATION 77-26
TABLE I
SOLVENT VAPOR CONCENTRATIONS PPM[a]

Location	Sample Number	Date	Acetone	Ethyl Alcohol	Methyl Ethyl Ketone	Methyl Isobutyl Ketone	Toluene	Isopropanol	Butyl Acetate	Isopropyl Acetate	Heptane	Butyl Cellosolve	1,1,2 Trichloro 1,2,2 trifluoroethane	Remarks
Line 1	R-1	12/7	28.0	<0.2[b]	11.0	0.2	3.0	<0.2	0.4	<0.1	1.0	<0.1	25.0	Activator Applied
Line 3	R-14	12/7	17.0	<1.0	8.0	<0.2	2.0	<0.4	<0.2	<0.3	<0.3	<0.2	9.0	" "
Line 4	R-20	12/8	8.0	<0.2	4.0	<0.5	2.0	<0.1	0.2	<0.1	0.3	<0.1	7.0	" "
Line 6	R-28	12/8	8.0	<0.2	5.0	0.5	2.0	<0.1	0.2	<0.1	1.0	<0.1	5.0	" "
Line 4	R-43	12/8	5.0[c]	<0.2	4.7	0.4	2.5	<0.1	0.2	<0.1	0.4	<0.1	4.4	" "
Line 6	R-51	12/8	7.6	<0.2	3.5	0.3	2.1	<0.1	0.1	<0.1	0.4	<0.1	6.0	" "
Line 1	R-2	12/7	14.0	<0.2	12.0	0.2	2.0	<0.1	0.2	<0.1	0.2	<0.1	3.0	Adhesive Applicator
Line 3	R-11	12/7	16.0	<1.0	11.0	<0.2	3.0	<0.4	0.2	<0.3	0.3	<0.2	1.0	" "
Line 5	R-24	12/8	5.0	<0.2	4.0	0.5	2.0	<0.1	0.2	<0.1	0.3	<0.1	2.0	" "
Line 4	R-47	12/8	<0.2	<0.2	3.1	0.3	2.0	<0.1	0.2	<0.1	0.3	<0.1	2.0	" "
Line 1	R-3	12/7	4.0	<0.2	50.0	<0.1	2.0	<0.1	0.2	<0.1	0.3	<0.1	0.4	Coil gluing
Line 1	R-4	12/7	14.0	<0.2	17.0[c]	0.1	3.0	<0.1	0.2	<0.1	0.3	<0.1	0.4	Gluing pigtails (318)
Line 2	R-10	12/7	8.0	<0.2	19.0	<0.1	2.0	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	Gluing leads (318)
	R-22	12/8	11.0	<0.2	5.0	1.0	2.0	<0.1	0.4	<0.1	1.0	<0.1	1.0	Gluing rims (318)
	R-26	12/8	8.0	<0.2	13.0	1.0	3.0	<0.1	0.4	<0.1	1.0	<0.1	3.0	Gluing pigtails (318)
	R-46	12/8	7.0	<0.2	4.0	0.4	3.1	<0.1	0.1	<0.1	0.4	0.1	<0.1	" " "
	R-49	12/8	7.3	<0.2	8.3	0.6	3.6	<0.1	0.3	<0.1	0.7	<0.1	0.3	" " "
Line 2	R-6	12/7	8.0	<0.2	37.0[c]	<0.1	2.0	<0.2	0.2	<0.1	<0.1	<0.1	0.4	Stacking off middle of line
Line 6	R-31	12/8	47[c]	<0.2	12.0	2.0	7.0	<0.2	0.2	<0.1	0.4	0.1	0.2	Stacking off end of line
Line 2	R-38	12/8	<0.1	<0.2	95.0	0.2	3.0	<0.2	0.3	0.7	0.5	<0.1	1.0	" " " " "
Line 1	R-40	12/8	30[c]	<0.2	9.0	0.2	2.0	<0.1	<0.1	<0.1	0.2	<0.1	0.3	Off loading
Line 6	R-54	12/8	28[c]	<0.2	8.0	2.6	5.4	<0.1	0.3	<0.1	0.4	0.1	<0.4	Stacking off
Line 2	R-61	12/8	6.4	<0.2	50.8	<0.1	3.0	<0.2	0.3	<0.1	0.6	<0.1	3.6	" "
Line 1	R-63	12/8	<0.2	<0.2	13.8	0.5	3.0	<0.2	0.2	<0.1	0.2	<0.1	<0.8	Off loading
Line 2	R-8	12/7	10.0	<0.2	36	<0.1	3.0	<0.15	0.2	<0.1	0.3	<0.1	1.0	Gluing housings (315)
Line 2	R-9	12/7	9.0	<1.0	12	<0.3	2.0	<0.4	0.2	<0.3	<0.2	<0.2	1.0	Gluing speakers (315)
Line 7	R-32	12/8	<0.1	<0.2	5.0	0.2	1.0	<0.1	<0.1	<0.1	0.2	<0.7	<0.1	Staking (315)
Line 7	R-34	12/8	<0.4	<1.0	6.0	<0.2	2.0	<0.5	<0.2	<0.3	<0.3	<0.2	<0.1	Gluing housings (315)
	R-55	12/8	<0.2	<0.2	4.8	<0.1	1.4	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	Staking (315)
	R-57	12/8	2.3	<0.1	3.0	<0.2	1.3	<0.1	<0.1	<0.1	0.3	<0.1	0.2	Gluing speakers (315)
Between Lines 1&2	R-13	12/7	8.0	<0.3	16.0	<0.1	11	<0.2	<0.1	<0.1	<0.1	<0.1	0.13	Speaker repair
Line 4	R-23	12/8	13.0	<0.1	5.0	1.0	7.0	<0.1	1.0	<0.1	2.0	<0.4	0.3	" "
Line 1	R-36	12/8	19.0	<0.2	8.0	0.2	5.0	3.6	0.6	1.2	1.5	<0.1	3.0	" "
Teardown	R-41	12/8	12.0	<0.2	6.0	0.5	5.0	<0.1	0.6	<0.1	1.7	<0.1	0.2	" "
Line 5	R-42	12/8	9.2	<0.2	18.7	0.3	2.6	<0.2	0.2	<0.1	0.35	2.1	<0.1	" "
Line 4	R-46	12/8	7.0	<0.2	4.1	0.4	3.1	<0.1	<0.1	<0.1	0.4	0.1	<0.4	" "
Line 1	R-59	12/8	23.8	<0.2	7.5	0.4	5.1	3.3	0.8	<0.1	1.6	<0.1	7.1	" "
Teardown	R-64	12/8	16.4	<0.2	5.9	0.5	5.2	2.0	0.8	<0.1	1.9	<0.1	1.0	" "
Line 5	R-65	12/8	3.0	<0.2	0.4	0.05	0.4	<0.1	0.02	<0.1	0.04	.51	<0.1	" "
Line 7	R-33	12/18	9.0	<0.2	6.0	1.0	3.0	<0.1	0.4	<0.1	1.1	<0.1	1.0	Glue preparation
Line 1	R-35	12/18	21.0	<0.2	8.0	1.0	5.0	2.2	0.9	<0.1	2.3	0.5	1.0	" "
Line 7	R-56	12/18	10.8	<0.2	5.8	0.6	3.9	<0.2	0.4	<0.1	1.1	10.1	0.4	" "
Line 1	R-58	12/18	119.3	<0.2	13.8	0.5	2.9	4.3	2.2	<0.1	4.2	0.6	<0.1	" "
Lines 1,2,3	R-37	12/18	<0.13	<0.2	15.0	0.2	2.0	<0.2	0.1	0.3	0.2	<0.1	0.3	Material Handler
Lines 1,2,3	R-60	12/18	4.0	<0.2	15.0	<0.1	2.0	<0.2	0.2	<0.1	0.3	<0.1	1.5	" "
Line 4	R-21	12/8	23[c]	<0.2	9.0	1.0	4.0	<0.1	1.0	<0.1	3.0	<0.1	3.0	Coating Cones with thinner
Line 6	R-29	12/8	20	<0.2	14.0	2.0	6.0	<0.1	0.4	<0.1	1.0	<0.2	0.4	Coating Cones 609 & 514
Line 6	R-30	12/8	47[c]	<0.2	12.0	2.0	7.0	<0.1	0.2	<0.1	0.5	0.1	1.0	Coating Cones 514
Line 4	R-44	12/8	12.2	<0.2	8.0	0.6	4.4	<0.1	0.5	<0.1	1.4	<0.1	0.3	Coating Cones with thinner
Line 6	R-52	12/8	17.2	<0.2	11.1	1.7	6.5	<0.1	0.3	<0.1	0.7	0.1	<0.1	Coating Cones 514
Line 6	R-53	12/8	22.7	<0.2	10.0	2.5	5.9	<0.1	0.3	<0.1	0.6	0.1	<0.1	" " "
Line 6	R-27	12/8	16.0	<0.2	3.0	0.2	2.0	<0.1	0.2	<0.1	0.3	<0.1	1.0	Gluing front plates 54 glue
Line 6	R-50	12/8	6.3	<0.2	0.2	0.1	1.6	<0.1	0.1	<0.1	0.3	<0.1	0.6	Gluing front plates 54 glue
Line 5	R-25	12/8	12.0	<0.2	11.0	1.0	3.0	<0.1	0.4	1.0	1.0	<0.1	3.0	Gluing cones, epoxy & rubber cement
Line 5	R-48	12/8	9.4	<0.2	7.0	0.6	3.8	<0.1	0.4	<0.1	0.8	<0.1	0.4	" " " "
Line 1	R-39	12/8	51	<0.2	9.0	<0.1	7.0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	A & R Helper
Line 1	R-62	12/8	119.3	<0.2	5.5	<0.1	6.9	<0.1	5.5	<0.1	<0.1	<0.1	<0.1	" " " "
	R-5	12/7	9.0	<0.2	15	<0.1	2.0	<0.2	0.2	<0.1	0.3	<0.1	0.1	Cementing Voice Coils
	R-7	12/7	<0.2	<0.2	80	<0.1	3.0	<0.2	0.2	<0.1	0.3	<0.1	1.0	Cementing in coil-epoxy
	R-12	12/7	16	<1.0	11	<0.2	3.0	<0.1	0.2	3.0	1.0	<0.1	1.0	Cementing metal frames 882
Exposure Limits			1,000	1,000	200 2(butanone)	100 (Hexone)	100	400	150	250	400	50 2-Butoxy Ethanol	1,000	

a) PPM denotes, parts of solvent per million part of air.
b) < denotes, less than.
c) significant amounts found in the reference portion of sample.

ROLA COMPANY
PUNXSUTAWNEY, PA
DIVISION OF PEMCOR
HEALTH HAZARD EVALUATION 77-26
TABLE II
JOB CATAGORIES

JOB	NUMBER EVALUATED	% OF TOTAL
Solder	7	8%
Cementer	16	18%
Stacker	9	10%
General Assembly	12	14%
Loctite	7	8%
Packing & Testing	10	11%
Gasketing	2	2%
Tear Down	2	2%
Group Leader	2	2%
Tuit Coils	1	1%
Repair	3	3%
Coning	5	6%
Activator	3	3%
Treater	2	2%
Feeder	1	1%
Riveting	1	1%
A & R	5	6%
Total	88	

ROLA COMPANY
PUNXSUTAWNEY, PA
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HEALTH HAZARD EVALUATION 77-26
TABLE III

SYMPTOMATOLOGY

	+	%+
Eyes	20	22%
Nose	34	38%
Throat	29	32%
Chest	14	16%
Cough	23	26%
Headache	11	12%

PHYSICAL EXAMINATIONS

	+	%+
Eyes	19	21%
Nose	26	29%
Throat	16	18%
Chest	4	4%
Colds	11	12%

ROLA COMPANY
PUNXSUTAWNEY, PA
DIVISION OF PEMCOR
HEALTH HAZARD EVALUATION 77-26
TABLE IV
TETRAMETHYL THIOUREA CONCENTRATIONS ($\mu g/m^3$)[a]

LOCATION	SAMPLE NUMBER	CONCENTRATION	REMARKS
Line 1	M-23[c]	45.9	General area sample approximating
	M-11	83.7	employees breathing zone, activator
	M-1	110	application
	FM-33[c]	90.9	
	FM-22	20.0	
	W-39[c]	98.4	
Line 2	M-3	1125	General area sample approximating
	M-13	107	employees breathing zone, activator
	M-24	23.4	application.
	FM-37	158.9	
	W-25	17.4	
	W-36	16.9	
L 6	M-7	23.3	General area sample approximating
	M-8	<10.0[b]	employees breathing zone, activator
	M-26	87.2	application.
	FM-27	21.9	
Line 5	M-9	<10.0	General area sample approximating
	M-10	<10.0	employees breathing zone, activator
	M-29	41.2	application.
	M-30	28.2	
.ine 1	M-2	<10.0	General area sample approximating
	M-12	<10.0	employee breathing zone mechanized drying ferris wheel front.
.ine 2	M-4	<10.0	General area sample approximating
	M-15	<10.0	employee breathing zone mechanized drying ferris wheel front.
.ine 2	M-5	139	General area sample approximating
	M-14	<10.0	employee breathing zone mechanized
	FM-31	17.2	drying ferris wheel front.

) denotes micro grams per cubic meter
' 'enotes less than
enotes samples collected with methanol (M, FM) or water (W)

Table IV (Continued)

LOCATION	SAMPLE NUMBER	CONCENTRATION	REMARKS
Line 2	M-6	10.0	General area sample approximating employee breathing zone, atop hood before application.
	M-16	10.0	
Line 3	M-33	10.0	General area sample approximating employee breathing zone, ferris wheel front.
	FM-35	60.0	
	W-32	83.3	
	W-34	81.6	
Line 7	M-28	25.8	General area sample approximating employee breathing xone, activator application.