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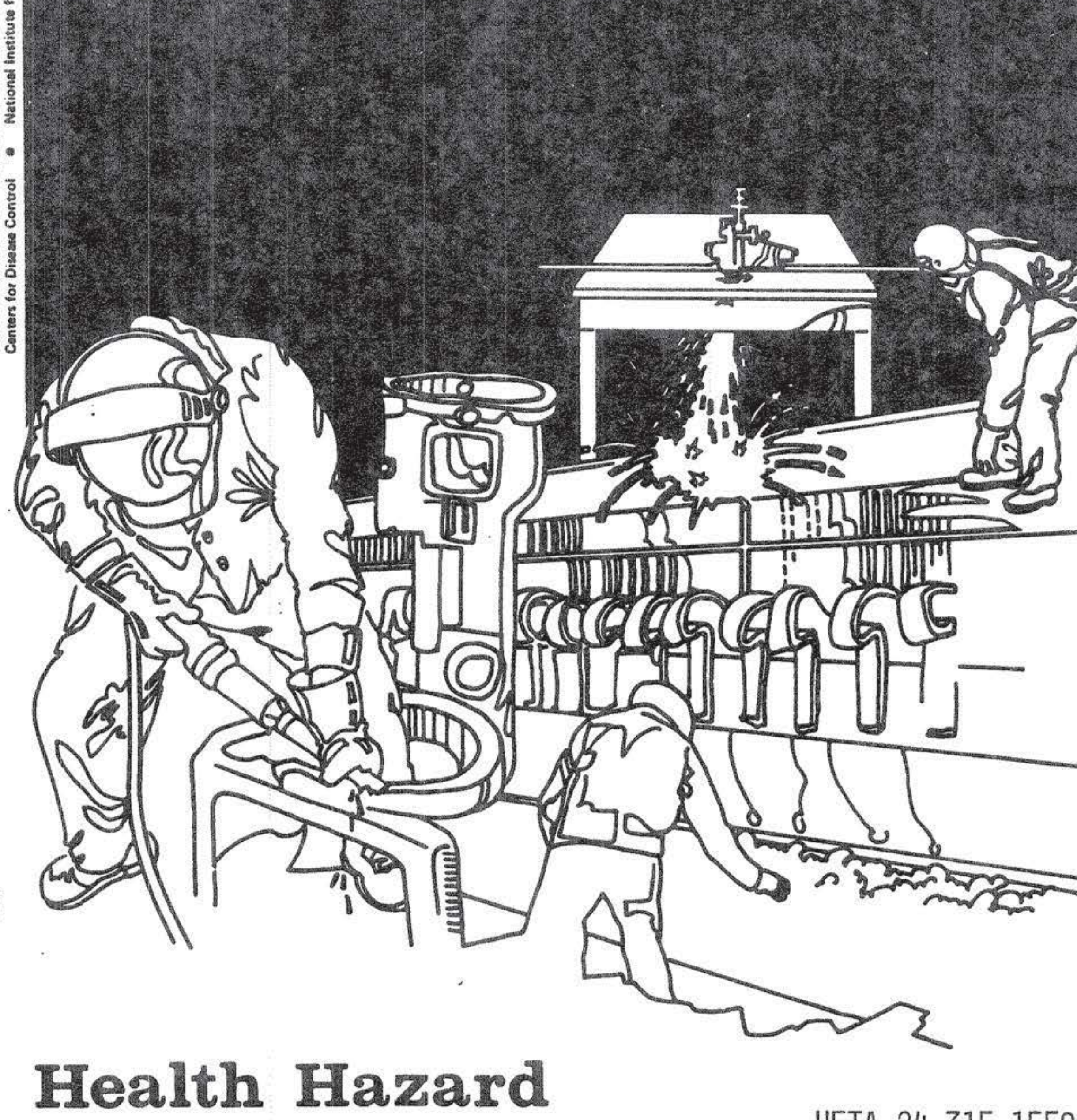

Health Hazard Evaluation Report

HETA 84-315-1550
DR. VINYL & ASSOCIATES
KANSAS CITY, MISSOURI

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 84-315-1550
JANUARY 1985
DR. VINYL & ASSOCIATES
KANSAS CITY, MISSOURI

NIOSH INVESTIVATOR:
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I. SUMMARY

On April 30, 1984, NIOSH was requested to evaluate working conditions at Dr. Vinyl & Associates, Kansas City, Missouri, by the owner/operator. This company is engaged in the repair and replacement of vinyl components and upholstery. This request was prompted because one of the workers was experiencing neurological symptoms that appeared to be work related.

An initial site visit was conducted on June 5, 1984; and on June 19, 1984, an environmental investigation was conducted. Personal and area samples to measure occupational exposures to vapors of methyl ethyl ketone (MEK), toluene, methyl isobutyl ketone (MIBK), cyclohexane and xylenes were collected from all areas in the plant. Toluene was present in the most samples and ranged from 12 to 280 mg/m^3 in the personal samples compared to a standard of 375 mg/m^3. However, when evaluated with exposures to all other solvents, their combined fraction of each individual chemical slightly exceeded the criteria of unity. Because of existing work practices, skin exposures were also evident and would result in additional body burden.

Based on the information gathered during this investigation, it is concluded that conditions in the plant were such that a health hazard exists due to overexposure to several solvents. Recommendations to remediate these working conditions are included in the report.

KEYWORDS: SIC 7531 (Automotive Repair Shops/Top and Body Repair Shops), vinyl dyes, methyl ethyl ketone, toluene, methyl isobutyl ketone, cyclohexane, xylene.

II. INTRODUCTION

On April 30, 1984, the National Institute for Occupational Safety and Health (NIOSH) received a request from the owner and manager regarding employee exposures to various solvents at Dr. Vinyl & Associates, Kansas City, Missouri. One of the employees in this plant had been complaining of fatigue, numbness and a tingling sensation while working in the plant and had been sent to the University of Kansas Medical Center for examination. The attending physician indicated that the employee's symptoms may be related to exposure to the chemicals he was working with and suggested that the owner contact NIOSH to conduct an investigation.

On June 5, 1984, the NIOSH investigator conducted an initial site visit to the facility to gather information concerning the request and to develop the strategy for conducting an investigation. On June 19, 1984, NIOSH returned to the facility to conduct a health hazard evaluation and to gather additional information so that definitive recommendations could be developed.

III. BACKGROUND

Dr. Vinyl & Associates has been located at 3001 Cherry Street in Kansas City, Missouri since October of 1978. The operations are housed in an older building approximately 130 ft. by 150 ft. The building (see Figure 1) is divided into six working areas, including office, parts and supplies, dye mixing, sewing, aerosol can filling, and general shop area. Dr. Vinyl employs approximately 15 people at this facility. Another ten people work out of the facility in vans doing repairs on call throughout the city. Of the 15 people on site, six work in the office and the remaining work in the various shop areas.

IV. PROCESS DESCRIPTION

The principal activities at this facility center around the replacement and repair of vinyl components and upholstery of automobiles. Automobiles are brought into the shop, and torn or aged vinyl parts are repaired or renewed. These jobs require the use of various cleaners and solvents, as well as a vinyl dye substance contained in an aerosol can.

Dr. Vinyl recently purchased the equipment to make the various vinyl dye materials under their own label. This operation is now housed in the mixing room and the aerosol can filling area. In the mixing room, pigment is weighed out and added to a 55-gallon drum of clear matrix. This mixture is then blended with an air driven propeller-type mixer for two hours. The mixture is then subjected to quality control procedures to determine its consistency and proper color. This procedure takes approximately one hour to complete. Next, the material is transferred across the room into the can filling machine. During our investigation, it took approximately two hours to transfer the mixture to one-gallon cans. The freshly canned mixture is then labeled and placed on shelves. This entire procedure is carried out by one individual.

The aerosol container filling operation takes place away from the mixing area. The vinyl dye mixture is added to pressurized containers, using an air pressure injection device. This task is accomplished by one individual on a table top under a canopy hood. The aerosol cans are then labeled and are used in the shop or sold to other Dr. Vinyl distributors.

V. METHODS

Area environmental samples were collected in the mixing room, the aerosol can filling room, the general shop and the office. Personal breathing zone samples were collected on the mixing room operator, the aerosol can filling operator and one individual doing repair work in the general shop area. The materials used in this plant are shown in Appendix A. The list contains a variety of solvents, and five were selected for sampling. Toluene, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), cyclohexane and xylenes were selected because they were present in most of the materials used and have been associated with peripheral neuropathy problems similar to the symptoms reported by one of the workers. In order to sample these chemicals, it was necessary to use two different solvent tubes. Toluene, MIBK, cyclohexane and xylenes were sampled using low flow sampling pumps and charcoal tubes in accordance with NIOSH Method P&CAM 127[1]. MEK was sampled using low flow sampling pumps and Ambersorb tubes in accordance with NIOSH Method S-3[2], with modifications. Method P&CAM 127 was used for the personal samples, and side-by-side area samples were collected so that the information gathered could be used to estimate worker exposure to MEK.

Work practices were observed to ascertain other routes of exposure, as well as to aid in the development of meaningful recommendations. Ventilation measurements were also made in the mixing and aerosol can filling area.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week, for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based solely on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Toluene[3] can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. Toluene may cause irritation of the eyes, respiratory tract, and skin. It may also cause fatigue, weakness, confusion, headache, dizziness, and drowsiness. Peculiar skin sensation may be produced, such as a "pins and needles feeling" or numbness. Very high concentrations may cause unconsciousness and death. The liquid splashed in the eye may cause irritation and temporary damage. Inhalation may also cause difficulty in seeing in bright light. Repeated or prolonged exposure to liquid toluene may cause drying and cracking of the skin.

MEK and MIBK[4] exposures result in symptoms similar to toluene, with the addition of gastrointestinal disturbances and more pronounced peripheral neuropathy problems. Cyclohexane[5] exhibits similar symptoms, as do the xylenes[6], with the possible exception that high exposures to xylenes may cause reversible damage to the kidneys and liver.

Environmental criteria for the various solvents sampled are shown in Table I. The levels recommended for xylenes and MEK are the same for all three organizations. Both NIOSH and ACGIH recommended the same level for toluene and MIBK, while the OSHA levels for these compounds are twice as high. Therefore, ACGIH levels were used to assess the severity of exposures in this study.

Since the symptoms exhibited by these solvents were similar, the exposure concentrations from each were combined to assess the overall hazard.

VI. RESULTS

The air sampling results are shown in Table II. Air concentrations are reported in mg/m^3, and these units will be used in the following discussion. Paired samples (charcoal and ambersorb) were collected in three locations. Morning and afternoon pairs were collected both in the mixing room and in the aerosol can filling area and one pair in the general shop area. The pair results from each location were used to develop ratios of MEK to toluene so that levels of personal exposure to toluene could be calculated. The ratios of MEK to toluene for the mixing room were .65 in the a.m. and .07 in the p.m. The ratios of MEK to toluene for the aerosol can filling area were .30 in the a.m. and .14 in the p.m. Only one paired sample was collected in the shop area, and it yielded a ratio of .39. Using these ratios, worker personal exposures to MEK can be estimated and are shown in Table III, along with exposure levels for the other chemicals sampled. Toluene exposure levels were the highest, with results ranging from 12. mg/m^3 on the shop worker to 280 mg/m^3 on the mixing room operator during his p.m. work cycle. The second highest exposures were to MEK, ranging from 4.7 mg/m^3 on the shop worker to 30 mg/m^3 on the mixing room operator during his p.m. work cycle. Exposure levels to MIBK were approximately the same as MEK, with lower values on the shop worker and 38 mg/m^3 on the mixing room operator. These results show that no measured concentration of any individual solvent exceeded the evaluation criteria.

Since the physiological effects of these solvents are similar, it seems reasonable to combine the measured concentrations in ratios to their respective recommended TLV guideline. With this approach, it is possible to ascertain the potential effect of all the chemicals due to inhaled exposures. The summation of the fractions are as follows:

	A.M.	P.M.
Mixing Room	.25	1.01
Aerosol Can Filling	.10	.30
Shop Worker	.04	.16

Combined fractions less than one would be within the recommended evaluation criteria. Only one was outside this range, and it was for the afternoon personal sample in the mixing room. It is also interesting to note that there appears to be a concentration buildup in all of the areas as the day progresses. This is probably caused by inadequate ventilation and not related to work habits or the type of chemicals being used.

The facility has exhaust-type ventilation in the mixing room and the aerosol can filling area. The rest of the shop area relies on natural ventilation from the various cracks and crevices in the building. The mixing room is ventilated during use by an exhaust fan on the roof. This fan is connected by a duct to a small spray booth at the east end of the approximately 20-foot X 50-foot room. An opening near the ceiling has been cut in the duct to "improve" the ventilation in the room. The opening is fitted with a hinged door that is opened or closed depending on the activity in the room. Air infiltrates into the room from various openings, but most comes through a 12-inch X 18-inch opening in the overhead door. Approximately 2,000-3,000 cubic feet per minute (cfm) of air is handled by the exhaust fan, resulting in a rather large air velocity through the opening in the door. This results in a sensation of lots of air movement, when, in fact, the turbulence is just dispersing the contaminants and not removing them.

A canopy hood is located on the east wall over the principal work table in the aerosol can filling area. The hood is approximately 2-3 feet above the worker's head and is ducted directly outside. Approximately 2,000 cfm is drawn through the hood when it is operating. The north and west walls of this area are concrete block halfway up and wire mesh on studs up to the ceiling. Therefore, air is drawn from the shop area into the room entraining vapors from the work table and into the worker's breathing zone.

Half mask cartridge respirators were used by the mixing room and aerosol filling operators while performing some of their duties. They both complained of problems with excessive sweating and subsequent irritation in the summer months. Neither worker had been properly fit tested, nor were their respirators periodically cleaned and maintained. Latex gloves were also worn at times during the performance of their duties.

VII. DISCUSSION AND CONCLUSIONS

Although the measured concentration of solvents only exceeded any recommended guideline in one instance, the NIOSH investigator believes that a potential overexposure does exist at this facility. Operations in the mixing room had been shut down for some time before the day of our study because of the medical problems experienced by the operator. The operator was called in for just that one day of operation so we could conduct the study. The way in which the operations were carried out in the mixing room leads one to believe that there would be additional solvent vapors in the air due to the residue present from day-to-day continuous operations. Also, the study only focused on inhalation exposures; and based on our observations during the study, there were many times when direct skin exposure was evident. This was observed most frequently during wiping and cleaning up operations when gloves were not being worn. At times, we observed employees wiping their brow with the same rags they used to clean up spilled materials and solvent. Therefore, we conclude that there is a link between the employee's medical symptoms and his exposure to solvents.

VIII. RECOMMENDATIONS

In order to control worker exposures in this facility, the sources of the vapors must be reduced to a minimum. This can be accomplished by a variety of means, including eliminating the source, controlling the vapors at the point at which they are emitted, providing adequate dilution ventilation in the space, modifying the physical configuration of equipment in the workplace, changing work habits, good housekeeping practices, and using personal protective equipment.

A. Mixing Room - The exhaust system in the mixing room should be modified so that inlets are close to the floor and extend across the room on the east end. Makeup air should then be supplied at the west end above the overhead door (see Industrial Ventilation - A Manual of Recommended Practices, 18th Edition, pp. 2-3)[10]. Air will then pass through the room in a downward motion, minimizing vapors in the worker's breathing zone. Ventilation volumes around 5,000 cfm should be adequate. Ideally, the room should be configured with the mixing area and can filling area close to the east end. Vapors emitted from these processes would then go directly into the exhaust system. The paint color quality control area should definitely be moved to the west end of the room because the worker spends the most time at this operation, and the west end should have the cleanest air. Rags soaked with solvent should be placed in covered containers and frequently removed from the room. These rag containers should be located toward the west end of the room. Barrels, five-gallon containers, and cans that at one time contained pigments or solvents should be removed from the space, as they will continue to emit vapors. If partially filled containers mustbe retained, they should be stored toward the west end and away from working spaces. Gloves should be worn at all times when there is a potential for direct skin contact with the pigments or various solvents. If a respirator is going to be used, a respiratory protection program needs to be implemented, which should include the following:

1. Written instructions for use of equipment;

2. Training on the selection of appropriate respirator cartridges and their limitations;

3. Quantitative and qualitative fit testing;

4. Proper donning and doffing techniques;

5. Proper cleaning and maintenance of devices; and

6. Proper disposal techniques.

B. Aerosol Can Filling Area - A new exhaust enclosure should be built around the operation. The entire operation should be placed in an enclosure that is closed on three sides, top to bottom. Exhaust air should then be removed through a high velocity slot (1,000 fpm) about 12 inches above table height. Vapors will then be drawn out of the enclosure and not into the worker's breathing zone. Impervious gloves should be worn at all times during the operation to prevent direct skin contact. Test spraying of a newly filled can should be directed into the waste receptacle. Cleaning rags, empty containers, etc. should be placed in covered waste containers and periodically removed to decrease the emission of fugitive vapors. Likewise, waste solvents should be placed in sealed containers and properly stored or disposed of. These improvements should delete the need for a respirator. However, if a respirator is going to be used in the interim, the same recommendations made for the mixing room should be utilized.

C. Shop Area - Workers in the general shop area who work inside of automobiles with the materials should do so with all the doors and windows open in the vehicles; and, whenever feasible, they should minimize the time they spend inside the vehicles. We see no need for personal protective equipment for these workers.

IX. REFERENCES

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X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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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), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from the NIOSH Publications Office at the above address.

Copies of this report have been sent to:

A. Dr. Vinyl & Associates

B. NIOSH, Region VII

C. U. S. Department of Labor/OSHA, Region VII

D. Kansas City, Missouri Health Department

E. Missouri Division of Health.

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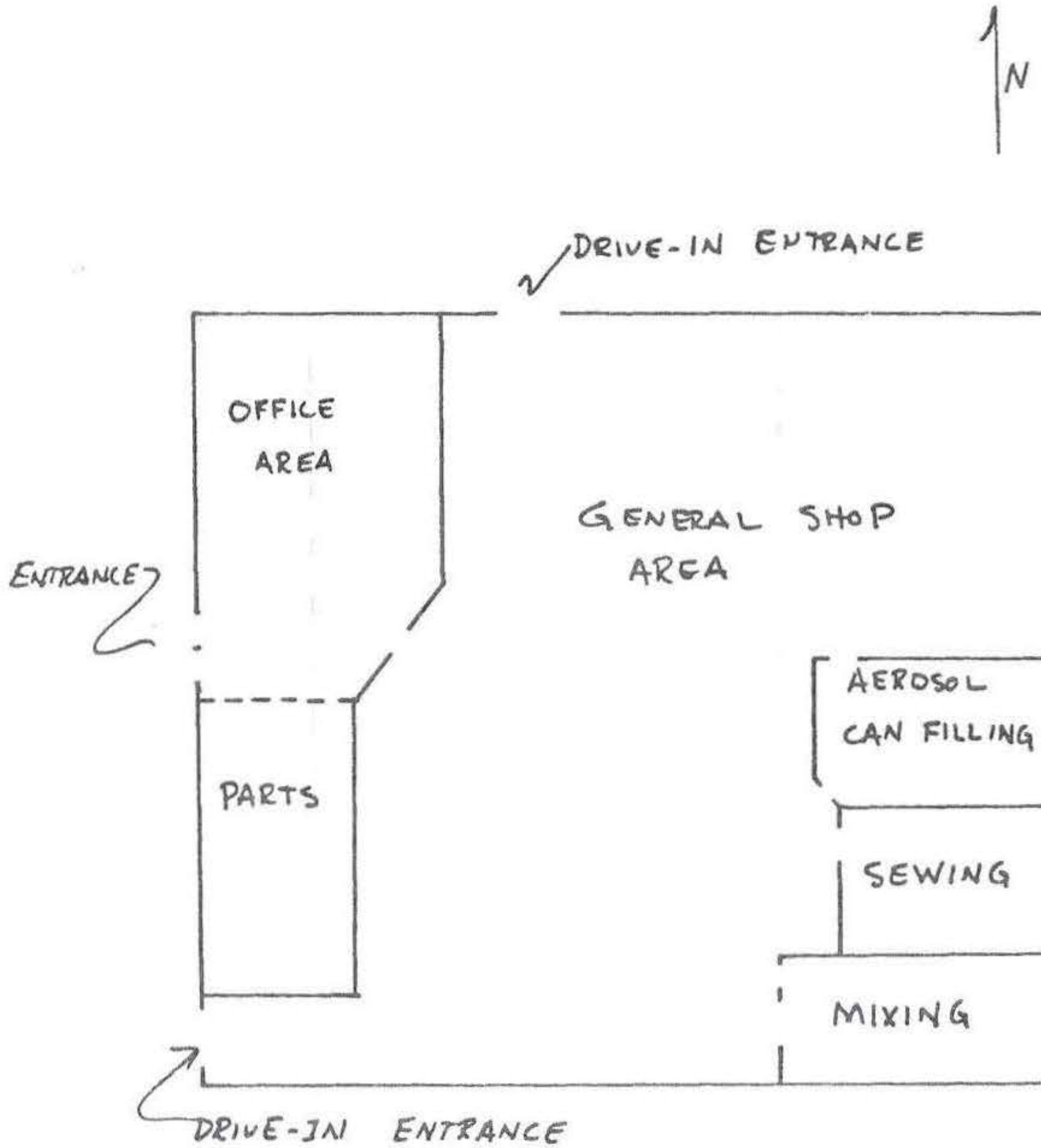

Figure 1 Schematic of Dr Vinyl Facility
Scale 1" ≈ 30'

TABLE I

Environmental Criteria

Dr. Vinyl & Associates
HETA 84-315
December 1984

	ACGIH[7] TLVs		OSHA[8] PEL		NIOSH[9] Rec. Criteria	
	ppm	mg/m3	ppm	mg/m3	ppm	mg/m3
MEK	200	590	200	590	200	590
Toluene	100	375	200	750	100	375
MIBK	50	205	100	410	50	205
Cyclohexane	300	1050	300	1050	--	--
Xylenes	100	435	100	435	100	435

TABLE II

Air Concentrations

Dr. Vinyl & Associates
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Sample #	Sampling Location	Sampling Period	Vol. m3	MEK Lab Result mg	MEK Conc. mg/m3	Toluene Lab Result mg	Toluene Conc. mg/m3	MIBK Lab Result mg	MIBK Conc. mg/m3	Cyclohexane Lab Result mg	Cyclohexane Conc. mg/m3	Xylenes Lab Result mg	Xylenes Conc. mg/m3
1	Office Area	0743-1435	.029			.24	8.3	.04	1.4	<.01		.02	0.7
2	Operator, Mixing Room	0754-0947	.007			.29	41.	.11	16.	<.01		.02	2.9
3	Operator, Aerosol Can Filling	0756-1130	.015			.40	27.	.07	4.7	<.01		.02	1.3
4*	Shop Area	0821-1453	.023	.05	2.2								
5*	Aerosol Can Filling Area	0814-1209	.017	.05	3.0								
6	Shop Area	0821-1451	.025			.14	5.6	.02	0.8	<.01		<.01	
7	Mixing Room Area	0808-1159	.017			.45	26.	.23	13.	<.01		.03	1.8
8*	Mixing Room Area	0809-1158	.018	.31	17.								
9	Aerosol Can Filling Area	0814-1208	.014			.14	10.	.02	1.4	<.01		<.01	
10	Repairman, Trim Shop	0802-1219	.019			.22	12.	.02	1.1	<.01		<.01	
11	Operator, Mixing Room	1100-1354	.011			3.1	280.	.42	38.	.07	6.4	.10	9.1
12	Operator, Aerosol Can Filling	1230-1607	.015			1.2	80.	.23	15.	.02	1.3	.06	4.0
13	Mixing Room Area	1205-1430	.011			1.6	145.	.18	16.	.03	2.7	.06	5.4

TABLE II
(Continued)

Air Concentrations

Dr. Vinyl & Associates
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December 1984

Sample #	Sampling Location	Sampling Period	Vol. m3	MEK Lab Result mg	MEK Conc. mg/m3	Toluene Lab Result mg	Toluene Conc. mg/m3	MIBK Lab Result mg	MIBK Conc. mg/m3	Cyclohexane Lab Result mg	Cyclohexane Conc. mg/m3	Xylenes Lab Result mg	Xylenes Conc. mg/m3
14*	Mixing Room Area	1205-1430	.011	.11	10.								
15	Aerosol Can Filling Area	1215-1540	.012			.47	39.	.10	8.3	.01	0.8	.03	25.
16*	Aerosol Can Filling Area	1215-1540	.015	.08	5.3								
17	Repairman, Trim Shop	1220-1555	.015			.57	38.	.05	3.3	.06	4.0	.04	2.7
18*	Blank			.01									
19*	Blank			.01									
20	Blank					.01		.01		.01		.01	
21	Blank					.01		.01		.01		.01	

*Ambersorb Media all others charcoal

TABLE III
Personal Sample Air Concentrations
(mg/m3)

Dr. Vinyl & Associates
HETA 84-315
December 1984

	ACGIH TLV	Mixing Room AM (2 hr)	Mixing Room PM (3 hr)	Aerosol Can Filling AM (4 hr)	Aerosol Can Filling PM (3.5 hr)	Shop Worker AM (4 hr)	Shop Worker PM (3.5 hr)
MEK*	590	27.	20.	9.0	11.	4.7	15.
Toluene	375	41.	280.	27.	80.	12.	38.
MIBK	205	16.	38.	4.7	15.	1.1	3.3
Cyclohexane	1050	--	6.4	--	1.3	--	4.0
Xylenes	435	2.9	9.1	1.3	4.0	--	2.7

*Estimated by using ratio of MEK/toluene from area samples

APPENDIX A

DR. VINYL

PLASTIC SURGERY AND OTHER COSMETIC OPERATIONS ™

PIGMENT

Vinyl Chloride Copolymer (VYHH)
Methyl Ethyl Ketone
Cyclohexanane
Toluene
Plasticizer
Pigment
Copolymer Vinyl Resin
Butyl Alcohol
Toluol
Copolymer Vinyl Resin Dispersant
Isobutyl Methyl Ketone

CLEAR

Xylene
Toluene ---mixed solvents
Syloid
VYHH or FPC 497
MIBK
Polysolve DPM
Acryloid B-66
Acyyloid A-101
D.O.P.

716 Thinner

I.P.A. = Isapropol Alcohol
Acitone
Lacquer Diluetent
Toluene

Rich Gold

98% Copper
Zink Aloe
2% Stearic Acid

Copper

98% Copper
2% Stearic Acid

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