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 HE 78-48-622

WHITE MOTOR COMPANY
EXTON, PENNSYLVANIA

OCTOBER 1979

I. TOXICITY DETERMINATION

Based on environmental evidence, confidential employee interviews, review of plant records, and observations of work practices and conditions, a potential hazard to the health of workers exposed to Centauri® paint did exist at White Motor Corporation, Exton, Pennsylvania during the period of the Health Hazard Evaluations, June 21-23, 1978, and February 28 - March 1, 1979. Exposure to lead exceeded standards in the chassis, hood, cab, finishing, and dip and spray departments. Company furnished biological monitoring data did not show excessive lead absorption by workers. All blood lead values reviewed were less than 40µg/100 g of whole blood. An adequate respirator program is necessary to maintain worker health protection. However, exposures must be further decreased below levels of known health effects by improved engineering control, such as substitution of less hazardous process materials, automation, better enclosure of processes or the redesign or replacement of existing mechanical ventilation system.

Environmental sampling indicated that one of five samples taken inside the cab spray booth for hexamethylene diisocyanate (HDI) in the Centauri paint system exceeded NIOSH recommended ceiling concentration and a second sample in the finishing department approached this value. A long term personal sample in the cab department approached the eight-hour TWA for this substance. Three of four confidential questionnaires and numerous spontaneous employee observations revealed running nose, coughing and watery eyes. The medical and environmental findings together suggest repeated overexposure to HDI with one worker having become sensitized. The evaluation criteria used here will not protect sensitized workers from symptoms if sensitization to HDI has already occurred (Table 2). Inadequate respiratory protection practices and marginal ventilation system function are factors that contribute to this finding.

Solvent exposures to toluene, xylene, and naptha associated with Centauri use were well below levels of hygienic significance. Spray paint hood performance was deemed marginal and observed respiratory protection practices inadequate to protect exposed personnel.

Recommendations to protect workers are suggested in Section VI of this report.

II. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this Determination Report are currently 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 of this report have been sent to:

a. Individual Requestor
b. White Motor Corporation, Auto and Trucks Division
   Lincoln Highway, Exton, Pennsylvania 19341
c. UAW, Local 131, 531 Lancaster Avenue
   Malvern, Pennsylvania
d. United Auto Workers, Social Security Department,
   800 E. Jefferson, Detroit, Michigan 48214
e. U.S. Department of Labor, Region III
f. NIOSH, Region III

For the purpose of informing the affected employees the employer shall promptly post for a period of 30 calendar days this determination report in a prominent place(s) near where the exposed 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 in the place of employment might have potentially toxic effects as it is used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from an authorized representative of workers regarding exposure to Centauri paint. The request stated that workers were experiencing constant headaches, nausea, sneezing, watery eyes, and running nose when exposed to Centauri.

A preliminary survey was conducted by the NIOSH Industrial Hygienist on June 21-23, 1978. Samples for lead, organic vapors and diisocyanates were collected. Velometer and smoke tube observations of paint spray booth ventilation, confidential medical questionnaires, and observations of work practices and personal protective equipment were made. A preliminary report was forwarded to representatives of labor and management July 31, 1978. Due to destruction of the isocyanate samples during relocation of the NIOSH Analytical Laboratory, air sampling and ventilation measurements were reaccomplished February 28 - March 1, 1979. A closing conference was held March 1, 1979 with representatives of Labor and Management.

IV. HEALTH HAZARD EVALUATION

A. Plant Process

The plant assembles truck cabs, and chassis. The production rate is about 12 units per day. This evaluation was limited to the spray painting areas designated as chassis paint, small parts painting, cab painting, final painting, and dip & spray. One or two operators apply Centauri paint using compressed air powered spray guns. Centauri is an enamel protective coating to which a polyurethane conversion material may be added for better finish characteristic. About 3700 gallons of the Centauri system are sprayed per month. Other paints are used only on special order. The chassis spray booth employs an electrostatic system to decrease overspray as well as exhaust ventilation. All spray hoods utilize dry type overspray collectors. Paint is mixed in a separate mixing room and transported to the booths. Workers wore respirators and company furnished protection clothing during painting operations.

B. Evaluation Design-Chemical Exposures

Hexamethylene diisocyanate, lead, and the solvents xylene and toluene were the substances of interest. Long-term (7-8 hour) personal and area samples for lead and organic vapors were collected. Both short-term (10-30 minute) and long term (7-8 hour) personal and area samples for hexamethylene diisocyanate were collected. Personal samples were used to evaluate the exposure of individual employees in each job location. Area samples were used to evaluate fume escape from the hoods. Smoke tubes and a thermoanemometer were used to evaluate local exhaust ventilation.

The plant nurse was interviewed and four confidential medical questionnaires were administered by the industrial hygienist.

Observations of work practices and personal protective equipment use were made.

The air sampling and analytical methodology for the different types of samples is shown in Table I. Included in Table 1 are, for each substance evaluated, the collection device, the range of sample durations, the pump flow rate, the analytical method and, where applicable, the reference for the sampling and analytical method. The personal air samples are those for which the subject actually wears the air sampler with the collection device pinned to the shirt or collar or held by hand, so as to obtain an air sample representative of the air in the breathing zone. The area samples are obtained by placing the sampling device in general work areas thought to have air quality similar to that of the subjects exposed. MSA Model D* pumps were used to collect samples analyzed for lead and hexamethylene diisocyanate. The charcoal tube (solvent) samples were taken with an MDA Model 808* personal sampling pump. Due to plant process changes accomplished between the first and second visit, and incomplete analytical data, only samples collected during February 28 - March 1, 1979 are reported.

*Mention of a specific product or trade name does not imply endorsement by the National Institute for Occupational Safety and Health.

C. Environmental Limits, Criteria and Health Effects

The environmental evaluation criteria used for the study are presented in Table 2. Listed in Table 2 for each substance are the recommended environmental limit, the source of the recommended limit, the principal or primary health effects underlying each recommended limit and the current OSHA standard.

There are four lead-in-air concentrations currently available as evaluation criteria.

1) The Old OSHA Standard: "The present occupational safety and health standard for lead and its organic compounds is found in Table Z-2 of 29 CFR 1910.1000 and was adopted in 1971 pursuant to Section 6(a) of the act. The permissible exposure limit, which is 200μg/M^3 as determined on the basis of an 8-hour time weighted average, was based on the national consensus standard of the American National Standards Insitute (Z37.11-1969). When the consensus standard was originally adopted, no rationale was provided for the level selected, "(42CFR52952, November 14, 1978 Occupational Safety and Health Administration Notice on Issuance of Final Standard for workplace Exposure to Lead)".

2) The New OSHA Standard: The final standard for Occupational exposure to lead, issued November 14, 1978, limited occupational exposure to lead to 50μg/M^3 based on an 8-hour time weighted average. It specified an effective date of February 1, 1979 and allowed 150 days from the effective date for compliance with the permissible exposure limits. Initially, respirators may be used for compliance with the PEL. However, industries other than primary lead production, secondary lead production, lead acid battery manufacturing, nonferrous foundaries, and lead pigment manufacturing must also implement engineering and work practice controls (including administrative controls) to reduce and maintain employee exposure to lead to 50μg/M^3 within one year of the effective date. The five named industries have longer compliance times. Federal Register Notice (44FR 14559, March 13, 1979 Occupational Safety and Health Administrative Notice of Partial Judicial stay of the lead standard), announced several provisions of OSHA's new standard for occupational exposure to lead (29 CFR 1910.1025) have been stayed by the U.S. District Court of Appeals for the District of Columbia Circuit pending full judicial review of the standard. After listing the stayed provisions the notice continued, "the effective date of the standard is March 1, 1979. In addition the standard for lead in 29CFR 1910.1000 will remain in effect during the period of the stay and will continue to be enforced by OSHA. Section 1910.1000, Table Z-2, sets a permissible exposure limit of 0.2 milligrams of lead per cubic meter of air as an 8-hour time weighted average, which must be complied by the use of feasible engineering or administrative controls (1910.1000)".

3) The NIOSH Criteria for a Recommended Standard ... Occupational Exposure to Inorganic Lead Revised Criteria-1978 states, "Occupational exposure to inorganic lead shall be controlled, so that workers shall not be exposed to inorganic lead at a concentration greater than 0.1 mg Pb/M^3 (100 µg/M^3) determined as a time-weighted average (TWA) exposure for an 10-hour workday, 40-hour work week.

4) The Threshold Limit Values for Chemical Substances in Workroom Air adopted by ACGIH for 1979 lists a time-weighted average value for lead, inorganic fumes and dusts (as Pb) as 0.15 mg/M^3 (150 µg/M^3).

V. DISCUSSION

A. Lead

Although lead can be acutely toxic in high doses, it is also a bioaccumulative toxin and a chronic illness from considerably smaller but repeated exposures is much more likely in the industrial setting. Lead may be absorbed by inhalation or ingestion and is excreted very slowly by the kidneys. It can affect the blood forming organs, the kidneys, and the nervous system, and also lead to a number of rather poorly defined symptoms.

Blood levels of lead up to 40 µg/100g of whole blood are found in the general population with no history of occupational exposure to lead, but the average level is somewhat below this. NIOSH has recommended that a blood lead value of 60 micrograms per 100 grams whole blood (60 µg/100 g blood) be the maximum tolerated occupational blood lead level. The new OSHA standard has dictated that by the end of four years this will become the level at which a worker must be removed from further lead exposure until his blood lead level has dropped to normal values. OSHA has further set an average blood lead level of 50 µg/100 g whole blood as requiring removal until blood lead levels are normal (by the fifth year of the standard). OSHA's aim is to keep as many workers' blood lead levels as possible below 40 µg/100 g, the upper limit of blood leads in unexposed individuals.

Women are probably slightly more susceptible to the ill effects on the blood forming organs, and in the case of pregnancy, the developing fetus is more sensitive to lead than is an adult. It is therefore, considered a good idea for women of childbearing age to maintain their blood lead levels below 30 µg/100g of whole blood. In view of the low blood lead levels reported by the plant, the general insolubility of paint pigments and the use of some type of respiratory protection making it unlikely that the lead will be inhaled, it does not appear that the workers are being overexposed to lead. However, the fact that there is lead in the paint and it is being sprayed makes it imperative that proper engineering controls, work practices, and an adequate monitoring program are followed to assure continued safety.

B. HDI

The diisocyanates, of which HDI is one of the less volatile examples, are irritating to the mucous membranes of the eyes, nose and throat, and to the lower respiratory tract. Sometimes this does not show up until the evening when the worker notices a tightness in his chest which clears by the next morning. The most severe reaction would be an asthma-type attack. Besides the direct irritation, the diisocyanates can cause an allergic sensitization. The symptoms are the same as those caused by the irritation, with a greater tendency to have chest complaints at lower and lower exposure levels. The fact that one worker was so symptomatic, even when not working as a sprayer, that he had to seek a transfer to some other department strongly suggests that he had become sensitized to the HDI. The recommended standards for the diisocyanates are set at levels which it is believed will prevent non-sensitized workers from becoming sensitized. However, these levels are not sufficiently low to allow a person already sensitized to diisocyanates to tolerate the exposure. These comments apply equally to men and women.

C. Evaluation Results

There was no hazard from exposure to the organic vapor, toluene, xylene, and total naptha based on the fact that the levels were below environmental criteria used here (Table 3). The naptha fraction included all hydrocarbons except toluene and xylene, primarily eight and nine carbon alkanes and cycloalkanes.

The lead in air results are distributed follows: Six samples were in the 0-50 $\mu g/M^3$ range. One sample was in the 100-200 $\mu g/M^3$ range and four were in excess of 200 $\mu g/M^3$. Thus four values were in excess of the current OSHA regulatory standard and only six of the eleven samples were below both the NIOSH Recommendation Standard and Proposed OSHA Standard.

Eighteen blood lead samples drawn on spray painters by management in November 1977 were reviewed during the June 1978 visit. The mean of this data was 21.6 µg/per 100 ml and the range was 15-28 µg/100 ml, about what one expects in the general population.

Seven area samples, nine short-term personal samples and four long-term personal samples were collected and analyzed for HDI*. One short-term area sample in the cab department exceeded the NIOSH ceiling standard of 140 mg/M^3, one long-term personal sample in the cab department and one short-term sample in the finishing department approached the recommended limits. No TDI or MDI was detected in any of these samples.

On the initial site visit four employees who worked near the area of concern were interviewed. Three of these four confidential questionnaires and numerous spontaneous employee comments received during the second visit reported runny nose, coughing, and watery eyes. One worker, although not directly involved in the spraying, felt obliged to transfer out of the area completely because of the same irritative symptoms plus coughing.

*The development analytical procedures used for identification and quantification of HDI are subject to the qualifications contained in the UBTL laboratory report of April 16, 1979 which is incorporated in this report as Appendix A.

D. Ventilation Survey

A screening ventilation survey was conducted using smoke tubes and a thermoanemometer. Qualitative observations were made during smoke tube tests which were then confirmed with air velocity measurements.

Ventilation measurements were made by dividing the hood area into a number of equal segments and averaging the velocities obtained in each segment. Booth dimensions were obtained by measurement. Hood cross section was determined by hood width by height. Measurements were also made at typical work station positions.

The values obtained were compared to three criteria: 29 CRF 1910.107 (b)(5)(i) which requires 100 FPM air velocity over the booth cross section during spraying (60 fpm if electrostatic spraying)[12], the Industrial Ventilation Manual[11] which suggests 50 CFM of exhaust per square foot of booth cross section for auto spray paint booths; and the NIOSH Recommended Industrial Ventilation Guidelines[10] which also suggests 50 CFM of exhaust per square foot of cross section. These results are reported Table 6. Visual observations are summarized below:

1. Cab Booth

a. Tests Results: The cab spray booth and primer area have been converted from water fall to dry spray booths by installation of disposable filters. Make-up air is drawn through similar filters from the plant environment. Compressed air spraying was employed. Although a swivel turntable is provided to rotate the workpiece, the operator may stand in any position in the booth, i.e. between the work and hood or with the work between himself and the hood. Some acceleration of air at the booth centerline and relatively rapid air flow at the exhaust filters was noted. There was little air movement noted in the breathing zone when the operator was positioned at the far wall with work between himself and the hood. The measured air velocity at this position was less than 20 fpm.

b. Finishing: The finishing area consisted of two parallel long narrow drive-through booths with vertical floor to ceiling take offs, at one end. Compressed air spraying was used. Filtered make-up air from the in-plant environment was drawn through doors at the opposite end of the booth from the vents. Visual observation of painting indicated considerable back spray/splash and sluggish air movement of 30-50 fpm at the make-up end. There were also spots of minimal air movement along the walls, the normal operator position, which were apparently due to blockage of airflow by solid structure at the make-up end supports. When two spray operators operate simultaneously on either side of the booth, overspray from the upwind gun can be drawn into the breathing zone of the downwind operator.

c. Chassis Spray: This pull through booth is on a chain driven assembly line. Two spray painters operate simultaneously on opposite sides of the booth most of the day. Electrostatic spraying is employed. Air is accelerated from the centerline of the booth towards disposable filters on each side wall. Make-up air is unfiltered and drawn into the ends of the booth from the factory. Chassis are drawn through an unventilated drying booth after this operation.

d. Dip and Spray: This was converted from a waterfall system by installation of disposable dry filters. Metal items are dipped in preparatory compounds and painted. The only normal operator position is with the work between himself and the hood. Make-up is drawn from the general interior environment.

The four area samples for lead, four area samples for organic vapors and four area samples for HDI taken outside the spray booths indicated escape of each of the index substances into the general environment. Since HDI is a sensitizer, this low level "leakage" can account for the complaints of individuals in adjacent areas if prior sensitization has occurred. Standards for NIOSH and OSHA environmental levels of HDI will not protect sensitized workers. The suboptimal features of ventilation control within the hoods include dead spots, areas of little or no air movement in the cab and finishing hood, in addition areas of air flow less than 100 fpm, and the practice of spraying both sides of the workpiece simultaneously in the finishing and chassis booth. All booth filters exhibited rapid build up of paint material throughout the day although the installed pressure drop warning monitors were not utilized. The practice of cleaning filters on a time basis, (daily) rather than on a pressure drop/hood performance criterion was employed.

Back spray towards the painters was particularly evident in the finishing booths.

E. Respirator Program

The respiratory protection program observed during both visits needed improvement. General guidelines for a respiratory program are outlined in the NIOSH Publication, A Guide to Industrial Respiratory Protection. Observations concerning the existing respirator program follow:

1. The respirators in use are air purifying chemical cartridge respirators. These are not appropriate for protection from diisocyanates. Since at least one sample inside the spray hoods was above the NIOSH recommended ceiling level and since the medical interviews suggest isocyanate sensitization, use of type C supplied air respirators, with full facepiece; operated in a pressure demand or positive pressure mode is recommended whenever the Centauri hardener is used.

2. Based on measured air lead values in excess of 1,500 $\mu g/M^3$, the type of air purifying respirator recommended for protection from this substance during the first year of the new OSHA lead standard is a high efficiency particulate filter respirable with a full facepiece.2 The dust half-face fume and mist respirator observed in use on both visits does not meet this standard. The supplied air respirator appropriate for protection from isocyanates would also be appropriate for protection from lead exposure.

3. Provisions for cleaning respirator facepieces on a daily basis should be made. The present practice of replacing the facepiece on a time interval basis of about once per month is inadequate.

4. Respirator cleaning requires specialized training in order to properly clean, reassemble, and test the mask. There are a number of short courses such as the NIOSH Occupational Respiratory Protection Course which provides such training. The employee responsible for implementing the Respiratory Protection Programs should attend such a course.

5. Masks should be bagged or otherwise protected from contamination when not in use. Numerous masks were observed and photographed unprotected in paint spray areas when not in use. This practice may result in a worker using a dirty and contaminated mask.

VI. CONCLUSIONS AND RECOMMENDATIONS

Exposure to inorganic lead was demonstrated by air sampling. Implementation of measures to control lead exposure are necessary. Exposure to HDI, a sensitizing agent, is indicated. Improved respiratory protection is necessary to initially minimize the health consequences of this exposure. (See Section E)

The ultimate reduction of the exposures to levels below those of known health effects must be accomplished by the improved engineering control of workplace contaminants such as by substitution of less hazardous process materials, automation, better enclosure of the process or redesign or replacement of existing mechanical ventilation system.

Company biological monitoring data, such as blood lead results, should be furnished to the affected employees or their designees upon request.

VII. REFERENCES

1. NIOSH Criteria for a Recommended Standard . . . Occupational Exposure to Diisocyanates, U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, 1978.

2. NIOSH Criteria for a Recommended Standard . . . Occupational Exposure to Inorganic Lead, U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, 1978.

3. NIOSH Criteria for a Recommended Standard . . . Occupational Exposure to Toluene, U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, 1973.

4. NIOSH Criteria for a Recommended Standard . . . Occupational Exposure to Xylene, U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, 1975.

5. NIOSH Criteria for a Recommended Standard . . . Occupational Exposure to Refined Petroleum Solvents, U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, 1977

6. 29 CFR 1910.1000 Table Z, Occupational Safety and Health Standards Subpart Z - Toxic and Hazardous Substances.

7. 29 CFR 1910.1000 Table Z-2, Occupational Safety and Health Standards Subpart Z-Toxic and Hazardous Substances.

8. 29 CFR 1910.1025, Occupational Safety and Health Standards Subpart Z-Toxic and Hazardous Substances.

9. American Conference of Governmental Industrial Hygienists, Documentation of the Threshold Limit Values for Substances in Workroom Air, 3rd, Edition, 1973.

10. NIOSH Recommended Industrial Ventilation Guidelines, U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, 1976.

11. American Conference of Governmental Industrial Hygienists Industrial Ventilation, A Manual of Recommended Practice, 15th ed., 1978.

12. 29 CFR 1910.107, Occupational Safety and Health Standards, Subpart H-Hazardous Materials.

13. NIOSH Manual of Analytical Methods, Vol. 1, 2nd, ed. U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, 1977.

14. A Guide to Industrial Respiratory Protection, U.S. Department of Health, Education and Welfare, PHS, CDC, NIOSH, 1976.

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TABLE I

Sampling and Analysis Methodology
White Motor Company
Exton, Pennsylvania
HE 78-48

Substance	Collecting Device	Flow Rate	Duration	Analysis	Limit of Detection	Reference
Hexamethylene diisocyanate	Nitro Reagent 2 midget impingers or 2 spill proof impingers in series	1.5 lpm midget impinger	10-30 minutes short term	Modified P & CAM #240	1.6 µg per sample	13
		1.0 lpm spill proof impingers	4-8 hours long term	(In most cases only the first of the 2 impingers was analyzed)		
Lead	AA filter	1.5 lpm	7-8 hours	P & CAM #173	5 µg per sample	13
Xylene Toluene Total Naptha	Charcoal tube (150 mg)	50 cc/min	7-8 hours	desorption with CS_2, gas chromatography	0.02 mg/sample 0.02 mg/sample 0.10 mg/sample	13

TABLE II

Environmental Evaluation Criteria
White Motor Company
Exton, Pennsylvania
HE 78-48

Substance	NIOSH Recommended Environmental Health Limit	Source	Primary Health Effects	OSHA Standard
Hexamethylene diisocyanate	35 $\mu g/m^3$ - TWA 140 $\mu g/m^3$ ceiling	Reference 1	See Text, P. 6	———
Lead	100 $\mu g/m^3$ - TWA	Reference 2	See Text, P. 5	200 $\mu g/m^3$ Reference 8
Toluene	100 ppm TWA(375 mg/M^3) ceiling - 250 ppm - 10 minutes(938 mg/M^3)	Reference 3	Central nervous system depressant	200 ppm TWA(750 mg/M^3) 300 ppm ceiling (1125 mg/M^3 500 ppm maximum (1875 mg/M^3) Ref. 7- Ceiling-10-minutes
Xylene	100 ppm TWA(435 mg/M^3)	Reference 4	Central nervous system depressant. Airway irritation	100 ppm TWA Reference 6
Total Naptha (painters naptha)	350 mg/m^3 - TWA	Reference 5	Skin, lung, and nerve irritation	400 mg/m^3 Reference 6
Ethyl acetate	1400 mg/M^3	Reference 9	Mildly narcotic, eye, nose and throat irritation	400 ppm (1400 mg/M^3) Reference 6

TABLE III

Organic Vapor
Air Sampling Results
White Motor Company
Exton, Pennsylvania
HE 78-48

February 28, - March 1, 1979

Location	Date	Type of Sample	Sample Volume	Concentration mg/m^3 Toluene	Xylene	Total Naptha
Chassis Dept.	1 March 79	Area	22.7	18.5	4.4	8.4
"	"	Area Uptrack	23.0	9.6	1.3	5.6
"	"	(Personal down track beyond oven)	14.5	25.0	5.7	7.8
"	"	(Personal down track beyond oven)	19.0	3.7	3.7	7.6
"	"	Personal	23.7	82.3	55.3	62.0
"	"	Personal (degreaser)	23.4	10.7	5.1	65.0*
Hood Dept.	"	Personal	21.7	63.1	14.3	27.2
Hood Dept.	28 Feb. 79	Personal	24.3	62.6	30.4	38.7
Cab Dept.	"	Area	24.1	13.7	4.6	17.4
"	"	Personal	23.4	62.8	32.0	62.0
Finishing Dept.	"	Area	22.2	10.8	1.8	6.3
"	"	Personal	19.0	78.9	42.6	95.8
"	"	Personal	22.8	50.4	18.0	27.6
Mixing*	"	Personal	22.2	68.1	31.5	46.6

*ethyl acetate 16.8 mg/m^3 was also detected in this sample.

Table IV
Lead
Air Sampling Results
White Motor Company
Exton, Pennsylvania

March 28, 1979

HE 78-98

Location	Type of Sample	Sample Volume	Concentration ($\mu g/M^3$)
Cab Dept.	Area	0.70	33
Cab Dept.	Personal	0.69	1600
Chassis Dept.	Area	0.71	10
Chassis Dept.	Area	0.67	11
Chassis Dept.	Personal	0.63	300
Finishing Dept.	Area	0.67	12
Finishing Dept.	Personal	0.68	16
Finishing Dept.	Personal	0.69	380
Hoods	Personal	0.70	540
Mixing	Personal	0.74	9
Dip & Spray	Personal	0.69	140

TABLE V

HDI
Air Sampling Results *
White Motor Comapny
Exton, Pennsylvania
HE 78-48

February 28, - March 1, 1979

Location	Date	Type of Sample	Sample Volume	Concentration $\mu g/m^3$
Cab Dept.	1 March 79	Area - long term	451	<1.6
Cab Dept.	1 March 79	Personal - long term	163	29.4
Cab Dept.	1 March 79	Personal - short term	26	<1.6
Cab Dept.	1 March 79	Area - Short term taken inside booth	26	192.5
Cab Dept.	1 March 79	Area - Short term taken in booth	26	<1.6
Finishing Dept.	1 March 79	Area - long term	451	<1.6
Finishing Dept.	1 March 79	Personal - long term	474	8.2
Finishing Dept.	1 March 79	Personal - short term	27	<1.6
Finishing Dept.	1 March 79	Personal - short term	27	<1.6
Finishing Dept.	1 March 79	Personal - short term	25	128.0
Chassis Dept. (after ovens)	1 March 79	Area - long term	430	<1.6
Chassis Dept. (after ovens)	1 March 79	Area - long term	338	6.2
Chassis Dept.	28 Feb. 79	Personal - long term	246	8.5
Chassis Dept.	28 Feb. 79	Personal - long term	244	13.5
Chassis Dept.	28 Feb. 79	Personal - short term	21	<1.6
Chassis Dept.	28 Feb. 79	Personal - short term	32	<1.6
Chassis Dept.	28 Feb. 79	Personal - short term	36	<1.6

*No TDI or MDI was detected in these samples.

TABLE VI

Ventilation Measurement Results
White Motor Company
Exton, Pennsylvania
HE 78-48

February 28, - March 1, 1979

Hood	Booth Cross Section $(ft)^2$	Volume Of Air Exhausted (cfm)	cfm Exhausted per ft^2 Cross section	Required Minimum Meets cfm per ft^2 of Section	Minimum Maintained Level of 100 lpm
Finish Painting					
1. South Bay	480	12000	25.7	50	No
2. North Bay	480	12000	25.3	50	
Main Assembly	Non-standard hood	9300	Non-standard hood	Non-standard hood	Non-standard hood
1. East Side					
2. West Side		10000			
Cab & Painting	145	18800	61.0	100	No
Dip & Spray	180	20000	110.0	100	Yes

UBTL Laboratory Report
April 16, 1979

Appendix A

Selected samples from the sets described above were analyzed for HDI. The first four samples, #2790-#2793 were analyzed first as requested. A modification of P&CAM #240 was followed. The samples were made up in two ml of dichloromethane after evaporation instead of one ml. This was done because varying amounts of a clear oily substance remained in the samples after evaporation. Dissolving the evaporated sample in dichloromethane, transferring it to a two ml volumetric flask and bringing it to volume permitted an accurate determination of sample volume. A waters µ-Bondapak CN column was used. The mobile phase consisted of 80% isooctane, 15% methanol and 5% isopropanol (isocratic). The flow rate was 2 ml/min and the wavelength was 254 nm. The limit of detection was 40 ng or 1.6 µg/sample for a 50 µl injection. This change in column and solvent system was made because it permits a successful separation of the analytes from the rather large amounts of interfering materials present in the samples.

No HDI was detected in the first four samples, #2790-#2793. No other alkyl isocyanates were detected. A large peak of unknown composition eluted 30-45 minutes after injection of the sample. After sample #2792 was run, a portion of it was spiked with 115 ng of HDI (as the urea) and 104 ng or 90% was observed upon reinjection into the LC.

Upon the recommendation of Dr. Geraci, the following samples were taken for analysis: #2794, #2802, #2804, #2806, #2808, #2810, #2812, #2814, #2816, #2818, #2822, #2824, #2826, #2828, #2830, and #2875, a blank. These samples were run under the conditions described above. No HDI was detected in samples #2794, #2822, #2824, #2826, and #2830.

NIOSH requested that the presence or abscence of TDI and MDI in the samples be verified. Under the conditions described above, TDI and HDI have similar retention times. Therefore, a new set of solvent conditions was devised which permitted the separation of HDI, TDI and MDI from each other as well as from the large interfering peaks. The new solvent conditions were: 72% isooctane, 7% methanol and 21% isopropanol. Samples #2802, #2804, #2806, #2808, #2810, #2812, #2814, #2816, #2818,and #2875 were re-run under the new conditions. Neither TDI nor MDI were detected in any of the samples. However, five samples, #2802, #2804, #2806, #2812 and #2814 had peaks which eluted in the HDI region of the chromatogram. Two samples, #2804 and #2812, had peaks too small to allow further verification procedures. They are reported as "unconfirmed" on the sample report sheet. The remaining three samples had peaks large enough to permit further verification. Their peak shapes and retention times were subject to question. Therefore, spikes of all three were prepared and the samples were run again under a third set of solvent conditions designed to resolve HDI from the suspected interferences. The third set of solvent conditions was: 80% isooctane, 5% methanol and 15% isopropanol. HDI was found in all three samples. The third set of solvent conditions resolved HDI from interferences in samples #2802 and #2814.

Observations on Sample Condition. Sample #2814 contained a significant amount of a yellow substance, possibly yellow paint. The sample was filtered before analysis to remove the larger particles. After filtration, the sample still had a cloudy yellow appearance. A description of the appearance of the rest of the samples as received follows:

#2790-#2793: colorless and clear
#2794: clear, faint yellow tinge, flocculent layer on top
#2802: clear, red tinge, red precipitate, red flocculent layer on top.
#2804: like #2794
#2806: clear, faint yellow tinge, brown specks on bottom of vial
#2808: clear, red tinge, red specks on bottom of vial
#2810: like #2808 with more red specks
#2812: like #2808 with much more red precipitate
#2816: clear, colorless, no precipitate
#2818: clear, faint yellow tinge, small amount of red precipitate
#2822: like #2816
#2824: clear, colorless, small amount of blue precipitate
#2826: like #2824
#2828: like #2824
#2830: like #2816
#2875: clear, colorless

Discussion of the Analytical Method. The presence of interfering materials has created some difficulty in the analysis of these and other isocyanate samples. In the process of resolving the analytes from the interferences the run times can become quite long. Working with different samples to resolve their particular interferences is time-consuming. During that time, the samples are subject to some degradation. It is suggested that a sample cleanup procedure be incorporated into the analytical method. Selective desorption from silica gel is a possibility.

The three component solvent system developed in the course of this work has distinct advantages. Isooctane (or hexane) has a very low polarity while the polarity of methanol is quite high. In the presence of isopropanol they are miscible. Varying the ratio of isooctane to methanol permits a wide range of control over elution times. In addition, the relative proportion of methanol to isopropanol affects the selectivity of the solvent system. Taken together, these properties provide a very "tunable" solvent system. The use of this flexibility is illustrated in the development of a separation of HDI, TDI and MDI. Under the first set of conditions, HDI and TDI had similar elution times. In order to resolve HDI, TDI and MDI, the ratio of methanol to isopropanol was changed from 3/1 to 1/3 while holding the isooctane at 80%. In the process, the elution times increased. These were shortened by decreasing the isooctane to 72%.

An effort was made to verify the presence of HDI by comparing the ratios of absorbances obtained at different wavelengths. Since the nitro reagent is the principal chromophore in the HDI urea derivative, this approach is not specific for HDI. It will give similar ratios for other compounds which contain the nitro reagent moiety. However, it was observed that at a wavelength of 280 nm the HDI response was approximately 15% higher than at 254 nm. It may be advantageous to use a wavelength of 280 nm for the determination of HDI.