ESIS, Inc.
a CIGNA company

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CIGNA

October 30, 1986

PLAINTIFF'S EXHIBIT
JMMC-33
PENGAD-Bayonne, N.J.

Dr. E. Edward Wang, Manager
Corporate Environmental Control
J-M Manufacturing Company, Inc.
1051 Sperry Road.
Stockton, CA 95206

RE: ESIS Contract # 51-180

Dear Dr. Wang:

On September 16 and 17, 1986, I made a visit to the Denison plant to conduct an Environmental Health Survey. As a result of that visit, I am submitting the attached recommendation which should receive your immediate attention and consideration.

You will also find the results of the Environmental Health Report attached. These results are an indication of the environmental health conditions that existed on the days of my visit.

I wish to thank you and your staff for the cooperation that was extended during the course of this visit.

If you have any questions regarding this report and recommendation, please do not hesitate to call me at (713) 933-1826.

Sincerely,

Aileen Teng/pal

Aileen Teng, CIH
Senior Environmental Health Specialist
CIGNA Loss Control Services, Inc.

cc: Charles Stelchek, Plant Manager, J-M Mfg., Denison, TX
John T. Armstrong, J-M Mfg., Denison, TX
Daniel Weetmen, Alexander & Alexander of NY

NOV. 1 0 1986

D 002260

NAME: J-M Manufacturing	LOCATION: Denison, TX

EH 86-1 As can be seen from the sample results presented in Table I, the UPL #2 inspector was exposed to an asbestos level in excess of the OSHA permissible exposure limit. The willow operator's exposure level exceeded the OSHA action level.

Routine monitoring of asbestos exposure levels and a medical surveillance program have already been implemented per the requirements of the 1972 asbestos standard. Several revisions were incorporated into the 1986 asbestos standards. It is recommended that the additional provisions for notification of monitoring and medical examination results, work practices, preventive clothing, hygiene facilities, warning signs, compliance program, respiratory protection, medical surveillance, record keeping and employee training in the 1986 standard be adhered to. A comparison of the two standards is presented in Appendix II for your reference.

ENVIRONMENTAL HEALTH REPORT

PREPARED FOR:

J-M Manufacturing Company, Inc.
Denison, Texas

DATE OF SURVEY:

September 16 & 17, 1986

CONDUCTED BY:

Aileen Teng, CIH
Sr. Environmental Health Specialist
CIGNA Loss Control Services, Inc.

ACCOMPANIED BY:

John T. Armstrong
J-M Manufacturing Co., Inc.

INTRODUCTION

On September 16 & 17, 1986, an Environmental Health Survey was conducted at your plant in Denison, Texas, to evaluate employee exposures to noise, vinyl chloride monomer, respirable dust, total dust, asbestos, organic solvents, and carbon monoxide. The survey was conducted at the request of J-M Manufacturing Company, Inc., as an on-going monitoring program.

The standards and guidelines, methods, results, and discussion pertinent to this report follow.

STANDARDS AND GUIDELINES

The recommendations made in this report are based on current OSHA standards and/or accepted state-of-the-art industrial hygiene practices to give reasonable protection to the health and well-being of your employees.

The standards pertinent to this report are found in the Appendix Section.

METHODS

Air sampling and analyses were conducted using the following.

Air Contaminant	Vacuum Source	Flow Rate Liters/Min.	Collection Medium	Analytical Method
Asbestos	Gilian HFS-113UT Pumps, DuPont 2500 Sampling PUmps	1.5	Open-faced 25mm AA filters, Cassettes with 50mm extension cowl	PCM*, NIOSH P&CAM #239
Vinyl Chloride Monomer	Gilian HFS-113UT Pumps	0.05	2CT** in series	NIOSH P&CAM #127 GC***
Respirable Dust	Gilian HFS-113UT Pumps	1.7	Pre-weighed PVC filters on mini-cyclones	NIOSH P&CAM #106
Total Dust	Gilian HFS-113UT Pumps	1.5	Pre-weighed PVC filters	Gravimetric
Tetrahydrofuran, Ethyl Acetate	DuPont P-4000 Sampling Pumps	0.2	CT	NIOSH P&CAM #127 GC
Methyl Ethyl Ketone, Methylene Chloride	Gilian HFS-113UT Pumps	0.05	2CT in series	NIOSH P&CAM #127 GC

Carbon Monoxide	Gilian HFS-113UT Pump	0.0035	Detector Tubes	Direct Reading

* PCM = Phase Contrast Microscopy
** CT = Activated Charcoal Tubes
*** GC = Gas Chromatography

Unless otherwise stated, samples were taken in the workers' breathing zones to obtain samples indicative of actual employees exposure. Pumps were calibrated prior to and after the sampling period.

All analyses were conducted by Environmental Health Laboratory in Macon, GA, which is accredited by the American Industrial Hygiene Association.

Noise

Sound level measurements were taken throughout the plant at the various operations in the hearing zones of the employees. General Radio Sound Level Meter, Type 1933, was used for the survey; this meter was acoustically calibrated with General Radio 1562 Sound Level Calibrator before and after use.

Quest Model M-7B noise dosimeter was used to measure cumulative exposure to noise. The noise dosimeter measures and accumulates noise and produces a continuous reading of the allowable exposure to which the wearer has been subjected. The microphone of the dosimeter was clipped on the employee's shirt collar near the ear, thereby receiving and accumulating approximately the same dosage as the ear.

RESULTS

Asbestos

The results of asbestos sampling are presented in Table I. The concentrations are presented in number of fibers (longer than 5 microns) per cubic centimeter, by job description. Also included are sample time, sample volume, and OSHA standard.

Respirable Total Dust

The results of respirable dust sampling are listed in Table II. The concentrations are presented in milligrams per cubic meter (mg/M^3), by job description and location, along with the applicable OSHA standard.

Vinyl Chloride

The results of vinyl chloride monomer sampling are presented in Table III. The concentrations are presented in parts per million (ppm), by job description and location, along with the applicable OSHA standard.

Organic Solvents

The results of organic solvents air sampling are listed in Table IV. The concentrations are presented in parts per million (ppm), by job description and location, along with applicable OSHA standards.

When two or more hazardous substances are present, their combined effect, rather than that of either individually, should be given primary consideration. The health effects must be considered additive unless there is evidence to the contrary; thus, exposures are added relative to their designated OSHA standards. When adding these exposures, a value "Em" (equivalent exposure for the mixture) is determined by the OSHA formula. Exposure is considered excessive when the value "Em" exceeds unity (1.00).

$$Em = \frac{TWA_1}{PEL_1} + \frac{TWA_2}{PEL_2} + \frac{TWA_3}{PEL_3} \ldots + \frac{TWA_n}{PEL_n}$$

Where: TWA is the Time-Weighted Average concentration of a particular substance and PEL is the corresponding permissible limit for the substance.

Total Dust

The results of total dust sampling are presented in Table V. The concentrations are reported in milligrams per cubic meter (mg/M^3).

Carbon Monoxide

The results of carbon monoxide sampling are presented in Table VI. The concentration is reported in parts per million (ppm).

Noise

The results of noise level measurements and Time-Weighted Average (TWA) exposure are listed in Table VII.

TABLE I

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - ASBESTOS

Job Description (J-M No.)	Employee Name	Date Sampled	Air Conc. (fibers/cc)	Federal Standard (fibers/cc)	TWA (1) (fibers/cc)	Sample Time (min)	Sample Vol. (liters)	Comments
13' Control Op. (D-2WE)	Charles Moore	9/16/86	<0.013	0.2	<0.013	258	387	
13' Utility Op. (D-8WE)	Cecil Bill	9/16/86	0.040	0.2	0.040	338	507	
13' Tender (D-1WE)	Arthur Dawson	9/16/86	0.040	0.2	0.040	351	526	
13' Head Curer (D-3WE)	Ray Terrell	9/16/86	0.085	0.2	0.085	335	502.5	
13' Curer (D-3WE)	Vernon Hall	9/16/86	0.039	0.2	0.039	339	508	
Willow Operator (D-7WE)	Johnny Crain	9/16/86	0.15 0.079	0.2	0.122	202 128	303 192	The TWA exposur[e] level exceeded the OSHA action level of 0.1 fibers/cc.
Steam Tank Op.	Jimmy Lang	9/17/86	0.018	0.2	0.018	303	454.5	

D 002266

TABLE I

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - ASBESTOS

Job Description (J-M No.)	Employee Name	Date Sampled	Air Conc. (fibers/cc)	Federal Standard (fibers/cc)	TWA (1) (fibers/cc)	Sample Time (min)	Sample Vol. (liters)	Comments
Service Man & Salvage Grinder Operator (D-8WE)	Phillip French	9/16/86	<0.011 0.013	0.2	0.012	30 312	45 468	
In-Process & Coupling Testing Area Inspector (D-13S)	Henry Coldiron	9/16/86	<0.012	0.2	<0.012	288	432	
Large Coupling Cut Off Op. (D-15F)	Bobby Brown	9/16/86	<0.048 0.051 0.077	0.2	0.047	72 130 93	108 195 140	
PVC Fitting Assembly Molder (D-11F)	James Blount	9/17/86	<0.0082	0.2	<0.0082	419	628	
Slash Saw & MOA Operator (D-1F & D-6F)	Gary Templeton	9/16/86	0.031 <0.019	0.2	0.015	175 176	262 264	
UPL #2 Op. (D-4F)	Bill Roger	9/16/86	0.045 0.038	0.2	0.042	176 171	264 256	Processing 16" Class 100 pipes

D 002267

TABLE I

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - ASBESTOS

Job Description (J-M No.)	Employee Name	Date Sampled	Air Conc. (fibers/cc)	Federal Standard (fibers/cc)	TWA (1) (fibers/cc)	Sample Time (min)	Sample Vol. (liters)	Comments
UPL #2 Inspector (D-11S)	Darvin Holder	9/17/86	0.15 0.52	0.2	0.33	181 165	272 248	a) The TWA exposure level exceeded OSHA's permissible exposure limit. b) Processing 16" Class 100 pipes.
UPL # 2 Hydrotester	D.F. Dill	9/16/86	0.027 <0.021	0.2	0.014	172 167	258 250	Processing 16" Class 100 pipes
UPL #2 Unit Loader (D-5F)	Raymond Hesse	9/16/86	<0.010	0.2	<0.010	330	495	Processing 16" Class 100 pipes
UCL #1 Op. (D-16F)	Larry Henderson	9/16/86	0.082	0.2	0.082	335	502	Processing 16" Class 100 pipes
UPL #2 Helper	Glen Weger	9/17/86	<0.0089	0.2	<0.0089	385	577.7	Processing 16" Class 100 pipes
Finishing Area Platform Driver & Cleaning of Bag House (D-30F)	Jerry Bruce	9/17/86	0.033 0.063*	0.2	0.052	175 293	262.5 439.5	

D 002268

TABLE I

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - ASBESTOS

Job Description (J-M No.)	Employee Name	Date Sampled	Air Conc. (fibers/cc)	Federal Standard (fibers/cc)	TWA (1) (fibers/cc)	Sample Time (min)	Sample Vol. (liters)	Comments
Sweeper Op. & Salvage Truck Operator (D-6S & D-10S)	Arlis Chambers	9/17/86	<0.010	0.2	<0.010	342	513	
Finishing Area Mechanic (D-26S)	George Kerley	9/17/86	<0.0094*	0.2	<0.0094	365	548	
Finishing Area Electrician (D-15S)	Troy McGehee	9/17/86	<0.011	0.2	<0.011	311	466	
Finishing Area Foreman	Bobby Reynolds	9/17/86	0.015	0.2	0.015	346	519	
Finishing Area Forklift Driver	Jack Hamsard	9/17/86	0.0092	0.2	0.0092	391	586	

* These samples were heavily laden with particulate matter; some fibers could have been obscured during the count; therefore, results may be low.

(1) TWA = The Time-Weighted Average concentration for a normal 8-hour workday. This determination is based on the actual exposure time to the air contaminant.

D 002269

TABLE II

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - RESPIRABLE DUST

Job Description (J-M No.)	Employee Name	Date Sampled	Air Conc. (mg/M^3)	Federal Standard (mg/M^3)	TWA (1) (mg/M^3)	Sample Time (min)	Sample Vol. (liters)	Comments
UPL #1 Operator	Bill Roger	9/16/86	0.11	5	0.113	223	379	"Processing 8" Class 150 pipe
UPL #2 Helper	Glen Weger	9/16/86	0.049	5	0.049	215	365	Processing 16" Class 100 pipe
UPL #2 Inspector	Darvin Holder	9/17/86	0.088	5	0.088	293	498	Processing 16" Class 100 pipe
UPL #2 Hydrotester	D.F. Dill	9/17/86	0.18	5	0.18	171	291	Processing 16" Class 100 pipe
MOA Operator	Gary Templeton	9/17/86	0.056	5	0.056	365	620.5	
13' Head Curer	Ray Terrell	9/16/86	0.058	5	0.058	232	394	
13' Utility Operator	Cecil Bell	9/16/86	0.25	5	0.25	226	384	
Boiler, Ball Mill & Dryer Op. (D-55)	Don Beturnbell	9/17/86	0.28	5	0.28	251	426.7	

D 002270

TABLE II

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - RESPIRABLE DUST

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(1) T.W.A. = The Time-Weighted Average concentration for a normal 12-hour workday. This determination is based on the actual exposure time to the air contaminant.

TABLE III

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - VINYL CHLORIDE

Job Description (J-M No.)	Employee Name	Date Sampled	Air Conc. (ppm)	Federal Standard (ppm) (1)	TWA (2) (ppm)	Sample Time (min)	Sample Vol. (liters)	Comments
Injection Molding Mixer Operator	Glen Reynolds	9/16/86	<0.048	0.7	<0.048	168	8.4	"
Injection Molding #1 & #2 Operator (V-21P)	Ralph Raper	9/16/86	<0.038	0.7	<0.038	207	10.35	
PVC Pipes Mixer Operator (V-1P)	Charles Caldwell	9/17/86	<0.038	0.7	<0.038	207	10.35	
Extruder #5 Operator (V-20P)	James Rhoads	9/16/86	<0.035	0.7	<0.035	230	11.5	
Permalock, Sonoco #3	Raymond Crites	9/17/86	<0.036	0.7	<0.036	223	11.15	

(1) The OSHA 8-hour TWA PEL for vinyl chloride is 1 ppm. The PEL for a 12-hour workday is calculated to be 0.7 ppm (1 ppm x 8/12 = 0.7 ppm).

(2) T.W.A. = The Time-Weighted Average concentration for a normal 8-hour and 12-hour workday. This determination is based on the actual exposure time to the air contaminant.

D 002272

TABLE IV

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING - ORGANIC SOLVENTS

Job Description (J-M No.)	Employee Name	Air Contaminant	Air Conc. (ppm)	Federal Standard (ppm)	TWA (1) (ppm)	Sample Time (min)	Sample Vol. (liters)	Em
PVC Moulding & Assembly Operator	Fred Kerley	Tetrahydro-furan	5.8 3.4	200	4.35	95 145	19 29	0.02
		Ethyl Acetate	<0.55 <0.36	400	<0.36	95 145	19 29	
Extruder #6 & #7 Operator	Roy Shives	Methylene Chloride	<0.90 3.0 3.0	333*	1.7	66 44 45	3.3 2.2 2.3	
		MEK	11 8.4 9.7	133**	9.9	66 44 45	3.3 2.2 2.3	

(1) T.W.A. - The Time-Weighted Average concentration for an 8-hour or 12-hour workday. This determination is based on the actual exposure time to the air contaminant.

* The OSHA PEL for methylene chloride is 500 ppm, 8-hour time-weighted average. The PEL for an average 12-hour workday is calculated to be 333 ppm (500 ppm x 8/12 = 333 ppm).

** The OSHA PEL for MEK is 200 ppm, 8-hour time-weighted average. The PEL for an average 12-hour workday is calculated to be 133 ppm (200 ppm x 8/12 = 133 ppm).

D 002273

TABLE V

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - TOTAL DUST

Job Description (J-M No.)	Employee Name	Date Sampled	Air Conc. (mg/M^3)	Federal Standard (mg/M^3)	TWA (1) (mg/M^3)	Sample Time (min)	Sample Vol. (liters)	Comments
PVC Pipes Mixer Operator	Charles Coldwell	9/16/86	1.6	15	1.6	248	372	
Injection Molding Mixer Op.	Glen Reynolds	9/17/86	1.6	15	1.6	200	300	

(1) T.W.A. = The Time-Weighted Average concentration for an 8-hour or 12-hour workday. This determination is based on the actual exposure time to the air contaminant.

D 002274

TABLE VI

Account: J-M Manufacturing
Location: Denison, TX

AIR SAMPLING DATA - CARBON MONOXIDE

Job Description (J-M No.)	Employee Name	Date Sampled	Air Conc. (ppm)	Federal Standard (ppm)	TWA (1) (ppm)	Sample Time (min)	Sample Vol. (liters)	Comments
Fork Lift Driver Finishing Area	Jack Hamsard	9/17/86	<10	50	<10	295	103	

(1) T.W.A. = The Time-Weighted Average concentration for an 8-hour or 12-hour workday. This determination is based on the actual exposure time to the air contaminant.

TABLE VII

Account: J-M Manufacturing
Location: Denison, TX

Date: 9/16 & 17/86

RESULTS OF NOISE MEASUREMENTS

Job Description	Employee Name	SLM dBA(1)	Dosimeter Test Time (2)	Dosimeter Reading (3)	Full Shift Dose	Equivalent TWA dBA
TRANSITE DIVISION						
Willow Operator (N-7WE)	Johnny Crain	82-84	316 min.	36.22%	82.53%	86
13' Utility Operator	Cecil Bell	-	338 min.	70.13%	149.39%	90
13' Control Op. (N-4WE)	Charles Moore	86-91	308 min.	69.39%	162.21%	91
13' Tender	Arthur Dawson	-	305 min.	59.18%	139.70%	89
13' Curer	Vernon Hall	84-90	338 min.	71.90%	153.16%	90
Serviceman & Salvage Grinder Operator (N-8WE)	Phillip French	-	350 min.	53.35%	109.75%	88
UPL #2 Unit Loader	Raymond Hesse	89-94	225 min.	50.90%	162.88%	91
UPL #2 Inspector	Darvin Holder	90-98	239 min.	87.73%	264.29%	94

D 002276

TABLE VII

Account: J-M Manufacturing
Location: Denison, TX

Date: 9/16 & 17/86

RESULTS OF NOISE MEASUREMENTS

Job Description	Employee Name	SLM dBA(1)	Dosimeter Test Time (2)	Dosimeter Reading (3)	Full Shift Dose	Equivalent TWA dBA
UPL #2 Operator (N-4F)	Bill Roger	90-107	226 min.	118.90%	378.80%	97
Slash Saw & MOA Operator (N-6F)	Gary Templeton	88-95 MOA Machine 100-104 Slash Saw	231 min.	65.42%	203.91%	92
PVC Moulding & Assembly Worker (N-17F)	Fred Kerley	82-96	189 min.	42.92%	109.00%	91
In Process & Coupling Testing Area Inspector	Henry Coldiron	83-92	277 min.	31.55%	82.01%	86
PVC Moulding & Assembly - Saw Operator	Jack Bartley	95-105 Cutting 83-87 Background	372 min.	161.01%	207.75%	95
Large Coupling Cut Off Operator (N-13F)	Bobby Brown	90-94 Cutting 86-89 Background	245 min.	55.70%	163.69%	91

D 002277

TABLE VII

Account: J-M Manufacturing
Location: Denison, TX

Date: 9/16 & 17/86

RESULTS OF NOISE MEASUREMENTS

Job Description	Employee Name	SLM dBA(1)	Dosimeter Test Time (2)	Dosimeter Reading (3)	Full Shift Dose	Equivalent TWA dBA
Extruder #3 (N-3P)		88-90				
Extruder #5	James Rhoads	88-90	194 min.	42.30%	156.99%	90
Extruder #6 Operator		87-89				
PVC Powder Hopper		92-94				
Grinder Operator	David Houston	-	364 min.	106.51%	210.68%	93
Mixer Operator (N-1IM)	Charles Coldwell	88-96	209 min.	70.95%	244.42%	94
Truck Driver	Sylvester Shives	-	125 min.	89.83%	517.42%	99
MAINTENANCE DEPT.						
Carpenter	Tommy Clipper	80-83	159 min.	13.10%	39.55%	83
SHIPPING DEPT.						
Load Driver	Marc Ayres	-	124 min.	20.30%	78.58%	88

D 002278

TABLE VII

Account: J-M Manufacturing
Location: Denison, TX

Date: 9/16 & 17/86

RESULTS OF NOISE MEASUREMENTS

Job Description	Employee Name	SLM dBA(1)	Dosimeter Test Time (2)	Dosimeter Reading (3)	Full Shift Dose	Equivalent TWA dBA
Finishing Area Forklift Driver	Jack Hamsard	-	81 min.	19.76%	175.64%	91
Finishing Area Platform Driver (N-20F)	Jerry Bruce	-	172 min.	35.86%	150.11%	90
Finishing Area Mechanic	George Kerley	-	274 min.	39.01%	68.34%	87
Finishing Area Electrician	Troy McGehee	-	228 min.	24.15%	50.84%	85
UCL #1 Operator (N-15F)	Larry Henderson	92-98 UCL#1 in operation 86-90 background	241 min.	76.25%	227.80%	93
PVC DIVISION						
Extruder #1 Operator		86-90				
PVC Powder Hopper		90-92				

D 002279

TABLE VII

Account: J-M Manufacturing
Location: Denison, TX

Date: 9/16 & 17/86

RESULTS OF NOISE MEASUREMENTS

Job Description	Employee Name	SLM dBA(1)	Dosimeter Test Time (2)	Dosimeter Reading (3)	Full Shift Dose	Equivalent TWA dBA
INJECTION MOLDING DEPT.						
Injection Molding #1 & #2 Op.	Ralph Raper	85-89	212 min.	34.37%	116.73%	88
Injection Molding Mixer Op.	Glen Reynolds	84-95	178 min.	39.92%	107.65%	91
PERMALOCK						
Permalock #3 Sonoco Operator	Raymond Crites	83-88	223 min.	21.59%	69.71%	87

(1) SLM dBA : General Radio Sound Level Meter reading in dBA (using the "A" weighted scale, slow response).
(2) Test Time: Duration of dosimetry test in minutes.
(3) Dosimeter Reading: Noise dose as the percentage of the daily allowable dose.

DISCUSSION

The J-M Manufacturing Company, Denison plant, manufactures three different types of pipes: transite; PVC; and permatran. The permatran plant was not in operation during the days of the survey. The transite plant is operated by one 3-day, 12-hour shift. The PVC plant operates around the clock.

Asbestos

OSHA has promulgated a new asbestos standard (1910.1001) on June 20, 1986 to lower the permissible exposure limit to 0.2 fibers/cc as an 8-hour time-weighted average. An action level, which will trigger requirements for periodic monitoring, medical surveillance, and employee training, is set at 0.1 fibers/cc.

As can be seen from the sample results presented in Table I, The UPL #2 inspector was exposed to an asbestos level in excess of the OSHA permissible exposure limit. The willow operator's exposure level exceeded the OSHA action level.

Routine monitoring of asbestos exposure levels and a medical surveillance program have already been implemented per the requirements of the 1972 asbestos standard. Several revisions were incorporated into the 1986 asbestos standards. It is recommended that the additional provisions for notification of monitoring and medical examination results, work practices, preventive clothing, hygiene facilities, warning signs, compliance program, respiratory protection, medical surveillance, record keeping, and employee training in the 1986 standard be adhered to. A comparison of the two standards is presented in Appendix II for your reference.

Vinyl Chloride, Respirable Dust, Total Dust, Organic Solvents, and Carbon Monoxide

As can be seen from the sample results presented in Tables II, III, IV, V, and VI, the exposure levels to vinyl chloride, respirable dust, total dust, organic solvents, and carbon monoxide were all within OSHA permissible exposure limits. OSHA permissible exposure limits are levels to which nearly all workers may be repeatedly exposed without adverse effects.

All the respirable dust samples listed on Table II had an insufficient dust deposit for a free silica analysis. Therefore, the OSHA silica permissible exposure limit is not applicable in this case. The exposure limit for respirable total dust is used to evaluate the exposure levels.

Though the exposure level to methylene chloride is well within the recommended exposure limit, the management at the Denison plant has expressed interest in the health effects of methylene chloride. The toxicological data on methylene chloride can be found in the Appendix III.

Noise

The results of noise measurements (Table VII) indicate that noise levels exceeded the OSHA permissible exposure limit in many areas. A comprehensive hearing conservation program has been implemented by the management. To assure the protection for the worker's hearing, the hearing conservation program should be continued.

CONCLUSION

Implementation of the above mentioned recommendations should assist you in providing a more healthful working environment and reduce the potential for occupational disease.

APPENDIX I

STANDARDS AND GUIDELINES

A complete listing of the appropriate health standards can be found in the following Appendix. Included in this table are the following:

1. Occupational Safety and Health Standards, Subpart Z, CFR Title 29, Section 1910.1000. These standards represent the legal exposure limits as set by the Department of Labor.

2. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's) refer to exposure limits as set by this organization. These limits, many of which were adopted by the Department of Labor, are the work of professional personnel in governmental agencies and educational institutions engaged in occupational safety and health programs. These TLV's should be used as guides in the control of health hazards and should not be used as fine lines between safe and dangerous concentrations.

3. The National Institute of Occupational Safety and Health (NIOSH) has proposed changes in certain standards based on new evidence in regard to human health. These proposed limits are awaiting review, but should be kept in mind as applicable standards for the near future.

APPENDIX I

STANDARDS AND GUIDELINES FOR AIR CONTAMINANTS

SUBSTANCE	UNITS	Occupational Safety and Health Administration 29 CFR 1910.			American Conference of Governmental Industrial Hygienists (ACGIH)			National Institute for Occupational Safety and Health (NIOSH) Proposed	
		8-hr[1]	Ceiling[3]	Peak[4]	8-hr[1]	Stel[2]	Ceiling[3]	10-hr[1]	Ceiling[3]
Asbestos	fibers/cc	0.2	-	-	2	-	-	0.1	0.5
Tetrahydro-furan	ppm	200	-	-	200	250	-	-	-
Ethyl Acetate	ppm	400	-	-	400	-	-	-	-
Methyl Ethyl Ketone	ppm	200	-	-	200	300	-	200	-
Methylene Chloride	ppm	500	1000	2000	100	-	-	75	500
Vinyl Chloride	ppm	1	5	-	5	-	-	Minimum detectable level	1
Carbon Monoxide	ppm	50	-	-	50	400	-	35	200
Respirable Total Dust	mg/M^3	5	-	-	5	-	-	-	-
Total Dust	mg/M^3	15	-	-	10	-	-	-	-

1 8-hr or 10-hr - The time weighted average for an 8- or 10-hour work shift in a 40-hour workweek.
2 STEL - ACGIH's standard maximum concentration to which workers can be exposed for a period up to 15 minutes. (Short Term Exposure Limit)
3 Ceiling (OSHA) - The concentration that should not be exceeded even instantaneously, except when the standard has a peak value (4).
4 Peak - Acceptable instantaneous peak exposure above ceiling concentration (4).

APPENDIX I

1910.95 Occupational Noise Exposure

a) Protection against the effect of noise exposure shall be provided when sound levels exceed those shown in Table G-16 when measured on the A scale of a standard sound level meter at slow response.

TABLE G-1

Permissible Noise Exposures

Sound Level (dBA)	Duration Hours/Day
90	8
92	6
95	4
97	3
100	2
102	1.5
105	1.0
110	0.5
115	0.25 or less

b) When workers are being exposed to excessive noise levels based on Table I, feasible administrative and/or engineering controls shall be utilized. If such controls fail to reduce noise exposure to within these limits, personal protective equipment shall be provided and its use strictly enforced.

c) When noise exposures exceed the action level (85 dBA equivalent) the employer shall administer a continuing effective hearing conservation program. This program should be made available to employees whose eight hour time weighted average (TWA) exposure equals or exceeds 85 (dBA) and such a program should consist of the following:

1. Perform noise monitoring to determine which employees may be exposed to noise equaling or exceeding 85 dBA eight hour TWA.

2. Provide baseline and annual audiometric testing of all exposed employees. Baseline test must be completed by March 1, 1984.

3. Make hearing protection available to employees whose noise exposures equal or exceed 85 dBA eight hour TWA.

4. Make hearing protection mandatory for:

   a) Employees whose 8 hour TWA exposure exceeds 90 dBA.

   b) Employees whose 8 hour TWA exposure equals or exceeds 85 dBA and who show a "significant threshold shift" or deteriorating hearing acuity, on their lastest audiogram.

5. Provide initial and annual training of exposed employees including the use and proper fitting of hearing protection.

APPENDIX II

Comparison of 1972 and 1986 OSHA Asbestos Standards

The following points are highlights of the differences between the old (1972) and new (1986) OSHA Asbestos Standards:

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD.
Effective Dates -	July 21, 1986	July 21, 1986 (All sections must be complied with 1/21/87)	July 7, 1972
PEL -			
8-hr. TWA	- 0.2 fiber/cc. Fibers are defined as longer than 5 microns with a length to width ratio of >3:1. Applies to chrysotile, amosite, crocidolite, tremolite, anthophyllite, actinolite and altered or chemically treated forms of the above. Requirements pertaining to non-fibrous forms have been stayed until 4/87.	- Same	2 fiber/cc. Fibers are defined as longer than 5 microns (no other dimensions are specified). (PEL lowered from 5 fibers/cc to 2 fibers/cc effective 7/1/76.)
Ceiling	- None. With the low TWA, the ceiling is effectively 6.4 fibers/cc.	- Same	10 fibers/cc
Action Level	- 0.1 fiber/cc - triggers monitoring, medical, and employee information and training requirements	- Same	None. Exposure to asbestos at any level triggers medical monitoring. 0.1 fiber/cc was used as the enforcement level.
Occupations	- Separate standards for Construction and General Industry. Occupational exposures are interpreted to include office workers and workers in the vicinity of abatement situations.	- See ATTACHMENT II for list of occupations.	Applies to all asbestos-related occupations. Does not specifically mention office workers

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD
Monitoring - Frequency	- *Initial monitoring for employees at or above the action level required by 10/20/86. - Repeat monitoring frequently enough to "reasonably" represent exposure, at least once every 6 months, unless documentation shows levels consistently below action level. - Whenever there is a change in work circumstances.	- Initial monitoring at the initiation of each job. - Daily monitoring representative of each employee in the regulated area. (Except where employees are wearing supplied air respirators - positive pressure mode) - Monitoring may be discontinued if data shows statistically validated levels below the action level.	- Effectively similar to new standard; however, no requirements for sampling after work changes are stipulated.
Type	- Personnel only, in breathing zone, full shift.	- Same	- Personnel and area samples required in breathing zone - full shift not specified; however, interpretation most often required full shift.
Media	- 25mm mixed cellulose ester (MCE) filter cassettes with 50mm extension cowl, open-faced.	- Same	37mm, 0.8 micron pore size MCE filter cassettes, open-faced.
Flow rate	- 0.5 to 2.5 liters per minute	- Same	None specified, usually interpreted as 2.0 liters per min.
Air Volume	- A sufficient air volume to yield between 100 and 1300 fibers/mm^2 on the filter.	- Same	None specified.

*Requirements for monitoring are detailed in the OSHA Standard Mandatory Appendix A.

Monitoring - (continued)

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD.
Shipping	- Use packing material with low electrostatic charge, e.g. no polystyrene.	- Same	- None specified.
Calibration	- Before and after sampling.	- Same	- Not specified.
Blanks	- 10% blanks, at least 2 (reject blank if >7 fibers/100 fields).	- Same	- Not specified.
Analysis	- Phase Contrast Microscopy (PCM), approximately 400 x, Walton-Beckett graticule, Phase Shift test slide, acetone/triacetin mounting procedure, 10% duplicate counts. Count using rules sililar to NIOSH 7400 A rules, effective QA program including round robins and microscopist training.	- Same	- 400 - 450 x Phase Contrast Microscopy
Employee Notification	- Written notification of monitoring results required within 15 days after receipt of monitoring results. - Written notification of medical exam results within 30 days after receipt.	- Notification required - no time limit specified for monitoring results. - Notification of asbestos related activities to other employers in the facility.	- Notification required within 5 days if employee exposure is higher than the PEL. Employees must have access to monitoring records.

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD
Engineering Controls	- Engineering Control Specifications required by July 20, 1988. - Local exhaust ventilation with HEPA-filtered exhaust systems (and other controls) designed and maintained to lower fiber levels to below 0.2 fibers/cc* - All hand operated power tools which would release asbestos fibers provided with local exhaust ventilation. - No usage of compressed air (except in conjunction with appropriate ventilation system). - HEPA-filtered vacuuming - Wet removal of asbestos materials - No spraying of asbestos materials - Waste shall be sealed in impermeable bags and disposed of.	- ADD: Negative pressure enclosures to be established where feasible. - "Competent person" to supervise setup, entry, exit, enclosure integrity, use of protective gear, monitoring, training, work practices, hygiene, decontamination, proper functioning of engineering controls. - Use of wetting agents or encapsulants during handling, mixing, removal, cutting, application, and cleanup. - Prompt disposal of waste. - Use of high-speed abrasive disk saws prohibited.	- Local exhaust ventilation systems designed and maintained to lower fiber levels as much as practical - All hand operated power tools which would release asbestos fibers provided with local exhaust ventilation - Wet removal of asbestos materials

*Exception - For the following operations, engineering controls to 0.5 fiber/cc are allowed if 0.2 is not feasible: coupling cutoff in primary asbestos cement pipe manufacturing, sanding in primary and secondary asbestos cement sheet manufacturing, grinding primary and secondary friction product manufacturing, carding and spinning in dry textile processes, and grinding and sanding in primary plastics manufacturing. Respiratory protection must be used to supplement other controls.

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD
Work Practices	- Requirements (effective 7/20/88) include no eating or drinking in area, adequate housekeeping to prevent accumulations of asbestos dust, cleanup of spills, washing prior to eating or smoking, showering after work, cleaning of clothing and equipment before entering clean areas.	- ADD: Decontamination area entry and exit procedures specified - Enter: through clean room, remove street clothes and don protective gear, pass through equipment room. Exit: remove gross contamination in work area, remove protective clothing in equipment room and place in bags - do not remove respirators in equipment room - shower, change into street clothes in clean room.	- Adequate housekeeping prevent accumulations of asbestos dust required.
Protective Clothing	- Full-body coveralls, gloves, head coverings, foot covering required for all employees exposed to levels above the PEL. Face shields and vented goggles required where appropriate. - Contaminated clothing must not be taken out of work area except for cleaning; must be stored in labeled, closed containers; clean clothing and equipment must be provided at least weekly; laundering must be done so as not to release fibers, cleaners must be informed of appropriate cleaning methods for asbestos - no blowing or shaking of clothing.	- Same except instead of requirement for weekly provision of clean clothing, standard specifies that the "competent person" will inspect clothing periodically for leaks and tears and immediately repair or replace clothing when damaged.	- Similar to NEW. No requirements for clothing replacement, prevention of shaking, or removal from work area.

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD
Facilities	- Limited access, demarcated, regulated areas; showers, change rooms, separate lockers for street and work clothes, and positive pressure lunchroom are required if exposure is above PEL. (Regulated areas are to be established by 11/17/86; showers and lunchrooms by 1/16/87.)	- Limited access, demarcated, regulated areas. - Clean change rooms (except for small, short duration jobs where HEPA vacuuming of clothing is allowed), separate storage facilities for street and work clothes, lunch area <action level, decontamination area adjacent and connected to regulated area, decontamination area to consist of equipment room, shower, and clean room in series.	- Change rooms and separate lockers are required if exposure is above PEL.
Warnings	- Warning signs of specific wording are required at all regulated areas and approaches; labels are required on all waste materials, MSDSs required of manufacturers and importers if asbestos >0.1% and not coated.	- Same	- Warning signs of specific size and wording required at all approaches if levels > PEL. Specific labels are required on all waste materials.
Compliance Program	- A written program to reduce employee exposure by means of engineering and work practice controls is required if levels exceed the PEL. - Program must be written by 7/20/87 and updated regularly. - Employee rotation shall not be used as a means of compliance with the PEL.	- Compliance program not specified.	- Written program not required. - Employee rotation prohibited.

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD
Respiratory Protection	- (Effective by 11/17/86 depending on employee exposure) Respirators shall not be used to comply with PEL. They are required while engineering controls are being implemented and can be used during maintenance activities, and in emergencies. Appropriate respirators are listed in ATTACHMENT I. - The employer will provide respirators at no cost to the employee. - *Respirators must be properly fit tested using specified quantitative or qualitative face fit tests at the time of initial fitting and at least every six months thereafter. - Employees using filter respirators must be allowed to change filter elements whenever an increase in breathing resistance is detected. - Employees wearing respirators must be allowed to wash their faces whenever necessary to prevent skin irritation. - If a physician determines that an employee cannot function normally while wearing a respirator, then that employee shall not be assigned to a task requiring respirators.	- Same	- Similar to NEW except for the following: - Specific face fit tests are not required - Maintenance activities are not included as allowable respirator usages.

*Fit testing requirements are detailed in OSHA Standard Mandatory Appendix C.

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD
Medical Surveillance	- For employees exposed to levels at or above the action level, medical monitoring must be instituted by 11/17/86 - *The program must include preplacement exams; termination of employment exam within 30 days of termination; annual exams; provision of standard, description of employees' duties and exposure details to physicians; a written opinion from the physician. - A standardized questionnaire must be used for documenting the medical program.	- Required if employees exposed to action level for 30 or more days per year. Exam must be provided within 10 working days following 30th day of exposure. Not required if exam provided previously within 1 year before assignment. Termination exams not specified.	- Similar to the new standard except that a standardized questionnaire is not required.
Recordkeeping	- The employer will maintain accurate records of all exposure measurements and applicable details (for 30 years), data for exempted operations, medical monitoring data (for 30 years), training records (for 1 year after termination of employment) - Records will be available for examination by affected employees or designated OSHA representatives	- Same	- Exposure measurements and applicable details must be maintained for 3 years, medical records for 20 years - Records will be available for examination by affected employees, their physicians, and OSHA representatives.

*Detailed exam requirements are included in the OSHA Standard. Mandatory Appendix E outlines interpretations of Chest Roentgenograms. The Medical Questionnaire is contained in OSHA Standard Mandatory Appendix D.

	NEW - GENERAL INDUSTRY	NEW - CONSTRUCTION	OLD
Training	- The employer must institute a training program for all employees who are exposed to levels at or exceeding the action level. Training must be prior to work assignment, and at least annually thereafter. Training must be provided by 10/20/86 and should include health effects, relationship between smoking and asbestos engineering controls and work practices, respirators, medical monitoring program, and a review of standard.	- Same except training not necessary if provided previously within 1 year before work assignment.	- Training not required.

Comparison of 1972 and 1986 OSHA Asbestos Standards

Respiratory Protection

New Standard:

<10 x PEL (<2 fibers/cc)	Half mask air-purifying respirator with high efficiency filters
<50 x PEL (<10 fibers/cc	Full face piece air-purifying respirator with high efficiency filters
<100 x PEL (<20 fibers/cc)	Any powered air-purifying respirator with high efficiency filters or any supplied-air respirator operated in continuous flow mode.
<1000 x PEL (<200 fibers/cc)	Full facepiece supplied-air respirator operated in pressure demand mode.
>1000 x PEL (>200 fibers/cc) or unknown	Full facepiece supplied air respirator operated in pressure demand mode equipped with an auxiliary positive pressure self-contained breathing apparatus.

Old Standard:

<10 x PEL (<20 fibers/cc)	Reusable or single use air purifying respirator.
<100 x PEL (<200 fibers/cc)	Full facepiece powered air purifying respirator or powered air purifying respirator.
>100 x PEL (>200 fibers/cc)	Type C continuous flow or pressure demand supplied-air respirator.

Comparison of 1972 and 1986 OSHA Asbestos Standards

Occupations/Processes Covered by Construction Standard

1. Demolition or salvage of structures where asbestos, tremolite, anthophyllite, or actinolite is present.
2. Removal or encapsulation of materials containing asbestos, tremolite, anthophyllite, or actinolite.
3. Construction, alteration, repair, maintenance, or renovation of structures, substrates, or portions thereof, that contain asbestos, tremolite, anthophyllite, or actinolite.
4. Installation of products containing asbestos, tremolite, anthophyllite, or actinolite.
5. Asbestos, tremolite, anthophyllite, and actinolite spill/emergency cleanup; and
6. Transportation, disposal, storage, or containment of asbestos, tremolite, anthophyllite, or actinolite or products containing asbestos, tremolite, anthophyllite, or actinolite on the site or location at which construction activities are performed.

NOTE: Exceptions for small-scale, short duration operations include pipe repair, valve replacement, installing electrical conduits, installing or removing drywall, roofing, and other general building maintenance or renovation.

APPENDIX III

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— an open transfer of the liquid;
— leakage from process equipment;
— maintenance or repair work done on process equipment or transfer systems containing methylene chloride;
— a failure of temperature controls and/or of exhaust ventilation systems or when these controls are inadequate, ineffective or improperly applied.

IV. Health Effects.

A. Routes of Exposure.

Methylene chloride can affect the body if it is inhaled or if it comes in contact with the eyes or skin. It can also affect the body if it is swallowed (45).

B. Metabolic Pathways/Pharmacokinetics.

Analysis of the capability of various tissues to metabolize methylene chloride indicates the liver as the primary site, with some metabolic action in the lung and kidney. Data from both in vitro and in vivo studies indicate that methylene chloride is metabolized via two pathways. The P-450 mixed function oxidase pathway is located in the microsomal fraction of the cell and yields carbon monoxide as an end product. The glutathione-dependent enzyme pathway found in the cytosolic fraction of the cell yields carbon dioxide as an end product with formaldehyde and formic acid as metabolic intermediates. Both pathways generate metabolically active intermediates; formyl chloride, formaldehyde or S-chloromethyl glutathione, which are theoretically capable of irreversibly binding to cellular macromolecules such as DNA (11).

In vivo data suggest that during exposure to low concentrations of methylene chloride the two pathways appear to be utilized equally. At high concentrations experimental animals exhale more carbon dioxide than carbon monoxide. This suggests the cytosolic pathway producing carbon dioxide may metabolize significantly more methylene chloride than the microsomal pathway yielding carbon monoxide (9).

At present there are no data to prove that humans utilize the cytosolic pathway. Some investigators have speculated that this pathway is functional in humans based on uptake data (9). Human utilization of the microsomal pathway has been confirmed by monitoring the carboxyhemoglobin (carbon monoxide attached to the usual oxygen site on the hemoglobin molecule) level following exposure (54).

The carbon monoxide generated as an end product of methylene chloride metabolism impairs the ability of the blood to transport oxygen to the tissues. Hemoglobin has a strong affinity for carbon monoxide, approximately 210 times greater than for oxygen. This results in carbon monoxide being readily attached to hemoglobin and slowly dissociated. Once the carboxyhemoglobin is formed the hemoglobin is unavailable to transport oxygen and the release of oxygen from oxygenated hemoglobin is affected.

C. Toxicology Data.

1. Animal Studies:

Experiments have been conducted to determine the carcinogenicity of methylene chloride. Some of these studies and the investigator's conclusions are summarized below.

The 1984 publication by Burek, et al. (3) reports the findings of a Dow Chemical Company 1980 study of chronic inhalation in rats and hamsters. Inhalation exposures of 0, 500, 1500, or 3500 parts of methylene chloride per million parts of air (ppm) for 6 hours per day, 5 days a week for 2 years were used. Burek's results showed an increase in benign tumors in female rats at all doses and in male rats at the highest doses. Burek also reported a significant increase in salivary gland sarcomas at the high dose only in rats. Hamsters showed no tumors, even at the highest dose levels.

In 1982 Dow Chemical Company performed a second inhalation study to explore the toxicity of methylene chloride at concentrations below those that cause saturation of the metabolic processes (0, 50, 200, and 500 ppm). No compound-related increased incidence of any other tumor type was observed by Dow researchers.

The NTP (19) inhalation bioassay of methylene chloride was conducted on F344/N rats and B6C3F1 mice. Both sexes were exposed at concentrations of 0, 1000, 2000 and 4000 ppm for rats and 0, 2000, and 4000 ppm for mice, 6 hours/day, 5 days/week, for 102 weeks. In both male and female rats there was an increased incidence of benign mammary gland neoplasms, primarily fibroadenomas. According to the NTP study there was a significant increase in hepatocellular neoplastic nodules and hepatocellular carcinomas (combined) by the trend test only in the female rats. NTP also noted a significant increase in mesotheliomas in male rats. In addition there was a statistically significant increase of mononuclear cell leukemias in female rats by age adjustment. A marginally significant increase was noted in adrenal pheochromocytomas and interstitial cell tumors in male rats and pituitary gland adenomas and carcinomas combined in male and female rats by the trend test only.

In the NTP mouse study, there was a highly significant increase in alveolar/bronchiolar adenoma and/or carcinoma in both sexes. The incidence of hepatocellular adenoma and hepatocellular carcinoma combined was increased in the high-dose groups for both sexes and in the lower dose female group. NTP reported a dose-related increase in the number of mice bearing multiple lung and liver tumors. While the control mice had no more than one lung tumor per mouse, 40 percent of all dose animals had multiple lung tumors. Likewise, 2 percent of the controls were found to have multiple hepatocellular tumors and 30 percent of the exposed animals exhibited multiple liver tumors.

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The NTP concluded that "there was some evidence of carcinogenicity of methylene chloride for male F344/N rats as shown by increased incidence of benign neoplasms of the mammary gland. There was clear evidence of carcinogenicity of dichloromethane for female F344/N rats as shown by increased incidence of benign neoplasms of the mammary gland. There was clear evidence of carcinogenicity of methylene chloride for male and female B6C3F1 mice, as shown by increased incidences of alveolar/bronchiolar neoplasms and of hepatocellular neoplasms."

2. Epidemiological Studies:

Friedlander, et al. (13) and the follow-up study by Hearne and Friedlander (17) performed mortality analyses of male Eastman-Kodak employees exposed to low levels of methylene chloride for up to 30 years. Proportionate and cohort mortality studies were used to assess whether adverse health effects could be shown to occur as a result of exposure to methylene chloride.

The proportionate mortality study was used to examine 334 deaths of methylene chloride exposed workers during 1956 to 1976. The control group consisted of Eastman Kodak workers who had not been exposed to methylene chloride. Eastman Kodak reported 71 neoplasms found while 73 were expected based on other Eastman Kodak employee mortality ratios. No single neoplasm site was over-represented.

In the Hearne cohort mortality study (17), 751 methylene chloride exposed workers were compared to two control groups: Eastman Kodak employees not exposed to methylene chloride and New York State males. The exposed group had a slightly elevated but not statistically significant rate of death from circulatory and respiratory diseases, a slightly higher but not statistically significant incidence of brain or nervous tissue cancers, and a significant excess of hypertensive heart disease compared to other Eastman Kodak employees.

Another facet of the cohort mortality study centered on 252 males with 20 year or more of exposure. Friedlander reported that this group did not demonstrate a statistically significant increase in neoplasms or in circulatory diseases when compared to the control groups.

The study by Ott, et al. (47) reported the results of a health evaluation of employees of a fiber production plant where a solvent mixture of methylene chloride, acetone and methanol was used. The control population was chosen from a plant where only acetone was used. The investigation focused primarily on health effects occurring to the cardiovascular system associated with the increased carboxyhemoglobin levels resulting from metabolized methylene chloride. The Ott, et al. study reported no statistically significant differences between observed and expected deaths.

EPA has criticized both of these studies stating that although neither showed excessive risk, both showed sufficient deficiencies to prevent them from being judged negative studies. EPA noted that the Friedlander, et al. study (13) lacked the statistical power to enable it to detect a potential carcinogenic effect and the Ott, et al. (47) study, among other deficiencies, lacked a sufficient latency period for site-specific cancer.

D. Adverse Human Health Effects.

Methylene chloride has a narcotic action and acts as a central nervous system depressant. The symptoms of exposure may be dizziness, nausea, tingling, numbness of the extremities, sense of fullness in the head, sense of heat, stupor, dullness, lethargy, and headache. Inhaling methylene chloride may cause a sensation of drunkenness with mental confusion and light-headedness. Exposure to very high concentrations may lead to staggering, rapid unconsciousness and death.

Skin contact with methylene chloride may cause irritation, dryness of the skin or dermatitis. The problem may be accentuated if the chemical is confined to the skin by contaminated gloves, shoes or tight fitting clothing.

Vapor concentrations of methylene chloride above 2,000 ppm may cause irritation of the eye and respiratory tract (4).

Since exposure to methylene chloride increases the carboxyhemoglobin level in the blood, ambient carbon monoxide levels would have an additive effect on that carboxyhemoglobin level. Under normal conditions blood contains about 0.5 percent carboxyhemoglobin while a one-pack-a-day smoker will have a carboxyhemoglobin level of approximately 5.9 percent (14). At high exposure levels (500 PPM and above), the carboxyhemoglobin level would be expected to reach a maximum between 12 and 15 percent. This level is below that considered hazardous for any normally healthy individuals but could place additional stress on compromised individuals, e.g. persons with cardiovascular diseases (11).

OSHA has initiated a program to evaluate all of the existing research in order to decide the validity of each. At the conclusion of this thorough investigation a more meaningful extrapolation of the data from experimental animal studies to human occupational exposure will be performed.

E. Classification.

EPA classified methylene chloride as a Probable Human Carcinogen (Group B2). The EPA Probable Human Carcinogen classification (Group B) is used when there is sufficient evidence of carcinogenicity in animals and evidence of carcinogenicity from epidemiological studies that ranges from "almost sufficient to inad-

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equate." To reflect this range, the category is divided into higher (Group B1) and lower (Group B2) degrees of evidence. The B1 category is reserved for those agents for which there is at least limited evidence carcinogenicity to humans from epidemiological studies. In the absence of adequate data in humans, it is reasonable to regard agents for which there is sufficient evidence of carcinogenicity in animals as probable carcinogens in humans. Agents for which there is sufficient evidence from animal studies but insufficient evidence from human studies are classified as B2 (12).

V. Permissible Exposure Limit (PEL).

The current OSHA standard for methylene chloride is 500 parts of methylene chloride per million parts of air (ppm) averaged over an eight-hour work shift, with an acceptable ceiling level of 1000 ppm and a maximum peak concentration of 2000 ppm for five minutes in any two-hour period. The National Institute for Occupational Safety and Health (NIOSH) has recommended that the permissible exposure limit be reduced to 75 ppm averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 500 ppm averaged over a 15-minute period (21). NIOSH further recommends that permissible levels of methylene chloride be reduced where carbon monoxide is present. The NIOSH Criteria Document for Methylene Chloride should be consulted for more detailed information (21). In 1986, the American Conference of Governmental Industrial Hygienists (ACGIH) published a Notice of Intended Changes for 1986-87 to lower the Threshold Limit Value-Time Weighted Average (TLV-TWA) for an 8-hour workday from 100 ppm to 50 ppm and deleted the Short Term Exposure Limit (STEL) of 500 ppm. ACGIH further classified methylene chloride in this notice as A2 (Industrial substance suspect of carcinogenic potential for man. Chemical substances or substances associated with industrial processes, which are suspect of inducing cancer, based on either (1) limited epidemiologic evidence, exclusive of clinical reports of single cases, or (2) demonstration of carcinogenesis in one or more animal species by appropriate methods) (2).

VI. Monitoring.

Personal and area monitoring should be conducted periodically to determine the levels of employee exposure. Personal samples measured over an entire workshift should be collected at the workers' breathing zones to determine their time-weighted average (TWA) exposures. Air samples of methylene chloride can be collected by charcoal tubes, the analyte desorbed with carbon disulfide and analyzed by gas chromatograph equipped with a flame ionization detector (22,23).

Because methylene chloride is a solvent with a high vapor pressure, there is a high probability of its migration once adsorbed on charcoal. For this reason, and since the amount of sample which can be collected is limited by the quantity each tube will hold before overloading, OSHA recommends that sampling be done with two charcoal tubes in series, each containing 100 mg front and 50 mg backup sections of charcoal at a maximum flow rate of 50 ml/min and not to exceed a sample volume of two liters of air (46).

VII. General Methods of Control.

Commonly used methods for controlling occupational exposure to methylene chloride include product substitution, engineering controls, work practice controls, and the use of personal protective clothing and equipment. Appropriate worker education and training programs are also major factors in the control of exposures to methylene chloride.

A. Substitution.

The best method for controlling exposure to any extremely toxic material is to use a less toxic material wherever possible. Methylene chloride has been described by industry as a very strong and effective solvent for a variety of industrial compounds, combining several important technical qualities in one solvent (e.g., it is a flammability suppressant, a vapor pressure depressant, a viscosity thinner, can be readily atomized, has a high evaporation rate and readily dissolves a wide variety of substances) (10, 15).

Industry has suggested the use of ethyl alcohol as a substitute solvent for use in hair sprays, room fresheners, degreasers and other household aerosol formulations. Possible alternative solvents for household aerosol spray paint formulations are acetone, methyl ethyl ketone or toluene. Care must be exercised in selection of these substitute solvents since they are highly flammable. For cold cleaning or vapor degreasing, 1,1,2-trichloro-1,2,2,-trifluoroethane (Fluorocarbon 113) or other less toxic halogenated hydrocarbons may be used (10,15).

Trichlorofluoromethane (Fluorocarbon 11) has been used as an alternative solvent to methylene chloride for use as a blowing agent in the manufacture of urethane foam products (5).

For many other important industrial processes, there may not be any viable alternatives to methylene chloride at this time.

B. Equipment or Process Design.

Open equipment which discharges methylene chloride to the ambient air should be avoided unless mechanical ventilation or solvent recovery units are available. Occupational exposure to methylene chloride can be minimized by the effective installation, use and proper maintenance of such items as full or partial process enclosures, including the use of baffles and covers. For

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