NIOSH Posthearing Comments to DOL

POSTHEARING COMMENTS FROM THE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
ON
THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
PROPOSED RULE ON
OCCUPATIONAL EXPOSURE TO METHYLENE CHLORIDE

29 CFR Parts 1910, 1915 and 1926
Docket No. H-71

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

January 14, 1993

On September 21, 1992, the National Institute for Occupational Safety and Health (NIOSH) presented testimony at the Occupational Safety and Health Administration (OSHA) hearing on methylene chloride [NIOSH 1992]. At the hearing, NIOSH was requested to provide additional information or to clarify certain issues related to our testimony.

The following are NIOSH comments that relate to corresponding pages of the transcript for NIOSH testimony:

Transcript Page(s)	Item
894 - 910	Correction of error made in the NIOSH testimony on confidence interval determination.

Response

As a part of the NIOSH testimony to OSHA on methylene chloride we compared confidence intervals for biliary cancer from the Lanes et al. [1990] and the Gibbs study (Exhibit 23-1) of cellulose fiber production workers exposed to methylene chloride. The purpose of the exercise was to test the consistency between the results from the Gibbs study with the results previously reported by Lanes et al. [1990]. It was noted that there was an error in our computation of these intervals, and we were asked to recompute them.

During the NIOSH testimony, NIOSH also was asked to explain the statistical methodology used for computing the confidence intervals and asked why our confidence intervals differed from those reported by Lanes et al. [1990]. We used a Fisher's exact procedure for calculating confidence intervals, which is described in *Epidemiologic Analysis With a Programmable Calculator* [Rothman and Boice 1979]. Our confidence intervals differ somewhat from those reported by Lanes et al. [1990] because they used a procedure based upon a mid-p correction.

Below is a table presenting the results from our revised calculations. Separate results are presented for the high (subcohort 1) and low (subcohort 2) methylene chloride exposed subcohorts in the Gibbs study, as well as for both subcohorts combined. Probably the most appropriate comparison is between the high exposure group (subcohort 1) in the Gibbs study and the Lanes study, since these two groups were reported by Gibbs to have similar exposure levels. It may be seen that the upper 95% bound estimate of the standardized mortality ratio (SMR) from subcohort 1 (10.71) of the Gibbs study is less than the SMR (20) reported by Lanes et al. This suggests that the results from the Gibbs study are inconsistent with the point estimate (SMR) reported by Lanes et al. It should be noted that the confidence intervals from the two studies overlap indicating that the difference between the two studies' findings are compatible with statistical variability.

Comparison Between the Results for Biliary Tract Cancer
Between the Study by Lanes et al. [1990] and Gibbs (Exhibit 23-1)
of Cellulose Fiber Production Workers Exposed to Methylene Chloride[a,b]

STUDY	OBS	EXP	SMR	95% CI LOWER	95% CI UPPER
Lanes et al. [1990]	3	0.15	20	4.1	58.4[c]
Gibbs (Ex. 23-1)					
Subcohort 1	1	0.52	1.92	0.05	10.71
Subcohort 2	1	0.88	1.14	0.03	6.33
Combined 1 and 2	2	1.43	1.43	0.17	5.16

[a]The following abbreviations were used in this table: OBS = observed number of deaths, EXP = expected number of deaths, SMR = standardized mortality ratio, 95% CI = the 95% confidence interval.

[b]Confidence intervals were computed using a program for calculating Fisher exact limits described in *Epidemiologic Analysis With a Programmable Calculator* [Rothman and Boice 1979].

[c]Lanes et al. [1990] used a different method for calculating their confidence interval (mid-p) and reported a somewhat narrower confidence interval (95% CI = 5.2-56).

Transcript Page(s)	Item
910 - 914	Evaluation of evidence from Dr. Green as requested by Mr. Paul Dugard.

Response

Upon reviewing the record of Dr. Trevor Green of the Imperial Chemical Industries Central Toxicology Laboratory, United Kingdom, as submitted to the OSHA docket on methylene chloride, we were not able to find the relevant toxicologic data from Dr. Green that Mr. Dugard referenced in his questioning of NIOSH. NIOSH has asked OSHA to forward these data for evaluation when they are submitted to the docket.

Transcript Page(s)	Item
924	Review of study by Mattsson on the neurologic effects of exposure to methylene chloride.

Response

In regard to NIOSH testimony about the proposed short-term exposure limit (STEL) of 125 parts per million (ppm), Mr. Caffey Norman, HSIA, asked during the hearing whether NIOSH had any comments on a study of methylene chloride exposure in rats by Mattsson et al. [1990] (attached to exhibit 19). We agreed to review the study and provide comments.

The study exposed rats to a maximum concentration of 2000 ppm methylene chloride for 6 hours/day, 5 days/week for 13 weeks. The rats were given behavioral and electrophysiological tests beginning 65 hours after the exposure ended, presumably after the chemical had been largely eliminated from the body. No effects of methylene chloride exposure could be detected. In contrast, a pilot study conducted by these investigators showed that EEG and somatosensory evoked potentials (SSEP) were significantly altered when measured immediately following 3 hours of exposure to methylene chloride at 2000 ppm. Thus, alterations of nervous system function could be found during, but not 2.5 days after exposure to methylene chloride. That Mattsson et al. [1990] found no enduring effects of methylene chloride after 13 weeks of exposure does not lessen our concerns about the possibility of neurobehavioral impairment from acute exposure at the proposed STEL.

The finding of nervous system impairment (i.e., altered EEGs and SSEPs) during methylene chloride exposure provides information about the mechanism of neurotoxicity, but cannot readily be extrapolated to help predict the effects of shorter exposure at lower concentrations in humans.

Transcript Page(s)	Item
929 - 931	Determine if there are any studies that show results that are inconsistent with earlier studies as alluded to by Mr. Norman.

Response

Mr. Caffey Norman, HSIA, requested the literature reference in which Benignus et al. found neurobehavioral impairment from carbon monoxide at carboxyhemoglobin (COHb) levels below 20%. The reference is: *Benignus VA et al. [1987]. Effect of low level carbon monoxide on compensatory tracking and event monitoring. Neurotoxicology and Teratology 9:227-234.* This study was an attempt to directly replicate research by Putz et al. (Exhibit 7-175); Benignus et al. found impaired neurobehavioral performance at 8.24% COHb. Subsequent to the 1987 study, Benignus and his group conducted other human exposure studies and reviews of the effects of carbon monoxide on human and animal performance [*Neurotoxicolgy and Teratology* 12:105-110 (1990a) and 111-118 (1990b)]. Benignus et al. [1990b] state: "Data from other experiments concerning the effects of COHb on tracking are difficult to reconcile with [the negative effects found in 1990a]. At low levels of COHb, three reports of significant and comparatively large effects exist, while a fourth experiment revealed no significant effects at high level COHb." "No obvious reasons for the disparities can be suggested. It is possible that under some

unknown conditions, COHb produces effects, while under other conditions, no effects are observed." NIOSH is not able to further clarify the discrepant findings in the effects of carbon monoxide reported in the above studies.

Transcript Page(s)	Item
943 - 945	Clarify the discussion of supplied-air respirators.

Response

The filter on the compressor of a supplied-air respirator is a particulate filter that is intended to protect the pump of the compressor from being damaged by airborne dust. The filter on the compressor does not remove methylene chloride or other airborne contaminants that the worker might breathe. Therefore, the compressor must be placed in a location in which the air is suitable for breathing.

Transcript Page(s)	Item
947 - 948	Explanation of Figure 1 from the NIOSH testimony.

Response

Figure 1 from the NIOSH testimony illustrates the estimated end-of-shift COHb levels which are expected to be produced by exposure to various concentrations of methylene chloride. The estimates were prepared using a physiologically-based pharmacokinetic model published by Andersen et al. [1991]. A copy of the Advanced Continuous Simulation Language code for this model was provided by Dr. Richard Reitz (Dow Chemical, Midland, MI), who was one of the co-authors of the Andersen et al. [1991] paper. The values of two of the model parameters were altered in order to adjust the COHb level at zero ppm methylene chloride to match the carboxyhemoglobin levels which had been reported in a study of New York City tunnel workers [Ayres et al. 1973]. An excess of ischemic heart disease mortality was subsequently detected in a NIOSH epidemiologic study among workers in the New York City tunnels [Stern et al. 1988].

The Ayres et al. [1973] study examined employees of the Triborough Bridge and Tunnel Authority in New York City. The COHb levels of tunnel workers (who were occupationally exposed to carbon monoxide) were compared to the COHb levels of subjects in Union Square, who served as the referent population for this study. The COHb concentration in the blood of the nonsmoking Union Square referents was given as 1.94 ± 0.62%, and the COHb concentration in the blood of the Union Square smoking group was given as 3.84 ± 2.06%. As published, the Andersen et al. [1991] physiologically-based pharmacokinetic model for methylene chloride metabolism predicts an 8-hour (end-of-shift) COHb concentration of 1.73% in the absence of methylene chloride exposure. In

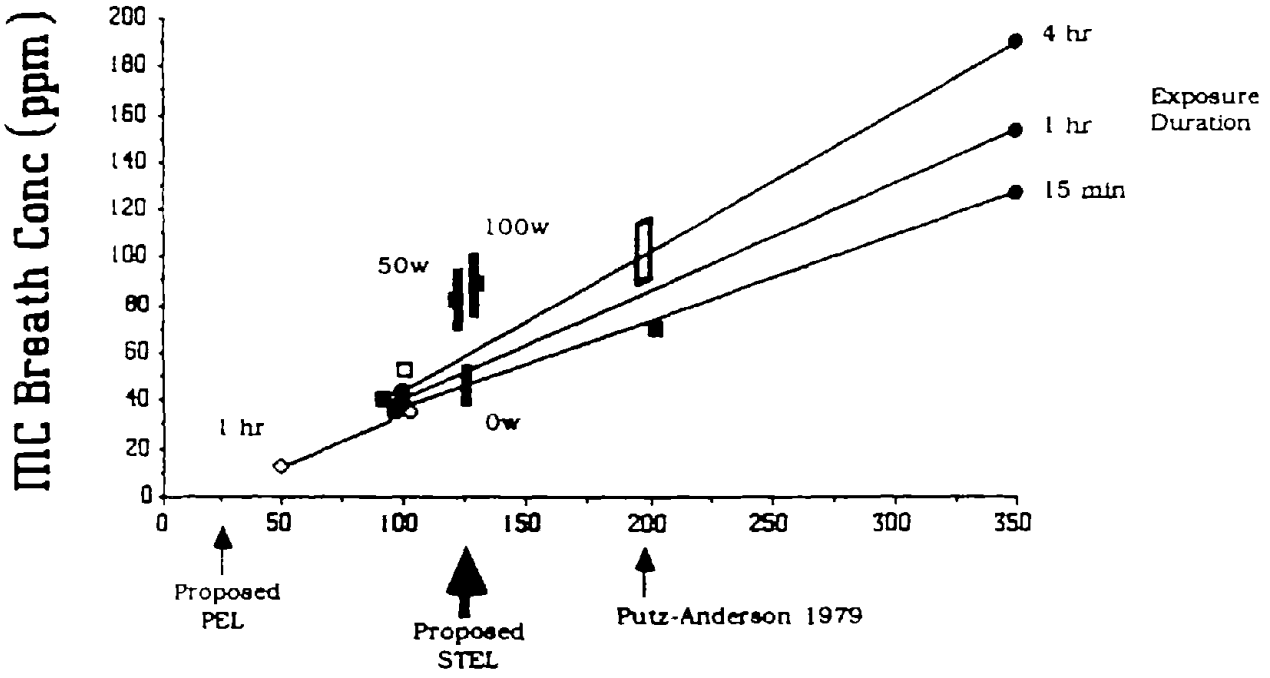
Methylene Chloride: Human Laboratory Studies

Experimentally determined methylene chloride breath concentrations.

- ◇ Peterson/Stewart 1975
- ● M. Andersen 1991
- □ Riley 1968
- ■ DiVincenzo 1972

Calculated mean ± S.D. breath concentration at which Putz-Anderson (1979) found neurobehavioral impairment.

Calculated mean ± S.D. breath concentration (based on Astrand, 1975) for subjects at rest (0 watts), and after 15 mins work at 50 and 100 watts at 125 ppm.



Methylene Chloride Concentration in Ambient Air (ppm)

order to match the COHb concentrations observed by Ayres et al., it was necessary to adjust the model to predict 8-hour COHb concentrations of either 1.94% (nonsmokers) or 3.84% (smokers), in the absence of methylene chloride exposure.

The "default" assumption in the Andersen et al. [1991] model is that the subject is exposed to a background (ambient) carbon monoxide concentration of 2.2 ppm, and has a rate of endogenous carbon monoxide production of approximately 0.04 mg/kg/hour. Since the Ayres et al. [1973] study was carried out in an urban environment, it is reasonable to presume that the ambient carbon monoxide concentration may have been somewhat higher than was assumed by Andersen et al. [1991]. Therefore, the background COHb predicted by the model was raised by increasing the ambient carbon monoxide concentration in the model, rather than by increasing the rate of endogenous carbon monoxide production. The assumption of an ambient carbon monoxide concentration of 4.0 ppm was sufficient to raise the predicted 8-hour COHb to the 1.94% observed by Ayres et al. [1973] for nonsmokers. A parameter governing the amount of carbon monoxide in the body at the beginning of the simulation was also adjusted, so that the COHb concentration at the beginning of the simulated exposure was 1.94%. The physiologically-based pharmacokinetic model was then used to estimate the 8-hour COHb concentrations which would be produced by continuous eight hour exposures to methylene chloride concentrations ranging from 5 to 1000 ppm.

Smokers are exposed to carbon monoxide from both the ambient air and from the combustion products of tobacco. Although the Andersen et al. [1991] physiologically-based pharmacokinetic model for methylene chloride does not include smoking as a part of the model, it is reasonable to assume that smokers are exposed to higher ambient carbon monoxide levels than nonsmokers. An assumption that the ambient carbon monoxide concentration was equal to 18.7 ppm was required to raise the predicted 8-hour COHb concentration to the 3.84% observed by Ayres et al. [1973] for smokers. After modifying the background carbon monoxide exposure to 18.7 ppm and increasing the initial COHb concentration to 3.84%, the physiologically-based pharmacokinetic model was used to estimate the 8-hour COHb concentrations which would be produced by continuous eight hour exposures to methylene chloride concentrations ranging from 5 to 1000 ppm. Figure 1 illustrates the expected 8-hour COHb concentrations of both smokers and nonsmokers exposed to methylene chloride.

Transcript Page(s)	Item
959	Provide information on flowrates and for eye washes and showers.

Response

NIOSH has no specific information on the flowrates necessary for eye washes and showers.

Transcript Page(s)	Item
978	Discussion of neurobehavioral impairment to peak exposure concentrations.

Response

OSHA requested information on the possibility of neurobehavioral impairment from exposure to methylene chloride at 325 ppm for 5 minutes and 175 ppm for 10 minutes (time-weighted average [TWA] equivalents of the proposed STEL). There are no data on neurobehavioral impairment after exposure to methylene chloride for 5 or 10 minutes. There are limited data on breath concentration only from Astrand et al. [1975]; methylene chloride breath and arterial concentrations for three sedentary human subjects were measured at 5-minute intervals after exposure to 250 and 500 ppm. After 5 minutes at 500 ppm, breath concentration in one subject was about 70 ppm; after 10 minutes at 250 ppm, the breath concentration of methylene chloride was about 40-55 ppm in two subjects. These data are insufficient to allow estimation of methylene chloride breath concentrations at 325 or 175 ppm.

Transcript Page(s)	Item
979 - 980	Recommendations regarding an appropriate 15-minute STEL for methylene chloride.

Response

The estimated breath concentrations after 15 minutes of exposure to 125 ppm methylene chloride in physically active workers overlap the methylene chloride breath concentrations estimated to be associated with neurobehavioral impairment (Exhibit 7-175). These estimates of potential neurobehavioral impairment at the proposed STEL are extrapolations; there are no studies of neurobehavioral function during exposure to 125 ppm methylene chloride for 15 minutes under relevant conditions. However, NIOSH is concerned that sufficient methylene chloride may be taken up during periods of increased respiratory and heart rate at the proposed STEL in amounts sufficient to produce mild neurobehavioral impairment.

Transcript Page(s)	Item
980 - 981	How low can concentrations of methylene chloride be reliably and accurately measured for a 15-minute STEL?

Response

Using the NIOSH analytical method for methylene chloride (NMAM 1005) [NIOSH 1987], the limit of quantitation for a 2.5 liter sample is 3.6 ppm. Because

this volume of air can be collected in a 15-minute sample, a 15-minute STEL for methylene chloride can be reliably and accurately measured to as low as 3.6 ppm.

Transcript Page(s)	Item
981 - 983	What type of clothing material would provide protection for a mixture of methanol and methylene chloride that is commonly found in paint stripping solutions?

Response

Two sets of gloves should be worn to protect workers against a mixture of methanol and methylene chloride. The inner glove should be made of a polyethylene and ethylene vinyl alcohol (PE/EVAL) laminate. This glove should protect against the individual components of the mixture (i.e., methanol and methylene chloride) for up to 4 hours [Forsberg and Mansdorf [1989]. However, unpublished NIOSH data indiciate that PE/EVAL material may provide adequate protection against the mixture for up to approximately one hour [Berardinelli 1993].

Furthermore, because the PE/EVAL glove material is not durable, an outer glove made of neoprene or nitrile rubber should be worn to protect the inner glove from tears and cuts. This combination of gloves may provide adequate protection for up to one hour of use, as well as to provide reasonable dexterity for paint stripping operations.

Transcript Page(s)	Item
983 - 984	Provide additional information on the type of control technology and protective equipment used in industries other than furniture or paint stripping.

Response

NIOSH has only performed control technology research on methylene chloride use in the furniture stripping industry. However, NIOSH has conducted health hazard evaluations (HHEs) in other industries. They do not constitute representative exposure data, nor do they provide detailed information on controls. The HHEs do provide evidence of exposure concentrations to which methylene chloride is being controlled in worksites NIOSH has evaluated, and whose employers and workers have been concerned about the healthfulness of working conditions.

The reports have been divided into industry segments using the same divisions used in the OSHA proposed rule.

Methylene Chloride Production

No reports were found that summarize effective controls.

Polyurethane Foam Blowing

HETA 87-350-2084, Trailmobile, Inc., Charleston, Illinois [1990] - Part of this report deals with a foam blowing operation used in the production of refrigerated tractor trailers. Methylene chloride is used to clean out the foam spray guns and is deposited in a waste solvent drum equipped with local exhaust ventilation. Eight-hour TWA exposures to methylene chloride ranged from 1.3 to 5.1 ppm, showing that exposures in this operation were well controlled.

HETA 86-420-2051, General Foam Corporation, West Hazleton, Pennsylvania [1990] - This survey was done at a facility with two continuous foam pouring lines, one of which used methylene chloride as a blowing agent. Seven 8-hour TWAs for methylene chloride ranged from 1.3 to 59 ppm, with only one TWA over 25 ppm. However, the pouring line only operated about 3 hours, which was typical for this plant. If the blowing line operated for longer times, 8-hour TWA exposures would be higher.

HETA 84-458-1733, Schlegel, Inc., Rochester, New York [1986] - This polyurethane foam seal producer used methylene chloride to clean foam heads. Each of the foam heads had local exhaust. Eight-hour TWA exposures ranged from 3 to 52 ppm, with an average of 13 ppm.

HETA 85-256-1716, AMF Head Division, Boulder, Colorado [1986] - This sports racket manufacturer foams-in-place polyurethane foam during the manufacture of some of these products. Methylene chloride is used in this foam-in-place operation. Area samples in this process area ranged from 1.1 to 4.8 ppm.

HETA 80-209-1396, Crain Western, Compton, California [1983] - This polyurethane foam block production operation used methylene chloride as a blowing agent and fire retardant. They had an automated foam line and used local exhaust at the foam tunnel and band saw cutting areas. Methylene chloride exposures ranged from 0.1 to 0.8 ppm.

HETA 81-128-1107, Janesville Products, Brodhead, Wisconsin [1982] - This plant, which produced polyurethane foam for seats for the automotive industry, used methylene chloride as a blowing agent and for cleaning foam heads. At the time of the first survey, methylene chloride 8-hour TWA exposures ranged from 4.7 to 40 ppm. However, short-term exposures ranged from 5.8 to 400 ppm. After installation of improved local exhaust ventilation at the foam heads, 8-hour TWA exposures were reduced to 7.5 to 8.1 ppm, with short-term levels of 9.8 to 14 ppm.

IWS 69-12, CPR, Torrance, California [1980] - At this plant which manufactured polyurethane foam thermal insulation, methylene chloride was used for cleanup, including mopping the floors. The one worker involved in this cleanup had an 8-hour TWA exposure of 11 ppm, but the cleanup operation generally takes less than an hour. This means that short-term exposures were considerably higher.

HETA 75-150-378, Reinell Boats, Inc., Poplar Bluff, Missouri [1977] - This plant manufactured 15- to 30-foot fibrous glass boats and used methylene chloride to clean foam guns used to add polyurethane foam between the decks and hull. There was no local exhaust used. Eight-hour TWA methylene chloride exposures ranged from less than 1 to 16 ppm.

HETA 74-148-239, Lange Co., Broomfield, Colorado [1975] - At this ski boot manufacturing plant that used polyurethane foam molding in this manufacturing process, methylene chloride exposures ranged from less than 1.4 to 30 ppm.

Aerosols

IWS 50-13, Virginia Chemicals, Inc., Portsmouth, Virginia [1977] - At this aerosol can filling operation, worker exposures ranged from 1.6 to 14 ppm. Exhaust hoods were employed at the cylinder cleaning stations and the location where cylinder valves were opened and removed. Also, an enclosing hood was employed at one cylinder packing station and used only when certain insecticide formulations were packed.

Polycarbonate Resins

No reports were found that summarized effective controls.

Pharmaceuticals

HETA 81-322-1228, Mylan Pharmaceuticals, Morgantown, West Virginia [1982] - Area methylene chloride exposures at this generic prescription drug manufacturing plant ranged from 1 to 25 ppm. Methylene chloride was used in the coating operation.

Manufacturing of Paint and Paint Removers/Strippers

No reports were found that summarized effective controls.

Degreasing and Metal Cleaning

HETA 90-300-2208, L-Tec Welding and Cutting Systems Corporation, Florence, South Carolina [1992] - This manufacturer of welding machines uses methylene chloride as a degreaser. They used a vapor-lock

degreaser equipped with local exhaust ventilation to control methylene chloride exposures. Personal full-shift methylene chloride exposures ranged from 1.6 to 22 ppm, with only 1 of 16 samples above 5 ppm.

Cellulose Triacetate Fiber and Film Base Production

No reports were found that summarized effective controls.

Electronics

Scarpace et al. [1989] - This report of industrial hygiene data from nine semiconductor manufacturing companies shows an average worker methylene chloride exposure of 0.45 ppm in wafer fabrication areas and 2.4 ppm in other areas of these plants.

Miscellaneous

Solvent Recovery - *TA 80-48, Chemical Recovery Systems, Inc., Elyria, Ohio [1980]* - Eight-hour TWA methylene chloride exposures at this chemical recovery plant ranged from 3.0 to 5.5 ppm.

Printing - *HETA 90-370-2107, Moore Business Forms, Angola, Indiana [1991]* - This printing operation used a type cleaning solvent containing 30 percent methylene chloride in the press area to clean equipment. Full-shift personal methylene chloride exposures ranged from 1.8 to 9.7 ppm.

Printing - *HETA 85-433-1638, Current, Inc., Colorado Springs, Colorado [1985]* - Methylene chloride was used as a solvent in this printing operation. Worker methylene chloride exposures in the press room ranged from 0.3 to 28 ppm.

Printing - *HETA 82-008-1226, Arts Consortium, Cincinnati, Ohio [1982]* - Methylene chloride was contained in the cleaning solvent used in the printing area of this facility. Worker exposures to methylene chloride ranged from 0.8 to 11 ppm.

Printing - *HETA 78-77-659, R.L. Polk Co., Cincinnati, Ohio [1980]* - Methylene chloride was used in the cleaning solvent at this multilith printing facility. Worker exposures to methylene chloride ranged from 5.5 to 18 ppm.

Epoxy Use - *HETA 87-075-1988, American Cyanimid, Wallingford, Connecticut [1989]* - This plant produces metal-coated fibers and coats them with an epoxy material in a sizing operation. Potential eight-hour TWA methylene

chloride exposures ranged from 3.7 to 21 ppm. However, workers wore air-supplied respirators when accessing the mixing booth and sizing tank containing methylene chloride.

Adhesive Use - *HETA 86-130-1775, Owens-Illinois, Glass Container Division, Hapeville, Georgia [1987]* - This glass bottle manufacturer used methylene chloride to glue foam labels to the bottles. This is primarily an automated process. Methylene chloride full-shift exposures ranged from none detected to 6.9 ppm.

Adhesive Use - *HETA 86-070-1774, Silver Deer Spectrum, Boulder, Colorado [1987]* - This plant polishes and glues leaded glass crystal into various art objects. Methylene chloride is a solvent in the glue. Methylene chloride worker exposures ranged from 0.2 to 4.5 ppm.

Paint Use - *HETA 85-486 and 86-116-1730, Winters Industry Foundry, Canton, Ohio [1986]* - Methylene chloride was used as a solvent in a core paint used in this aluminum foundry. Full-shift methylene chloride exposures ranged from none detected to 1.4 ppm.

Foundry Use - *HETA 83-131-1412, Midwest Foundry, Coldwater, Michigan [1984]* - Methylene chloride exposures in the coremaking operation of this grey iron foundry ranged from none detected to 0.7 ppm.

Cleaner Use - *HETA 79-156-899, Gulf-Wandes Corp., Baton Rouge, Louisiana [1981]* - Methylene chloride was used as a cleaning solvent in this fibrous glass tank, hood and duct manufacturer. Worker methylene chloride exposures ranged from none detected to 17 ppm.

Solvent Use - *HETA 78-125-712, Owens Corning Fiberglass Corporation, Conroe, Texas [1980]* - Methylene chloride was used as a solvent in this fibrous glass tank and pipe manufacturer. Worker exposures ranged from 5.2 to 24 ppm.

Transcript Page(s)	Item
985 - 996	Explanation of NIOSH discussion on carcinogenicity of methylene chloride in response to questioning from OSHA staff.

Response

The explanation was submitted as a report entitled "Adjusting for protocol differences, the healthy worker effect and statistical variability when comparing animal and human studies: methylene chloride a case study" to the OSHA docket on methylene chloride on December 23, 1992.

In addition to the previous responses that were requested during the hearing, NIOSH has enclosed a report (Attachment 1) that explains the need to incorporate into risk assessments the intersubject variability in methylene

chloride metabolism. Also enclosed (Attachment 2), is a description of a procedure developed by NIOSH for estimating breath concentrations of methylene chloride from ambient air concentrations of methylene chloride that are associated with neurobehavioral impairment.

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REPORT DOCUMENTATION PAGE	1. REPORT NO.	2.	PB95-200432

4. Title and Subtitle: NIOSH Testimony on Occupational Exposure to Methylene Chloride by J. D. Millar, January 14, 1993

5. Report Date: 1993/01/14

6.

7. Author(s): NIOSH

8. Performing Organization Rept. No.

9. Performing Organization Name and Address: NIOSH

10. Project/Task/Work Unit No.

11. Contract (C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words) This testimony summarizes information provided to clarify earlier testimony related to methylene-chloride (75092) exposures. An error made in earlier testimony concerning confidence interval determination is discussed. During a study on methylene-chloride exposure in rats, nervous system damage was recorded, but this cannot be extrapolated to help predict the effects of shorter exposure at lower concentration in humans. With regard to questions concerning the effects of carbon-monoxide (630080) on human and animal performance reported in various studies, NIOSH was not able to offer any further clarification of the issue. In a discussion of supplied air respirators, NIOSH indicates that the filter on the compressor is a particulate filter intended to protect the pump from being damaged by airborne dust. The compressor must therefore be located where the air is suitable for breathing. In response to a question regarding flow rates for eye washes and showers, NIOSH indicated that there was no available information. Information was provided regarding neurobehavioral impairment to peak exposure concentrations and to recommendations regarding an appropriate 15 minute short term exposure limit for methylene-chloride. Discussion is also provided regarding the type of clothing material which would provide protection for a mixture of methanol (7439965) and methylene-chloride and on the type of control technology and protective equipment used in industries other than furniture or paint stripping.

17. Document Analysis a. Descriptors

b. Identifiers/Open-Ended Terms: NIOSH-Publication, NIOSH-Author, NIOSH-Testimony, Millar-J-D, Air-quality-monitoring, Organic-solvents, Solvent-vapors, Personal-protective-equipment, Neurotoxic-effects, Chlorinated-hydrocarbons

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
		15
	22. Security Class (This Page)	22. Price