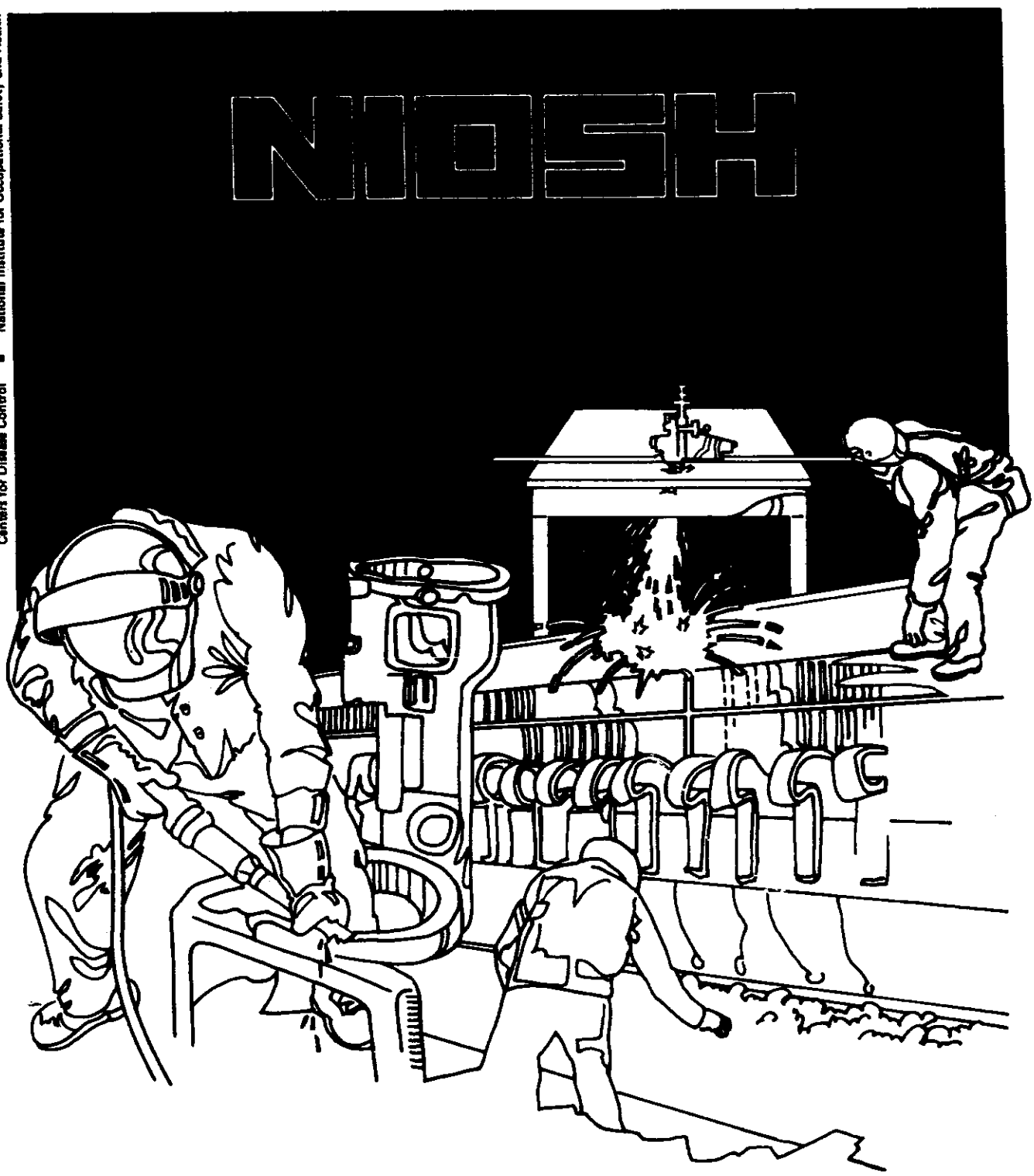
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health

NIOSH



Health Hazard Evaluation Report

HETA 87-309-1906
LOUISIANA-PACIFIC CORPORATION
MISSOULA, MONTANA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 87-309-1906
JUNE 1988
LOUISIANA-PACIFIC CORPORATION
MISSOULA, MONTANA

NIOSH INVESTIGATOR:
Steven A. Lee, CIH

I. SUMMARY

In June 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Montana Department of Health (MT.H.D.) for a health hazard evaluation of the particle board painting department at Louisiana Pacific, Missoula, Montana. The request was submitted after several workers complained of upper respiratory irritation, headaches, and dizziness. At the time of the study, there were eight workers employed to operate the automated painting processes.

On November 3, 1987, NIOSH and MT.H.D. investigators conducted environmental sampling and evaluated local exhaust ventilation (LEV) systems. Air samples were collected for methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), xylene, toluene, butyl acetate, butanol, styrene, butyl cellosolve, and formaldehyde.

Toluene, MEK, and MIBK were found to be the major components of airborne exposure to solvent mixtures. Full-shift time-weighted average (TWA) exposure to solvent mixtures among five workers ranged from 26 to 110% of the combined evaluation criteria, based on the most recent NIOSH recommended exposure limits (RELs) or American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs) for the individual solvents. These same exposures to solvent mixtures ranged from 13 to 70% of the combined OSHA permissible exposure limit (PEL).

One worker was exposed to 900 milligrams per cubic meter (mg/M^3) of MEK during a 20 minute job of cleaning paint rollers. ACGIH recommends a short-term exposure limit of 885 mg/M^3 for MEK.

One worker was exposed to 40 mg/M^3 of butyl cellosolve during a 3 hour painting operation. Butyl cellosolve is an organic solvent that belongs to a group of structually related glycol ethers that have demonstrated adverse reproductive effects in animals. NIOSH recommends that exposure be reduced as much as possible.

Four area air samples found concentrations of formaldehyde ranging from 0.1 to 0.3 mg/M^3 at the time of the NIOSH visit. NIOSH recommends that exposure be reduced to the minimum.

LEV systems were ineffective at the time of the NIOSH visit. An inadequate make-up air supply system appeared to be reducing LEV exhaust volumes. In addition, canopy hoods were too far (four feet) above the processes and had no enclosed sides.

On the basis of the data obtained in this evaluation, it was determined that there was a hazard from overexposure to mixtures of organic solvents. There were also potential carcinogenic and reproductive hazards due to exposure to formaldehyde and butyl cellosolve, respectively. Recommendations are provided to reduce exposures.

Keywords: SIC 2492 (Particle board), solvent mixtures, toluene, methyl ethyl ketone, methyl isobutyl ketone, formaldehyde, butyl cellosolve.

II. INTRODUCTION

In June 1987, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Montana Department of Health (MT.H.D.) for a health hazard evaluation of the particle board painting department at Louisiana Pacific, Missoula, Montana. The request was submitted after several workers complained of upper respiratory irritation, headaches, and dizziness while working with paints and solvents in that department.

An initial walkthrough was conducted on July 21, 1987, to gather information on the painting process. On November 3, 1987, NIOSH and MT.H.D. investigators conducted an industrial hygiene survey consisting of air sampling and assessment of ventilation systems.

III. BACKGROUND

The board painting department was built in 1969 and employs eight workers to operate the automated painting process. Boards manufactured at the adjacent particle board plant are sent to the Painting Department where they are conveyed through machines that apply the paint with rollers. There is generally one operator for each of the three solvent-based painting stations, one operator for a water-based painting station, one grader who inspects the final product, and several workers who mix paints, clean machines, and fill the machines' paint reservoirs.

Solvents used in the paints are methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK), xylene, toluene, butyl acetate, butanol, and styrene. Butyl cellosolve is the major solvent in paints used at one of the painting stations. MEK is used to clean the paint rollers. In addition, formaldehyde is emitted from the freshly manufactured particle board.

IV. METHODS

NIOSH and MT.H.D. investigators collected 12 air samples on November 3, 1987, to evaluate worker exposure to butyl cellosolve, MEK, MIBK, xylene, toluene, butyl acetate, butanol, styrene, and formaldehyde.

Five personal breathing-zone full-shift air samples for MIBK, xylene, toluene, butyl acetate, butanol, and styrene were collected and analyzed by gas chromatography according to NIOSH Methods 1300, 1401, 1450, and 1501.[1] One charcoal tube sample collected by the same methods during a three-hour painting process was analysed for butyl cellosolve according to NIOSH Method 1403.[1]

Two personal breathing-zone air samples for MEK were collected on Ambersorb tubes at a flow rate of 0.05 liters per minute and analysed by gas chromatography according to NIOSH Method 2500.[1] One full-shift sample was collected and one short term sample was collected during a 20-minute task of cleaning the paint rollers.

Four area air samples for formaldehyde were collected in midjet impingers containing 20 milliliters of 1% sodium bisulfite. The samples were drawn at a flow rate of 1 liter per minute for about 4 hours and analysed by visible spectroscopy according to NIOSH Method 3500.

Ventilation measurements of local exhaust hoods were obtained with an Alnor Model 8100 air velocity meter.

V. EVALUATION CRITERIA

A. Environmental Criteria

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

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

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

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

B. Toxicological

1. Organic Solvents

Each of the paint solvents used in this department may cause irritation of the eyes, nose, and throat. Effects of direct skin contact with solvents range from dry skin or mild rash to a dry, scaly, fissured dermatitis. Higher concentrations of these chemicals affect the central nervous system (CNS) such that exposed workers may complain of headache, nausea, lightheadedness, dizziness, and uncoordination. Extremely high concentrations of these compounds can adversely affect the liver and kidney.

Simultaneous exposure to substances, such as solvents, which affect the body in a similar fashion may have an additive effect. To evaluate these additive effects, the exposure level of each substance is computed as a percentage of the evaluation criterion for that substance. If the sum of these percentages exceeds 100%, the worker is considered to be overexposed to that mixture of substances.

Recent research on the effects of multiple solvent mixtures has focused on behaviorial and psycological effects which may indicate nervous system damage or deviations from normal CNS function.[2] For example, an epidemiology study was conducted on Finnish car painters exposed to a mixture of toluene, xylene, butyl acetate, and white spirits for a mean duration of 15 years. Average combined exposures were less than 32% of ACGIH TLV's, however, researchers found more memory disturbances, decreased vigilence, and more absent-mindedness among car painters when matched with railroad engineers as controls. Visual intelligence and verbal memory were the most affected. The authors concluded that car painters, although not ill in the clinical sense, showed clear signs of central and peripheral nervous system lesions more often than members of the control group.[3,4,5,6]

2. Butyl Cellosolve

Butyl cellosolve, also known as 2-butoxyethanol or ethylene glycol n-butyl ether, is an organic solvent that causes the same irritative and neurologic effects discussed earlier. In addition, it belongs to a group of structually related glycol ethers that have demonstrated dose-related embryotoxicity and other reproductive effects in several species of animals exposed

by different routes of administration. Of particular concern are those studies in which exposure of pregnant animals to air concentrations of cellosolve or methyl cellosolve at or below their respective OSHA PELs led to increased incidences of embryonic death, teratogenesis, or growth retardation. Exposure of male animals to these compounds at concentrations below the OSHA PELs resulted in testicular atophy and sterility. Based on these findings, NIOSH recommends that cellosolve and methyl cellosolve be regarded in the workplace as having the potential to cause adverse reproductive effects in male and female workers.[7]

Although additional studies are being conducted by NIOSH and others, the present information is insufficient to fully assess the potential for adverse reproductive effects on humans due to exposure to butyl cellosolve or the other glycol ethers that share a similar stereochemical configuration with cellosolve and methyl cellosolve. Preliminary test results of some structually related glycol ethers indicate that they also have the potential for causing adverse reproductive effects. Therefore, NIOSH recommends that worker exposure to all of these compounds (Appendix I) be reduced to the lowest extent possible.[7]

3. Formaldehyde

Acute exposure to formaldehyde causes burning, tearing eyes and irritation of the nose and throat. These symptoms can occur at concentrations as low as 0.1 ppm. Exposure to formaldehyde vapor, solutions or resins can also cause dermatitis.[8]

Formaldehyde has induced a rare form of nasal cancer in inhalation studies of mice and rats. Formaldehyde has also demonstrated mutagenic activity in several test systems.[8] NIOSH investigators recently conducted a proportionate mortality study of garment industry workers exposed to formaldehyde levels ranging from 0.1 to 1.0 ppm. Statistically significant excesses in mortality were observed for cancers of the mouth, biliary passages and liver, and other lymphatic and blood-forming sites. The authors concluded that these observed excesses in cancer mortality could be related to occupational formaldehyde exposure.[9]

NIOSH recommends that occupational exposure be reduced to the lowest feasible level.[8]

VI. RESULTS AND DISCUSSION

Full-shift TWA exposures to solvent mixtures ranged from 26 to 110% of the combined evaluation criteria, based on the most recent NIOSH RELs or ACGIH TLVs for the individual solvents (Table I). Toluene, MEK, and MIBK were the major components of solvent mixture exposures. When comparing solvent exposures to the OSHA PELs, exposures to the mixture ranged from 13 to 70% of the combined PEL. The differences between the

exposure level percentages of the combined REL and combined PEL were due mostly to the different exposure limits for MIBK and toluene. Exposure limits currently recommended by both NIOSH and ACGIH for these compounds are half of the OSHA PELs. In addition to his full-shift solvent exposure shown in Table I, the UV operator had a short-term exposure to MEK while cleaning the paint rollers. During the 20 minute job, he was exposed to 900 mg/M^3 of MEK. ACGIH recommends a 15 minute exposure limit of 885 mg/M^3 for MEK.

Air formaldehyde concentrations in the painting department ranged from 0.1 to 0.3 mg/M^3 (Table II). The OSHA PEL for formaldehyde is 1.2 mg/M^3. NIOSH recommends that exposure be reduced to the lowest possible level.

The printer operator was exposed to 40 mg/M^3 of butyl cellosolve (Table I). The OSHA PEL for butyl cellosolve is 240 mg/M^3 and the ACGIH TLV is 120 mg/M^3. NIOSH recommends that exposure to butyl cellosolve be reduced to the lowest possible level.

None of the painting station local exhaust ventilation systems were effectively operating on the day of the NIOSH visit. One of the canopy hoods (Hood No. 4) had a face velocity of 600 feet per minute (fpm), but due to its excessive distance of four feet from the painting machine and the absence of any enclosed sides, there was no measurable capture velocity (<50 fpm) at the paint rollers. Although a roof inspection revealed that the fans connected to the other canopy hoods were running, there was no detectable air movement at the face of the hoods. This could have either been caused by one or more problems with LEV system design, such as underpowered fans, or it could have been caused by an inadequate make-up air system to supply the air that the LEV systems are suppose to exhaust.

VII. CONCLUSIONS

There was a potential hazard from overexposure to organic solvent mixtures at the time of the NIOSH visit that is consistent with the workers' irritative and neurologic symptoms that prompted this request. Also, there was exposure to potentially irritating levels of formaldehyde which probably added to the irritating effects of the solvent vapors. Formaldehyde is also a suspected human carcinogen. In addition, there was a potential reproductive hazard due to exposure to butyl cellosolve.

VIII. RECOMMENDATIONS

Air sampling has shown exposures to be within the OSHA PELs. However, since the NIOSH recommended exposure limits are based on more recent information than are most of the OSHA PELs, the prudent approach to the prevention of solvent-related illnesses, and potential carcinogenic and reproductive effects, would be to reduce exposures. Therefore, the following recommendations are made:

1. The overall LEV system in the Painting Department should be checked to ensure that it is capable of providing the recommended capture velocity of 50-100 fpm at the paint rollers.[10] ACGIH provides a complete discussion of design, construction, operation, and testing of LEV systems in "Industrial Ventilation - a Manual of Recommended Practice."

2. Insufficient make-up air creates negative pressure which increases the static pressure the exhaust fans must overcome. The mechanical make-up air system should be checked and adjusted to ensure that it supplies the total volume of air that is supposed to be exhausted from the department.

3. The efficiency of LEV hoods should be improved, particularly at the DRC and UV stations. The efficiency of canopy hoods should be increased by enclosing at least three sides of each process with curtains.

4. Since some of the painting machines must be pulled away from their exhaust hoods to clean the paint rollers, a respirator should be worn during this procedure. A half-facepiece respirator fitted with organic vapor cartridges should be used in accordance with OSHA 1910.134. This regulation states that a Respirator Program must be established by standard written operating procedures governing worker training and the selection, use, maintenance, inspection, cleaning, and storage of respirators.

5. Butyl cellosolve should be replaced by a solvent that is not among the structually related glycol ethers (Appendix I) suspected of posing potential reproductive hazards. If no replacement is available, the process should be enclosed to the greatest possible extent and the worker should wear respiratory protection in accordance with the Respirator Program.

6. The make-up air supply system that is needed for the LEV systems would also provide additional dilution ventilation to help reduce formaldehyde concentrations. Further reductions should be made by minimizing the amount of particle board that is stored in the Department.

7. A medical surveillance program should be established to evaluate both the acute and chronic effects of exposure to organic solvents.[2] The physician should be given information concerning the adverse effects of exposure to them. This information should include any available results from workplace sampling and a description of any protective devices or equipment the worker may be required to use. A medical and work history should be taken initially and updated periodically. Workers who are currently exposed or who may be exposed to organic solvents should have preplacement and periodic evaluations focusing on their histories of previous exposure to organic solvents and other agents, particularly those associated with neurotoxic effects. The examining physician should direct

particular attention to the nervous, respiratory, reproductive, and cardiovascular systems, and to the skin, eyes, liver, blood, kidneys, and gastrointestinal tract, as these are the most likely targets for the adverse effects of organic solvents.

IX. REFERENCES

1. National Institute for Occupational Safety and Health. NIOSH Manual of Analytical Methods. 3rd. ed. Cincinnati, OH: National Institute for Occupational Safety and Health, 1984. (DHHS (NIOSH) Publication No. 84-100).

2. National Institute for Occupational Safety and Health. Current Intelligence Bulletin 48 -- Organic Solvent Neurotoxicity, Cincinnati, OH: National Institute for Occupational Safety and Health, 1987. (DHHS (NIOSH) Publication No. 87-104).

3. Hanninen H, Eskelinen L, Husman K and Nurminen M. 1976, "Behavioral Effects of Long-Term Exposure to A Mixture of Organic Solvents", Scand. J. Work Environ. and Health, V. 4, pp 240-255.

4. Sepplainen AM, Husman K and Martenson C. 1978, "Neurophysiological Effects of Long-Term Exposure to a Mixture of Organic Solvents", Scan. J. Work Environ. and Health, V. 4, pp 304-314.

5. Husman K. 1980, Symptoms of Car Painters with Long-Term Exposure to a Mixture of Organic Solvents", Scand. J. Work Environ. and Health, V. 6, pp 19-32.

6. Husman, K. and Karli P. 1980, "Clinical Neurological Findings Among Car Painters Exposed to a Mixture of Organic Solvents", Scan. J. Work Environ. and Health, V. 6. pp 33-39.

7. National Institute for Occupational Safety and Health. Current Intelligence Bulletin 39 -- glycol ethers. Cincinnati, OH: National Institute for Occupational Safety and Health, 1983. (DHHS (NIOSH) Publication No. 83-112).

8. National Institute for Occupational Safety and Health Current Intelligence Bulletin 34 -- Formaldehyde: Evidence of Carcinogenicity. Cincinnati, OH: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) Publication No. 81-111).

9. Stayner, L. et al. 1985, "Proportionate Mortality Study of Workers in the Garmet Industry Exposed to Formaldehyde", American Journal of Industrial Medicine, Vol. 7, No. 3, pages 229-240.

10. American Conference of Governmental Industrial Hygienists. ACGIH industrial ventilation: A Manual of Recommended Practice. ACGIH Committee of Industrial Ventilation: Lansing, Michigan, 1984.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared By:	Steven A. Lee, M.S., CIH Industrial Hygienist NIOSH - Denver Region Denver, Colorado
Field Assistance:	William Hooper Industrial Hygienist Montana Department of Health and Environmental Sciences
Originating Office:	Hazard Evaluations and Technical Assistance Branch (HETAB) Division of Surveillance, Hazard Evaluations, and Field Studies (DSHEFS) Cincinnati, Ohio
Report Typed By:	Marile F. DiGiacomo Secretary NIOSH - Denver Region Denver, Colorado

XI. DISTRIBUTION AND AVAILABILITY

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publication Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), Port Royal Road, Springfield, Virginia 22161. 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:

1. Louisiana Pacific Corp.
2. U.S. Dept. of Labor/OSHA - Region VIII
3. NIOSH - Denver Region
4. Montana Department of Health

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

Table I

Personal Breathing-Zone Air Samples for
Organic Solvent Vapors
Louisiana-Pacific Corporation
Missoula, Montana
HETA 87-309
November 3, 1987

Job/ Location	Sampling Time	Concentration in Milligrams per Cubic Meter (mg/M^3)									Percent of Combined REL & PEL	
		Butyl Cellosolve	MEK	MIBK	Xylene	Butyl Acetate	Toluene	Butanol	Isobutanol	Styrene		
Printer Operator	10:30a - 1:50p	40	-	-	-	-	-	-	-	-	-	17
DRC Operator	7:50a - 2:22p	-	130	65	22	15	100	18	14	3.9	110	70
UV Operator	7:39a - 1:50p	-	38	95	11	8.5	38	5.0	6.0	42	94	52
Grader	7:50a - 2:30p	-	-	21	7.3	5.9	20	4.5	4.5	2.3	26	13
Bullnose Helper	7:55a - 2:30p	-	-	35	10	9.0	20	3.8	3.3	3.3	34	17
Bullnose Helper	8:10a - 2:30p	-	-	41	10	11	24	4.5	4.0	2.5	37	19
Evaluation Criteria (NIOSH or ACGIH recommended exposure limits)		LFL*	590	200	435	710	375	150	150	215	100%	-
OSHA Permissible Exposure		240	590	410	435	710	750	300	300	430	-	100%

LFL* = Lowest feasible level

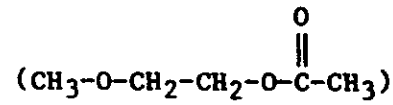
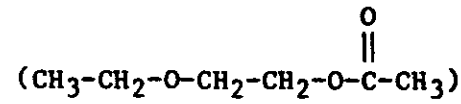
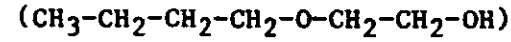
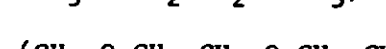
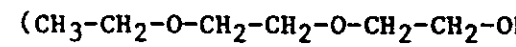
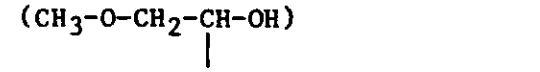
Table II

Air Formaldehyde Concentrations
Louisiana-Pacific Corporation
Missoula, Montana
HETA 87-309
November 3, 1987

Location	Sampling Time	Concentration (mg/M^3)
Grader	8:05a - 12:00p	0.1
Bullnose	8:22a - 12:05p	0.2
Water-Based Fill Station	8:15a - 12:00p	0.2
Printer	11:15a - 1:52p	0.3
Evaluation Criteria		Lowest Feasible Level

APPENDIX I

STRUCTURALLY RELATED GLYCOL ETHERS

2MEA	=	2-Methoxyethyl acetate	
2EEA	=	2-Ethoxyethyl acetate	
2BE	=	2-Butoxyethanol	
2PE	=	2-Phenoxyethanol	
EGdiME	=	Ethylene glycol dimethyl ether	
bis2ME	=	bis(2-methoxyethyl)ether	
2EEE	=	2-(2-Ethoxyethoxy)ethanol	
1MP	=	1-Methoxy-2-propanol or propylene glycol monomethyl ether	