U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45202

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 74-4-175

OLIN CORPORATION
PISGAH FOREST, NORTH CAROLINA
FEBRUARY 1975

I. TOXICITY DETERMINATION

An environmental-medical evaluation was conducted during the period March 4-6, 1974 at the Olin Corporation, Pisgah Forest, North Carolina concerning employee exposure to vapors of toluene, tetrahydrofuran, and isopropyl alcohol in the coating operations of the plant. Exposure to solvent vapors during most operations are controlled to levels of one-half or less of present hygienic standards for workroom air. No chronic toxic effects from exposure to the substances were observed based upon medical histories collected from the coating operation employees. Cutaneous exposure has been controlled adequately with impermeable gloves and barrier creams.

However, during certain intermittent procedures, short exposures to high concentrations of solvent vapors are reported to cause acute episodes of irritant and narcotic toxicity to a significant portion of the work force. During medical interviews, one half or more of the exposed workers reported reversible symptoms of slight to moderate dizziness, headache and eye irritation during these intermittent episodes. A more detailed discussion of the factors which may contribute to the irritant and narcotic toxicity during intermittent exposures is contained in the Evaluation Results and Discussion Section (IV. F) of this Report.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this Determination Report are available upon request from the Hazard Evaluation Services Branch, NIOSH, U.S. Post Office Building, Room 508, 5th and Walnut Streets, Cincinnati, Ohio 45202. Copies have been sent to:

a) Olin Corporation, Pisgah Forest, North Carolina
b) Authorized Representative of Employees
c) U.S. Department of Labor - Region IV
d) NIOSH - Region IV

For the purposes of informing the approximately 35-50 "affected employees" the employer shall "post" the Determination Report in a prominent place(s) near where exposed employees work for a period of 30 calendar days.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) authorizes the Secretary of Health, Education, and Welfare, following a written request by 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 National Institute for Occupational Safety and Health received such a request from an authorized representative of employees regarding exposure of workers to vapors of tetrahydrofuran and toluene.

The request alleged that the #1 and #2 coating operators were experiencing headaches, dizziness, stuffy noses and eye irritation. Also some employees have had a skin rash from liquid contact.

IV. HEALTH HAZARD EVALUATION

A. Plant Process - Conditions of Use

The process involves the application of a coating onto cellophane film to give the film desired final properties. The cellophane sheet passes through two covered baths containing the coating (a resin dissolved in tetra-hydrofuran and toluene) with the excess doctored from the sheet. The sheet is dried by passing up and then back down a tower where nearly all the solvent is evaporated. The air containing solvent vapor is transferred through ductwork to the Recovery House where the solvent is trapped on charcoal to remove it from the air stream. Normally solvent vapors tend to be removed from the room since the sheet entrance into the tower is located just above the dip tank. However, solvent may evaporate from the bath during operation, especially when the dip tank is "dropped" during a break to rethread the sheet. At such times the coating operators may be exposed to solvent vapor levels higher than normally occur in the coating area. Normally four No. 1 Operators, two No. 2 Operators, a Solvent Recovery Operator, Rewind Operator, and Batch Mix Operator work on each shift, and the operation is run continuously on a 24 hour basis.

The Number One Coating Operator is in charge of running the coating machine. When the coating machines are running smoothly, he has very little exposure to solvents. This operator is responsible for dropping the dip tank to rethread the machine and may be exposed to solvent vapors at that time.

He may also be exposed to the liquid if he doesn't utilize protective gloves. If there is no trouble with the rethreading, it may be done with the breath held. During periods of poor film quality, the exposure problem is compounded as all machines will usually be having the same type of problem. After several breaks on the same roll, it is removed for rewinding. Two to four breaks are usual per shift, but a bad run may involve up to 8 or 9 breaks per shift.

The Number 2 Operator is responsible for putting on new rolls and removing the coated rolls. Other duties include helping to thread the film through the tower after a break and cleaning the roller at the top of the tower when necessary. Isopropyl alcohol is used for various cleanup jobs primarily in the coating areas.

The Rewind Operator is the entrance job in this department. His job is to take rejected rolls of film and rewind them with more even tension. Since the rewinding is done in another area, this work affords very little solvent exposure. The Solvent Recovery Operator may be exposed when samples are obtained for quality control analysis and during cleanup. The majority of the time this operator spends in a control room which affords little continuous exposure to the solvents.

The Mix Operator prepares the coating liquid by mixing the resin and the solvents. Some of this work is performed around open tanks which affords solvent exposure.

B. Plant Medical Program

The plant is served by a medical department headed by an experienced physician. In addition to pre-employment examinations and specific hazard screening, periodic re-evaluation has been instituted. Impermeable gloves are supplied. Barrier cream is available through the Medical Department.

The OSHA log showed that the few industrial illnesses recorded in the past two years represented CS_2 exposure in another department. No significant trends in illness had been noted in this section of the plant.

C. Evaluation Design

It was decided that employee exposures to organic vapors should be determined by obtaining personal samples during a normal work shift. It was also decided to conduct medical interviews with all available workers from the Coating Tower Operation and to include the few workers from the Polymer Coating Operation who work in the Coating Towers from time to time.

D. Evaluation Methods

1. Organic vapor sampling

Employee exposures to tetrahydrofuran, toluene, and isopropyl alcohol were measured using personal air sampling equipment. The vapor concentrations were determined by adsorbing the organic vapors onto charcoal air sampling tubes and then analyzing the tubes by the gas chromatographic method of White et al.[1]

2. Medical interviews

Medical work histories were collected from workers by asking non-directed questions (i.e. had work with solvents caused any symptoms or illness) followed by directed questioning related to specific symptoms of exposure to toluene, tetrahydrofuran, and isopropyl alcohol.

E. Environmental Criteria

Environmental standards of substances investigated

Environmental standards intended to protect the health of workers have been required or recommended by several sources. These standards are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime. In this study the environmental criteria from three sources were considered:

a) Federal Standards - the standard enforced by the Department of Labor as described in the Federal Register, Vol. 37, Section 1910.93, June 27, 1974.

b) Threshold Limit Value (TLV) - developed by the TLV Committee of the American Conference of Governmental Industrial Hygienists.

c) Criteria for a recommended standard...Occupational Exposure to Toluene HSM 73-11023 USDHEW, Public Health Service, NIOSH, Rockville, Maryland, 1973.

The environmental exposure criteria selected for this study were the Federal Standards for isopropyl alcohol and tetrahydrofuran and the NIOSH Criteria Document recommendation for toluene:

Substance	8-hour time weighted average concentration - ppm*
Isopropyl alcohol	400
Tetrahydrofuran	200
Toluene	100

* Parts per million of vapor per million parts of contaminated air by volume.

F. Evaluation Results and Discussion

1. Environmental Results

The company conducts periodic monitoring of the coating area by making detector tube measurements. The results of these measurements were reviewed with a company representative; the maximum tetrahydrofuran measurement was 20 ppm while most of the toluene results were reported as zero with the maximum results expressed as an occasional trace. The source of tetrahydrofuran and toluene is primarily from the coating operation while the isopropyl alcohol exposure occurs during sporadic cleaning operations performed in the coating area. Twelve detector tube measurements were made by the NIOSH investigator in the coating area to determine toluene levels; all measurements were below the detectable level of 20 ppm with three exceptions. The three exceptions are discussed in the Medical Results portion of this report.

Tetrahydrofuran measurements could not be made simultaneously with toluene detector tube measurements since the manufacturer of the detector tube pumps used does not supply a detector tube specific for tetrahydrofuran. However, judging from charcoal tube sampling results, the concentration of tetrahydrofuran in ppm present simultaneously with the toluene could be three to ten times higher than the toluene concentration.

Personal sampling results are shown in Table I. If the relief operator is excluded, sampling periods ranged from 307 to 398 minutes. The relief operator worked only a short part of the shift, and his exposure was evaluated for 61 minutes. Operations during the day were judged to be normal with only a few episodic type exposures experienced by the Number 1 operators during sheet breaks.

Three compounds were measured by the charcoal tube-gas chromatographic technique: tetrahydrofuran, toluene, and isopropyl alcohol. No other substances were detected on any of the tubes analyzed. The results of the personal samples are lower than the established criteria for these substances. The levels of isopropyl alcohol are quite low compared to the measured levels of toluene and tetrahydrofuran in relation to the standards. An equivalent exposure for the combined exposure to all three substances was calculated by the method outlined in the Federal Register, Volume 37, Subpart G, §1910.93(d), June 27, 1974. The results of these computations are contained in Table I for all the charcoal tube measurements. If the NIOSH recommended standard for toluene of 100 ppm and the Federal Standards for isopropyl alcohol and tetrahydrofuran are used to calculate the equivalent exposure, the equivalent exposure ranges from 0.10 to 0.38.

An area sample was collected in the #2 Coating Operators' work area. The concentration of tetrahydrofuran was 18 ppm, toluene 2 ppm, and isopropyl alcohol 2 ppm for this sample. These levels are in the same concentration range as the personal charcoal tube sample results for the two #2 Coating Operators indicating their exposure is substantially from general workroom air. Half of the #1 Coating Operators' personal sample results are higher than the #2 Coating Operators' results and this result may be due to working nearer the sources of solvent vapors and being exposed to higher short term concentrations.

TABLE I

Results of personal samples first shift March 5, 1974

Area	Job	Length of sample (min)	Concentration - PPM			Equivalent Exposure
			Tetrahydrofuran	Toluene	Isopropyl Alcohol	
Coating	#1 Op-1	398	39	8	3	0.28
Coating	#1 Op-2	353	43	5	24	0.33
Coating	#1 Op-3	342	15	2	4	0.10
Coating	#1 Op-4	335	31	3	16	0.22
Coating	#1 Op-Relief	61	<11	<8	<13	0.16
Coating	#2 Op-1	375	21	3	6	0.14
Coating	#2 Op-2	311	18	2	5	0.12
Recovery	Rec. Op.	382	21	7	3	0.17
Mix	Mix Op.	307	46	14	3	0.38
Environmental Criteria			200	100	400	1.0

2. Medical Results

Medical evaluation consisted of individual interviews in which workers were asked if their work with the solvents caused any discomfort or illness (non-directed question) followed by questions regarding specific symptoms. Both toluene and tetrahydrofuran can cause irritation of mucous membranes (eyes, nose and throat) and have a narcotic action (cause headaches, nausea, fatigue, drowsiness, "drunkenness," and in the extreme, unconsciousness). These substances can also cause skin irritations, particularly the toluene and tetrahydrofuran. All three shifts working at the time of this evaluation were seen. The Coating Tower and the Polymer Coating Operation (PCG) were covered. Following the interviews, a conference was held with the plant doctor and then with labor and management prior to departure.

Table II gives a characterization of the workers seen by position, age, and years with the company. In all 30 workers were seen. Average age was 40 years and average length of employment was 14 years.

Table III presents the symptomatology as obtained in the interview. Symptoms as reported to the non-directed question are distinguished from symptoms obtained on total questioning. Total symptomatology was further divided into slight, moderate or severe on the basis of intensity and frequency and of surrounding circumstances. By necessity this is subjective. Past and present symptomatology are included, although the data is primarily historical as there was little current symptomatology at the time of this evaluation. Runability at the time of evaluation was considered average. The medical interviews indicated some workers become symptomatic during certain brief, intermittent exposures.

Symptoms suggesting high exposures may, reportedly, occur after a break on the coating machine or while the operator is cleaning the top roll of the coating machine. On the day of the study, during normal operations, one "toluene vapor detector tube" measurement, of short duration, indicated a concentration of 40 parts per million (ppm) of toluene in the breathing zone of coating machine operator, while the dip tank was dropped to rethread a machine. Two other detector tube measurements, taken near the top roll of a coating tower (where operators must routinely clean the rolls) indicated levels of 50 and 60 ppm of toluene vapor. These levels, for toluene alone, are below the concentration normally considered to cause irritation. However, this test is not capable of detecting or measuring the concurrent air concentration of the solvents, tetrahydrofuran and isopropyl alcohol. Other analytical tests indicate that considerably higher concentrations of these other two solvents (approximately 4 times as high) may be present for these short exposures. All of these solvents are known to be irritating at concentrations near their Threshold Limit Value and their physiologic effects are probably additive. Thus, the reported symptomatology, was probably due to these short term peak exposures, which were not observed or quantitated during this study.

Forty percent of the workers felt they had no problems on the non-directed question. The two major spontaneous complaints were Headaches (17%) and Rashes or Skin Irritation (13%). On total questioning only one worker had had no problems. 63% had had skin rashes or irritation, 60% had experienced dizziness or a feeling of "drunkenness," 50% had had headaches and 50% had had eye irritation. Most symptoms were slight and very few were severe.

Table IV presents symptomatology by job description. There is a noticable difference in the incidence of nasal irritation and/or sinus problems between the #1 Operators and the #2 Operators. This is 73% (11 out of 15) for #1 Operators compared to 0% (0 out of 8) for #2 Operators. (The likelihood of this result being due to chance alone is only 0.4% using the Chi Square Test). The higher incidence of "other problems" among the #1 Operators, Mix Operators and Solvent Recovery Workers as compared to the #2 Operators and Rewind workers might be expected from the difference in average age of the two groups.

There is a suggestion that the Batch Mix Operators may be getting more than their share of nausea, but the numbers are too small for any conclusion. The skin problems have been considerably helped by the introduction of impermeable gloves. Most men use the gloves because they have found them to help.

TABLE II

CHARACTERIZATION OF SAMPLE: (All White Male)

POSITION	NO.	AGE			TIME WITH COMPANY		
		AVER.	MEDIAN	RANGE	AVER.	MEDIAN	RANGE
#1 Operator (incl. 1 PCG)	15	45.8	45	29-59	19.2 yr	23 yr	10-23 yr
#2 Operator (incl. 2 PCG)	8	25.5	23.5	18-39	34.3 mon	10 mon	3 mon-16 yr.
Rewind	2	24	24	20-28	3 mon	3 mon	3 mon
Batch Mix Operator	3	56	54	53-61	22.7 yr	23 yr	22-23 yr
Solvent Recovery	2	50.5	50.5	49-52	23 yr	23 yr	23 yr
TOTAL	30	40.3	41.5	18-61	14.1	17	3 mon-23 yrs.

TABLE III

HISTORY OF SYMPTOMATOLOGY (PAST AND PRESENT) (TOTAL INDIVIDUALS - 30)

Symptoms	As given to non-directed question		As found on total questioning		Severity		
	Total	% Showing Symptom	Total	% Showing Sympton	Slight	Moderate	Severe
Rash or skin irritation	4	13	19	63	15	3	1
Dizziness or "drunkenness"	2	7	18	60	13	5	0
Headaches	5	17	15	50	10	4	1
Eye Irritation	2	7	15	50	8	5	2
Nasal irritation, stuffiness; loss of smell or taste	2	7	11	37	5	4	2
Nausea and/or vomiting	1	3	9	30	6	3	0
Sleepiness (on graveyard shift)	0	0	8	27			
Sinus Problems	0	0	6	20			
Other Problems	7	23	12	40			
No Problems	12	40	1	3			

Note: The severity breakdown is subjective, based on intensity and frequency of symptom and surrounding circumstances.

The non-directed question asked if the worker had any discomfort or illness he thought might be due to his work with solvents.

TABLE IV

SYMPTOMATOLOGY VS. JOB DESCRIPTION

Symptoms	#1 Op.		#2 Op.		Mix		Solvent		Rewind	
	No.	%	No.	%	No.	%	No.	%	No.	%
Rash or skin irritation	10	67	6	75	1	33	1	50	1	50
Dizziness or "drunkenness"	10	67	3	38	3	100	2	100	0	0
Headaches	9	60	3	38	1	33	1	50	1	50
Eye Irritation	10	67	4	50	0	0	1	50	0	0
Nose irritation, etc.	9	60	0	0	1	33	1	50	0	0
Nausea/vomiting	5	33	2	25	2	67	0	0	0	0
Sleepiness	6	40	2	25	0	0	0	0	0	0
Sinus problems	4	27	0	0	0	0	2	100	0	0
Other problems	6	40	2	25	3	100	1	50	0	0
No problems	0	0	0	0	0	0	0	0	1	50

V. RECOMMENDATIONS

1. Since most symptoms of solvent vapor exposure occur due to work around the dip tank during breaks, it is recommended that engineering controls such as local ventilation be installed to control this exposure.

2. Suitable respiratory protection should be worn by workers when cleaning rolls at the top of the coating towers. An organic cartridge respirator approved by NIOSH would be sufficient for this purpose.

VI. REFERENCES

1. White, W.D., Taylor, D.B., Mauer, P.A. and R.E. Kupel, A Convenient Optimized Method for the Analysis of Selected Solvent Vapors in the Industrial Atmosphere, Am. Ind. Hyg. Assoc. J., Vol. 31, March-April 1970.

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