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MORTALITY STUDIES OF EMPLOYEES EXPOSED TO VINYL CHLORIDE

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38 46 - FOLLOWUP

INTRODUCTION

This report examines the mortality experience of workers occupationally exposed to vinyl chloride at two locations of the Company. One location is designated Unit A, and the other Unit B. Because of considerable differences in the exposure levels between the two units, the results of the two studies should not be considered as directly additive. The objectives of the studies were twofold. The first objective was to review the to-date mortality experience of employees in the populations of concern. The second, more long-range objective, was to establish two cohorts of employees who were exposed to vinyl chloride so that subsequent followup would be simplified. This report does not include a medical interpretation of the significance of the findings, but does include a description of the statistical methodology.

Pursuant
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STUDY OF UNIT A

METHODOLOGY

Selection of the Population

Company
6093 S(H)
Western District of New York

The exposed population included all employees of the Saran V₁V₂ Department with the exception of salaried women personnel. The interval covered by the study was from 1949, when production first began, through 1963. January personnel lists for each of the years were examined to identify inscope employees. Through this mechanism, a total of 167 men were identified.

Because the procedure for identifying employees in the exposed population used only January lists, a few individuals with less than one year of exposure might not be included in the study. However, virtually all employees with several years of exposure would have been identified. No mortality followup of released employees other than retirees was undertaken.

Recent industrial hygiene data (1972) have indicated that T.W.A. exposure levels to vinyl chloride for all jobs within the V₁V₂ area are well below 50 ppm. The exposure

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patterns were characterized as involving very low background levels with occasional short term excursions to higher levels (e.g., over 500 ppm). A number of other chlorinated hydrocarbons were present in the plant atmosphere, including ethylene dichloride. Discussions with personnel familiar with past operations did not indicate that prior exposure levels differed greatly from recent levels. It was felt that lab assistants who collected samples from the production streams might have experienced the highest vinyl chloride exposures. Some high exposures to ethylene dichloride may have been experienced in the past years.

In the analyses, exposure was quantified only in terms of years on the job within the department. No attempt was made to distinguish between different job classifications within the department.

The employment and vital status of the exposed population as of January, 1973 was as follows:

<u>Employment and Vital Status Group</u>	<u>Total Group</u>	<u>< 1 Yr. Exposure</u>	<u>1-6 Years Exposure</u>	<u>6+ Years Exposure</u>
Total Group	167	17	72	78
Still Working For Company	74	4	17	53
Retired	10	0	5	5
Transferred	7	0	2	5
Releases Other Than Retirees	66	11	44	11
Deceased	10			4

Material Produced Pursuant
Case No. 90-4837
The Dow Chemical Company
Case No. 94-CV-0393 S(H)
Western District of New York

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Sources of Mortality Data and Comparison Population

The mortality analysis is based on copies of death certificates received by the Company Group Insurance Department as proof of death. A cohort of 4,100 hourly employees of the location followed between 1954 and 1973 served as a control population.

Mortality rates by age group and year of death were multiplied by the appropriate years at risk in the exposure group to provide the expected number of deaths. Since

the Company mortality rates for total malignant neoplasms closely paralleled the corresponding area white male mortality rates, these rates were used in computing the expected number of deaths due to malignant neoplasms.

RESULTS

The observed and expected deaths by duration of exposure and interval since initial exposure are shown in Table 1. The frequencies are too small for statistical tests of significance to be meaningful.

A brief summary of the exposure history for each decedent is shown below.

<u>Cause of Death</u>	<u>Department Work History</u>
1) Cancer of lip with metastases to lung and neck. Died 9/66.	Janitor 8/62-9/66 4
2) Alveolar Cell Carcinoma. Died 11/71.	Operator 4/56-9/59 Lab Assistant 9/59-5/67. 15 -
3) Carcinoma Brain and Lungs. Died 12/58.	Operator & Shift Foreman. 9 - 10/49-12/58
4) Malignant Mediastinal Tumor Unclassified With Generalized Metastases. Died 1/63.	Operator 1/62-1/63 1
5) Ischemic Heart Disease. Died 6/71.	R&D Engineer 9/48-10/49
6) Abscess Left Frontal Lobe. Died 3/58.	Welder 5/52-2/53
7) Acute Myocardial Infarction. Died 2/65.	Operator 9/51-2/65
8) Accidental Drowning. Died 5/61.	Operator 3/52-5/61
9) Auto Accident. Died 7/58.	Clerk 10/50-3/51
10) Unknown. Died 9/50.	Clerk 9/48-9/50

Produced Pursuant

Case No. 90-4837

Western Chemical Company
Case No. 94-CV-0393 S(H)
Western District of New York

STUDY OF UNIT B

METHODOLOGY

Selection of the Population

With the assistance of Industrial Hygiene, a number of job classifications within several departments were identified as appropriate for study. These jobs were chosen because they involved more than minimal exposure to vinyl chloride. We attempted to select jobs with T.W.A. concentrations of at least 50 ppm. In a number of instances, where measurement data were not available, decisions were made subjectively. Concurrent exposure to vinyl and vinylidene chloride did not rule out a job classification. However, if the exposure primarily involved vinylidene chloride, the job was not included. The list of selected jobs is shown in Table 2.

In the analysis, exposure was quantified only in terms of years on the job prior to 1960. No attempt was made to estimate individual dosage levels from the industrial hygiene data which were available.

One hundred eighty-seven men were identified who were assigned to at least one of the job classifications listed in Table 2. These men were traced by reviewing personnel lists over the period January 1942 to January 1955. The status of the exposed population as of November 1972 was as follows.

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	<u>< 1 Yr. Exposure</u>	<u>1-6 Yrs. Exposure</u>	<u>6+ Yrs. Exposure</u>
Still working for company	16	50	39
Retired	5	6	14
Releases other than retirees	23	13	2
Deceased	3	6	10

Produced Pursuant

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Arco v. Conoco, Inc., Case No. 90-4837
Calcasieu Parish, LA
Smith v. The Dow Chemical Company
Case No. 94-CV-0393 S(H)
Western District of New York

Because the procedure for identifying employees in the exposed population used only January lists, a number of individuals with less than one year of exposure might not be included in the study. However, virtually all employees with several years of exposure would have been identified. No mortality followup of released employees other than retirees was undertaken.

Source of Mortality Data

The mortality analysis is based on copies of death certificates received by the Company Group Insurance Department as proof of death. A cohort of 6500 Dow hourly workers, followed between 1954 and 1969, has served as a control population for our mortality studies. Mortality rates by age and cause of death observed for this cohort of employees, when multiplied by the years at risk in the exposure group, provide the number of expected deaths in the exposed population. The cohort does represent a cross-section of Dow hourly employees. However, it should be recognized that employees in a particular exposed population may be subject to selection biases which are not present in the control population. Thus, significant differences between exposed individuals and controls cannot be automatically attributed to the exposure.

RESULTS

The observed and expected deaths by duration of exposure and interval since initial exposure are shown in Tables 3 and 4. Table 3 relates to total deaths and Table 4 relates to deaths due to malignant neoplasms. Cohort 1 refers to employees who first worked in the exposure area prior to 1950. Cohort 2 refers to those employees who first worked in the area between 1950 and 1955. Overall, the following results were obtained.

Cause of Death	Observed	Expected
All Causes	19	18.5
All Malignant Neoplasms	8	4.4
Respiratory Malignancies	1	1.7

Produced Pursuant
to Protective Order
in Case No. 94-CV-00483
Subscribed by The Dow Chemical Company
Case No. 94-CV-0393 S(H)
Western District of New York

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Almost a twofold difference was found between observed and expected deaths due to malignant neoplasms. This difference was not, however, significant at the .05 level.

If there were a relationship between malignant neoplasms and exposure to vinyl chloride, the peak risk for employees in the higher exposure groups would likely extend from 15 to 40 years after initial exposure.

Five malignancies were observed during this period, as opposed to an expected number of 2.3. Again, while the mortality ratio was 2.2, the probability of observing these results under the hypothesis of no difference is approximately .08.

A brief summary of the exposure history for the eight individuals who died from malignancies is shown below.

<u>Cause of Death</u>	<u>Work History</u>	<u>Smoking History</u>
(1) Widespread metastatic carcinoma - Age 54, 25 years after first VC1 exposure	Saran Polymer 27 years; 3 yrs. exposure to >50 ppm VC1	Had formerly smoked 40 cigarettes per day for 36 years
(2) Adeno carcinoma of colon, carcinomatosis - Age 56, 25 years after first VC1 exposure	Saran Polymer 26 years; Carbon tetrachloride 8 years; 7 yrs. exposure to >50 ppm VC1	Unknown
(3) Squamous cell carcinoma primary site undetermined; generalized metastases undifferentiated - Age 61, 28 years after first VC1 exposure	Saran Polymer 24 years; 9 yrs. exposure to >50 ppm VC1	Unknown
(4) Carcinoma of lung - Age 54, 17 years after first VC1 exposure	Saran Polymer 17 years; Cal Mag 2 years; 3 yrs. exposure to >50 ppm VC1	Unknown
(5) Leukemia, acute granulocytic - Age 45, 20 years after first VC1 exposure	Saran Polymer 10 years; Ethylbenzene 10 years; Brom Indigo 2 years; 7 yrs. exposure to >50 ppm VC1	1 cigar/day for 20 years

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Industrial Chemical Company
Case No. 94-CV-0393 S(H)
Western District of New York

<u>Cause of Death</u>	<u>Work History</u>	<u>Smoking History</u>
(6) Carcinoma stomach meta-static to vertebrae, retroperitoneal lymph nodes and lungs - Age 54, 12 years after first VC1 exposure	Saran Polymer 13 years; Wrought Prod. 3 years; Electro-Chem 1-1/2 years; 1 year exposure to > 50 ppm VC1	Unknown
(7) Carcinoma prostate with metastases - Age 60, 11 years after first VC1 exposure	Vinyl Chloride Monomer 7 years; Tetrachloroethylene 11 years; Anhydrous HCl 4 years; 7 years exposure to > 50 ppm VC1	Unknown
(8) Carcinoma of brain - Age 61, 4 years after first VC1 exposure	Saran V ₁ V ₂ 4 years; Wells 4 years; Graphite 1-1/2 years; Ethylene Dichloride 1 year; Acetanilide 1 year; Lt. Stabilizer 2 years; 2 years exposure to > 50 ppm VC1	Unknown Dow Chemical Confidential Material Produced Pursuant to Protective Order Re: <u>Smith v. The Dow Chemical Company</u> , Case No. 93-4837 Eastern District of Louisiana Case No. 94-CV-0383 S(H) Western District of New York

SUMMARY

These studies found no significant statistical differences ($P < .05$) between the mortality experience of employees exposed to vinyl chloride and the corresponding control populations of Dow employees. However, in dealing with small numbers, only large relative differences can be detected statistically. There is no comfort in the approximate twofold increase in malignancies, even though it could well be a chance occurrence.

Two future courses of action could be recommended. First of all, updating these studies on a yearly basis would be a relatively simple undertaking. Secondly, combining these results with the findings of other companies could prove invaluable in two ways: the size of the study could be increased, and, selection biases could be better controlled in a multi-company study.

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Table 1. Observed and Expected Deaths by Duration of Exposure and Years since First Exposure - All Causes and Total Malignant Neoplasms

PLANT "A"

Duration of Exposure In Years	Interval Since First Exposure	Number of Deaths All Causes	
		Observed	Expected
Total Group	<15 Years	8	4.8
	15+ Years	2	4.7
1 Year	<15 Years	2	.3
	15+ Years	0	.1
1-6 Years	<15 Years	3	2.1
	15+ Years	1	1.4
6+ Years	<15 Years	3	2.4
	15+ Years	1	3.2

Duration of Exposure In Years	Interval Since First Exposure	Number of Deaths Malignant Neoplasms	
		Observed	Expected
Total Group	<15 Years	3	1.1
	15+ Years	1	1.1
1 Year	<15 Years	0	.1
	15+ Years	0	.0
1-6 Years	<15 Years	2	.5
	15+ Years	0	.4
6+ Years	<15 Years	1	.5
	15+ Years	1	.7

4-2.2

R&S 008973

Dow Chemical Confidential Material Produced Pursuant
To Protective Order
Ross v. Genaco, Inc., Case No. 90-4837
Calcasieu Parish, LA
Smith v. The Dow Chemical Company
Case No. 94-CV-0393 S(H)
Western District of New York

Table 2. Departments and Job Classifications To Be Included In Study.

Saran Poly Semi Plant

Foreman	1947 - 1955
Polymer Operator (or equivalent)	1946 - 1955
Asst. Polymer Operator (or equivalent)	1946 - 1955
Wheel Filter Operator (or equivalent)	1946 - 1955

Saran Polymer Department (Or Equivalent)

Foreman, Shift Foreman, Subforeman*	1941 - 1950
Polymer Operator (or equivalent)	1941 - 1955
Drier Operator (or equivalent)	1941 - 1955
Assistant Operator	1944 - 1955
Tank Car Unloader (or equivalent)	1951 - 1955
Asst. Polymer Operator	1952 - 1955
Asst. Drier Operator	1952 - 1955
Plant Mechanic	1941 - 1955

Vinyl Chloride Department

Foreman	1946 - 1954
Vinyl Chloride Operator	1946 - 1954

Produced Pursuant to Court Order in Case No. 90-4837
The Dow Chemical Company
Case No. 94-CV-0393 S(H)
Western District of New York

Saran VLV2 Plant**

Shift Foreman	1952 - 1955
Polymer Operator	1952 - 1955
Coagulator Tank Wheel Operator (or Equiv.)	1952 - 1955
Drier Operator	1952 - 1955

*After 1950, personnel lists for Saran Polymer and Saran Color and Blending were combined. Thus, it was not possible to distinguish which operations the foremen were connected with. The assumption was made that foremen who were known to supervise the polymerization operations prior to 1950 continued in that section after 1950.

**To the extent that employees in Saran VLV2 had previously worked in Soluble Saran, this exposure experience will be considered additive. However, men who worked only in Soluble Saran would not be included in the study.

Table 3. Observed and Expected Deaths By Duration of Exposure,
Years Since First Exposure, and Cohort--All Causes.

PLANT-B

Duration of Exposure In Years	Interval Since First Exposure	Number of Deaths--All Causes			
		Cohort 1		Cohort 2	
		Observed	Expected	Observed	Expected
<1 Year	<15 Years	1	1.0	2	.5
	15 - 24 Yrs.	-	1.3	--	.1
	25 - 32 Yrs.	-	.2	--	--
	Total	1	2.5	2	.6
1 - 6 Yrs.	<15 Years	--	1.1	2	2.6
	15 - 24 Yrs.	1	.9	2	1.9
	25 - 32 Yrs.	1	.2	--	--
	Total	2	2.2	4	4.5
6+ Yrs.	<15 Years	1	1.2	1	1.7
	15 - 24 Yrs.	1	3.1	4	1.8
	25 - 32 Yrs.	3	.9	--	--
	Total	5	5.2	5	3.5

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NY 60-4837

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Duration of Exposure In Years	Interval Since First Exposure	Number of Deaths--All Causes	
		Both Cohorts	
		Observed	Expected
<1 Year	<15 Years	3	1.5
	15+ Years	0	1.6
1 - 6 Years	<15 Years	2	3.7
	15+ Years	4	3.0
6+ Years	<15 Years	2	2.9
	15+ Years	8	5.8

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Table 4. Observed and Expected Deaths By Duration of Exposure,
Years Since First Exposure, and Cohort--Malignant Neoplasms.

Duration of Exposure In Years	Interval Since First Exposure	Number of Deaths Due To Malignant Neoplasms			
		Cohort 1		Cohort 2	
		Observed	Expected	Observed	Expected
<1 Year	<15 Years	0	.2	0	.1
	15 - 24 Years	0	.3	0	.0
	25 - 32 Years	0	.1		
	Total	0	.5	0	.1
1 - 6 Years	<15 Years	0	.2	2	.5
	15 - 24 Years	1	.2	0	.5
	25 - 32 Years	1	.1		
	Total	2	.5	2	1.0
6+ Years	<15 Years	1	.3	0	.4
	15 - 24 Years	0	.8	1	.5
	25 - 32 Years	2	.2		
	Total	3	1.3	1	.9

Duration of Exposure In Years	Interval Since First Exposure	Number of Deaths Due To Malignant Neoplasms Both Cohorts	
		Observed	Expected
<1 Year	<15 Yrs.	0	.3
	15+ Yrs.	0	.3
1 - 6 Years	<15 Yrs.	2	.7
	15+ Yrs.	2	.8
6+ Years	< 15 Yrs.	1	.7
	15+ Yrs.	3	1.5

Low Chemical Confidential Material Produced Pursuant
To Protective Order
Hess v. Case No. Inc. Case No. 90-4837
Culicau Parish, LA
Smith v. The Low Chemical Company
Case No. 94-CV-0393 S(H)
Western District of New York

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