

**UNION
CARBIDE**

**INTERNAL
CORRESPONDENCE**

UNION CARBIDE CORPORATION 270 PARK AVENUE, NEW YORK, NY 10017

To (Name)	Dr. D. H. Glenn	Date	September 11, 1981
Division	P. O. Box 471	Originating Dept.	HS & EA - Toxicology
Location	Texas City, Texas	Area	4th Floor
Area		Subject	

Enclosed is a rough draft of the Texas City Brain Tumor Case Control Study. This has been sent to our reviewers, Drs. Enterline and MacMahon today, Friday, September 11, 1981 and I expect to receive their comments the early part of next week. I would also appreciate your review of this paper with specific attention to the statements that are made regarding practices at the Texas City plant and creation of the chemical exposure - departmental dictionary.

I look forward to talking with you next week.

Very truly yours,

Susan G. Austin

Susan G. Austin, Sc.D.
Corporate Epidemiologist

SGA:lm
Enclosure

UCC 096816

THE RELATIONSHIP BETWEEN OCCUPATIONAL FACTORS

AND BRAIN TUMORS

DRAFT

INTRODUCTION

In mid 1978 a cluster of brain tumor cases (deaths) was identified among former employees of The Union Carbide Corporation (UCC) chemical plant in Texas City, Texas. As a result of a formal employee request to The Occupational Safety and Health Administration (OSHA), the National Institute of Occupational Safety and Health (NIOSH) and UCC initiated a two-pronged investigation to determine ^{*if this cluster was occupationally related.*} ~~the occupational relatedness of this cluster.~~ The first prong of the investigation was a retrospective cohort mortality study of all employees who ever worked at the Texas City Plant and a comparison of their overall mortality experience since 1941 with the mortality experience of the United States. The second prong of the NIOSH investigation was a case-control study to identify any exposure or work areas that were shared in common by the brain tumor cases.

In addition to assisting NIOSH in the data collection requirements for their studies, UCC also initiated studies independently of NIOSH. The purpose of this report is to describe the results of an independent UCC sponsored case

UCC 096817

DRAFT

control study.

PURPOSE

The purpose of this study was to identify any occupational factors that could serve to distinguish the brain tumor cases from a randomly selected sample of all former UCC employees. Specifically, the study was intended to assess the likelihood that exposures to known or suspect carcinogens at the UCC Texas City plant could have been related to the occurrence of the brain tumors among the population of employees who ever worked at the plant.

A second purpose of the study was to attempt to replicate the results of the NIOSH case control study using an independently selected comparison population. This was considered an appropriate objective, since the validity of these studies often depends on the adequacy with which the comparison populations selected for study represent the underlying population from which the cases were drawn. Since both the UCC and NIOSH studies selected a random sample of the aggregate UCC Texas City employee population (approximately 9,000 individuals) to serve as "controls", both studies are subject to some degree of sampling error which could lead to spurious results. The chances that both studies will obtain the same spurious results are rather small;

UCC 096818

DRAFT

therefore the results of the two analyses, taken together, should provide some assurance that a "real" association between some chemical and the brain tumor cases will not be missed.

METHODS

The methods used in this study involved comparisons between the number - or proportion - of brain tumor cases exposed to a particular chemical during employment at Texas City, with the number - or proportion - of non-brain tumor "controls" exposed to the same chemical during employment at Texas City.

Carcinogens

The five known or suspected carcinogens that were studied in this investigation include benzene, ethylene dichloride, ethylene oxide, diethyl sulfate and vinyl chloride. Although ethylene dichloride was a suspect carcinogen at the time this study was initiated, additional long term animal studies have been completed which have resulted in removal of this chemical from the suspect carcinogen list.¹ For this study, however, results for ethylene dichloride will be presented together with the other four suspect human carcinogens.

DRAFT

Other Chemicals

For the purpose of replicating the results of the NIOSH case control study, the same thirty (30) chemicals under investigation in that study were also included for study in this investigation. (Figure 1) These chemicals were selected by NIOSH because at least four brain tumor cases were found to have had the potential for exposure to the chemicals at some time during their employment at UCC Texas City.

Description of Cases

For the purpose of this study, a case was defined as any former UCC Texas City employee known to have had a primary brain tumor on the basis of autopsy information, pathology reports, clinical evidence in medical records or death certificates. This definition of a "case" includes both malignant, benign and unspecified (malignancy) tumors.

Case validation was performed by NIOSH and resulted in the identification of twenty-one (21) cases shown in Table 1. This table indicates the most accurate diagnosis available in this investigation as determined by NIOSH. The "source of confirmation" indicates the most valid source of information used in determining the specific diagnosis of the primary tumor. A code of "1"

UCC 096820

Figur 1

LISTING OF 30 CHEMICALS TO WHICH FOUR
BRAIN TUMOR CASES WERE EXPOSED AT UCC
TEXAS CITY

Ethylene	Methyl ethyl ketone
Acetaldehyde	Methyl isobutyl ketone
Acetic acid	Monoethanolamine
Acetone	Propylene
Butadiene	Sodium carbonate
CO ₂	Sodium hydroxide
Diethanolamine	Styrene
Ethane	Sulphuric acid
Ethanol	Toluene
Ethylene glycol	Vinyl acetate
Hydrochloric acid	Tergitols
Isopropanol	Mesityl oxide
Isopropyl acetate	Chlorine
Methane	Trichloroethane
Methanol	Sodium sulphite

UCC 096821

DRAFT

indicates that a tissue specimen, either from autopsy, biopsy, or surgery, was available and sent to pathologists at the Armed Forces Institute of Pathology (AFIP) for independent confirmation. Codes "2" and "3" indicate that no tissue specimens were available, but original copies of the pathology report from autopsy or surgery were available to NIOSH. A code of "4" indicates that no pathology report was available (either no surgery was performed or records had been destroyed), and the diagnosis listed represents that found in the hospital record. A code of "5" indicates that the death certificate diagnosis was the sole source of information regarding the presence and type of brain tumor. For the purpose of this analysis, codes "1", "2" and "3" were considered by UCC as confirmed and codes "4" and "5" were considered unconfirmed.

In all, this case series consisted of 21 cases: 17 classifiable as gliomas - or tumors arising from the glial cells, and 4 classifiable as meningiomas - or tumors arising from the cerebral lining (meninges). (Of the four meningiomas, three were benign tumors and one was malignant.) Of the seventeen (17) gliomas, thirteen were confirmed by available autopsy or pathology reports.

DRAFT

Selection of Controls

For purposes of comparison with Cases, two series of control groups were selected from all former UCC Texas City employees whose deaths were known to the company. Decedents were used as controls for two reasons: 1) their causes of death were known and could be verified as non-brain tumor cases; and 2) all twenty-one (21) cases were also deceased.

The two control groups differed in that Control Group I excluded employees whose cause of death was attributable to any malignant neoplasm. Both control groups consisted of eighty (80) male employees randomly selected from 450 decedents known to the company in June of 1979.

Exposure Determination

Exposure determinations were made on the basis of official employment records available at the Texas City plant. These records contained detailed job titles and plant departmental assignments for each employee from date of hire to date of termination at UCC Texas City. For each unique departmental code symbol, principal chemicals used or produced at any time in the history of the plant were identified and "linked" with that department (by UCC industrial hygienists). It was not possible to specify these associations by year.

UCC 096824

DRAFT

An employee was considered "exposed" to a given chemical if he ever worked in a department linked with that chemical. An employee was considered "unexposed" if he never worked in a department linked with that chemical. The "unknown" exposure designation was reserved for employees who were never known to have been exposed to a given chemical but who had worked in a department (e.g. maintenance) for which no specific chemicals could be listed.

ANALYSES

The proportion of cases exposed to a particular chemical was compared with the proportion of controls exposed to the same chemical. For this comparison, employees whose exposure was "unknown" were excluded from analysis for both cases and controls.*

*Is this true?
or just a hypothesis?*

Because it is expected that a chemical carcinogen possibly capable of inducing brain tumors would be associated primarily with glial cell tumors, the proportion of glioma cases exposed to specific chemicals was also calculated for comparison.

In addition to overall analyses in which the comparison was between proportions of cases and controls ever exposed to specific chemicals at any time during their employment with UCC Texas City, a separate analysis was

*This will
cause questions!*

*Analyses were also performed where (1) "unknowns" were considered "exposed" and (2) "unknowns" were considered "unexposed". The results of these analyses are not reported in the paper.

UCC 096825

performed in which the latent period of chemical carcinogenesis was taken into consideration. In this analysis, comparisons between cases and controls were restricted to employees whose first exposure to a particular chemical occurred a minimum of fifteen years prior to death.

Because the nature of this study was primarily descriptive, no tests of statistical significance were performed routinely. When tests were used, the Mantel Haenszel Chi statistic² was calculated to determine whether the observed difference between two proportions could have been due to "chance" or random fluctuation if there were really no difference present in the underlying population.

RESULTS

Demographic and Occupational Characteristics

The controls used in this study were selected for the purpose of representing the underlying population of males ever employed at Texas City. For this reason the controls were not matched to the cases on any demographic or occupational characteristics. Because the population from which the controls were selected were decedents whose deaths were known to company management, they likely underrepresent employees with brief periods of

DRAFT

employment*.

A comparison of selected characteristics of cases and controls is shown in Table 2. Cases resembled controls quite closely on the characteristics year of hire, payroll status and race.

A higher proportion of cases worked for less than 10 years than controls and terminated for reasons other than death, disability or retirement (voluntary quit, layoff, etc.). Cases were also found to be generally younger at hire than the controls. It is possible that these two factors are inter-related, i.e. employees with brief periods of employment who terminate for reasons other than death or disability may be younger at hire than employees with longer periods of employment.

Age at death was younger for cases than controls, reflecting the fact that the peak incidence of brain tumors is in the fifth and sixth decade of life. Fewer cases died before 1960 than controls and a greater proportion survived a minimum latent period of fifteen (15) years following hire at the Texas City Plant.

* Company identified deaths were known through the corporate employee benefits department and through locally published obituary notices routinely screened by the plant medical department.

Table 2

COMPARISON OF CASES AND CONTROLS
FOR SELECTED CHARACTERISTICS

CHARACTERISTIC	CASES		CONTROL I		CONTROL II	
	NO.	%	NO.	%	NO.	%
<u>Termination Reason</u>						
Death	10	47.6	38	47.5	36	45.0
Disability	2	9.5	16	20.0	21	26.3
Retirement	3	14.3	19	23.8	14	17.5
Other	6	28.6	7	8.8	9	11.3
<u>Yrs. Service</u>						
< 10	7	33.3	13	16.2	12	15.0
11-20	5	23.8	38	47.5	35	43.8
> 21	9	42.8	29	36.2	33	41.2
<u>Yr. Of Hire</u>						
1940-1945	8	38.1	30	37.5	34	42.5
1946-1950	8	38.1	31	38.8	29	36.2
1951-1955	5	23.8	13	16.2	13	16.2
1956-	0	0.0	6	7.5	4	5.0
<u>Age At Hire</u>						
< 25 Yrs.	5	23.8	14	17.5	11	13.8
25-34 Yrs.	10	47.6	27	33.8	30	37.5
35 Yrs.	6	28.6	39	48.8	39	48.8
<u>Payroll Type Status</u>						
Ever Hourly	21	100.0	72	90.0	74	92.2
Never Hourly	0	0.0	8	10.0	7	8.8
<u>Race</u>						
White	18	85.7	63	78.8	66	82.5
Other	3	14.3	17	21.3	14	17.5
<u>Age At Death</u>						
< 50 Yrs.	4	19.0	24	30.0	18	22.5
50-69 Yrs.	16	76.2	46	57.5	52	65.0
70+ Yrs.	1	4.8	10	12.5	10	12.5
<u>Yr. Of Death</u>						
1950-1959	1	4.8	7	8.8	12	15.0
1960-1969	6	28.6	28	35.0	17	21.2
1970+	14	66.7	45	56.2	51	63.8
<u>Latency</u>						
< 15 Yrs.	2	9.5	20	25.0	18	22.5
> 15 Yrs.	19	90.5	60	75.0	62	77.5
<u>Cause of Death</u>						
Neoplasma	21	100.0	18	22.5	0	0.0
Circulatory Diseases	0	0.0	36	45.0	52	65.0
Accidents	0	0.0	10	12.5	13	16.3
Other	0	0.0	16	20.0	15	18.7
TOTAL	21	100.0	80	100.0	80	100.0

DRAFT

This finding is likely attributable to the higher proportion of causes of deaths among controls for which the median age at death is lower.

With the possible exception of the differences related to age at hire all discrepancies between cases and controls appear to be attributable to differences in cause of death between Cases and Controls or to the higher proportion of cases terminating for reasons other than death, disability or retirement.

These differences do not appear to be large enough or of sufficient significance to affect the comparability of exposure histories of cases and controls if a minimum latent period is taken into consideration.

Exposure Characteristics

Table 3 indicates overall exposure determinations for cases and controls for each of the five suspect human carcinogens, benzene, diethyl sulfate, ethylene dichloride, ethylene oxide and vinyl chloride. It can be seen from this table that exposure determinations could not be made for 47 to 57 percent of the cases and for 55 to 70 percent of the controls in each group. As a result, the number of cases and controls that could be used in the analysis were greatly reduced. This was due to the high proportion of UCC Texas City employees who are assigned to maintenance departments where plantwide travel

Exposure Status Of Cases And Controls For Five Chemicals
Used Or Products At The Texas City Plant (1941-1977)

CHEMICAL	CASES			CONTROL I			CONTROL II		
	Exposed N (%)	Unexposed N (%)	Unknown N (%)	Exposed N (%)	Unexposed N (%)	Unknown N (%)	Exposed N (%)	Unexposed N (%)	Unknown N (%)
BENZENE	1 (4.8)	8 (38.1)	12 (57.1)	12 (15.0)	19 (23.7)	49 (61.2)	5 (6.2)	19 (23.7)	56 (70.0)
DIETHYL SULFATE	4 (19.0)	6 (28.6)	11 (52.4)	17 (21.2)	21 (26.2)	52 (65.0)	12 (15.0)	20 (25.0)	48 (60.0)
ETHYLENE DICHLORIDE	4 (19.0)	6 (28.6)	11 (52.4)	14 (17.5)	22 (27.5)	44 (55.0)	14 (17.5)	17 (21.2)	49 (61.2)
ETHYLENE OXIDE	2 (9.5)	7 (33.3)	12 (57.1)	9 (11.2)	25 (31.2)	46 (57.5)	11 (13.7)	20 (25.0)	49 (61.2)
VINYL CHLORIDE	4 (19.0)	7 (33.3)	10 (47.6)	12 (15.0)	22 (27.5)	46 (57.5)	13 (16.2)	18 (22.5)	49 (61.2)

UCC 096830

makes exposure to all chemicals theoretically possible but technically unknown. In all subsequent tables, the "percentage exposed" is based on only those employees whose exposure status could be determined, and excludes those whose exposure status was unknown.

Table 4A compares exposures between cases and controls for each of the five suspect carcinogens. It can be seen that the proportion of cases exposed differs only slightly between all cases and all glioma cases. In addition the proportion of cases exposed is generally lower than or consistent with that for either Control Groups for each of these chemicals.

Because the results of these analysis may be diluted due to the inclusion of salaried employees (who are at a lower risk of exposure to chemicals) in the control groups, analyses are shown on Table 4B using only hourly controls. Again, there is little difference between the proportions of cases and the proportions of controls exposed to these chemicals.

A more meaningful analysis is one which allows for some minimum latent period between initial exposure to a given chemical substance and the onset of disease or death. Tables 5A and 5B show the comparison of exposure frequencies among cases and controls for only those persons who were employed

Table 4A

Proportions of Cases and Controls Exposed
to Five Chemicals at UCC Texas City

CHEMICAL	ALL CASES		GLIOMAS		CONTROL I		CONTROL II	
	Total	Percent Exposed	Total	Percent Exposed	Total	Percent Exposed	Total	Percent Exposed
BENZENE	9	11.1	8	12.5	31	38.7	24	20.8
DIETHYL-SULFATE	10	40.0	9	33.3	38	44.7	32	37.5
ETHYLENE DICHLORIDE	10	40.0	9	44.4	36	38.9	31	45.2
ETHYLENE OXIDE	9	22.2	8	25.0	34	26.5	31	35.5
VINYL CHLORIDE	11	36.4	10	40.0	34	35.3	31	41.9

Table 4B

Proportions of Cases and Hourly Controls
Exposed to Five Chemicals at UCC Texas City

CHEMICAL	ALL CASES		GLIOMAS		CONTROL I		CONTROL II	
	Total	Percent Exposed	Total	Percent Exposed	Total	Percent Exposed	Total	Percent Exposed
BENZENE	9	11.1	8	12.5	26	42.3	22	18.2
DIETHYL-SUFLATE	10	40.0	9	33.3	32	46.9	30	36.7
ETHYLENE DICHLORIDE	10	40.0	9	44.4	31	41.9	29	44.8
ETHYLENE OXIDE	9	22.2	8	25.0	29	31.0	29	34.5
VINYL CHLORIDE	11	36.4	10	40.0	29	37.9	28	39.3

UCC 096832

Table 5A

Proportions of Cases and Controls Exposed
to Five Chemicals at UCC Texas City at
Least 15 Years Prior to Death

CHEMICAL	ALL CASES		GLIOMAS		CONTROL I		CONTROL 2	
	Total	Percent Exposed	Total	Percent Exposed	Total	Percent Exposed	Total	Percent Exposed
BENZENE	9	11.1	8	12.5	30	30.0	23	4.3
DIETHYL-SULFATE	9	33.3	8	25.0	33	42.4	28	25.0
ETHYLENE DICHLORIDE	9	33.3	8	37.5	31	32.3	27	33.3
ETHYLENE OXIDE	8	12.5	7	14.3	31	19.4	27	22.2
VINYL CHLORIDE	10	30.0	9	33.3	33	30.3	28	46.4

Table 5B

Proportions of Cases and Hourly Controls
Exposed to Five Chemicals at UCC Texas City
at Least 15 Years Prior to Death

CHEMICAL	ALL CASES		GLIOMAS		CONTROL I		CONTROL II	
	Total	Percent Exposed	Total	Percent Exposed	Total	Percent Exposed	Total	Percent Exposed
BENZENE	9	11.1	8	12.5	26	30.8	22	4.5
DIETHYL-SULFATE	9	33.3	8	25.0	29	44.8	27	25.9
ETHYLENE DICHLORIDE	9	33.3	8	37.5	27	33.3	26	34.6
ETHYLENE OXIDE	8	12.5	7	14.3	27	22.2	26	23.1
VINYL CHLORIDE	10	30.0	9	33.3	29	31.0	26	30.8

UCC 096833

DRAFT

at UCC, Texas City a minimum of fifteen years prior to death. For all five chemicals, the proportion of cases exposed were comparable with the proportion of controls exposed. This result was obtained even when salaried employees were removed from the control groups (Table 5B).

Although no associations were detected between suspect carcinogenic chemical exposures and brain tumor cases, the possibility of some other chemical used or produced at the plant having an association with the brain tumor cases was also investigated. In this analysis, proportions of exposed cases and controls were compared for each chemical to which at least four of the brain tumor cases were exposed. This criteria resulted in the selection of 30 chemicals.

Tables 6 and 7 compare exposures of cases with all controls and with hourly controls for each of the thirty chemicals. For approximately half of the chemicals listed, both "all cases" and "all glioma cases" were exposed less frequently than either Control Group I or Control Group II. The actual number of chemicals for which this was true increased by two (2) when salaried employees were removed from the control groups.

For five chemicals, - ethylene, isopropanol, vinyl acetate, chlorine and

UCC 096834

Table 6

PROPORTION OF CASES AND CONTROLS

"EVER EXPOSED" BY CHEMICAL

CHEMICALS ¹	ALL CASES ²		GLICHAS ³		CONTROL I		CONTROL II	
	N	%	N	%	N	%	N	%
Ethylene	9	88.9	8	87.5	36	72.2	27	70.4
Acetaldehyde	11	36.4	10	40.0	34	44.1	31	51.6
Acetic acid	11	36.4	10	40.0	40	55.0	36	58.3
Acetone	11	72.7	10	80.0	43	79.1	37	81.1
Butadiene	9	44.4	7	42.9	31	67.7	24	70.8
CO ₂	10	70.0	9	77.8	36	63.9	30	70.0
Diethanolamine	10	40.0	9	44.4	33	51.5	24	50.0
Ethane	8	37.5	7	28.6	32	50.0	24	25.0
Ethanol	9	33.3	8	25.0	35	37.1	32	37.5
Ethylene glycol	11	54.5	10	50.0	38	50.0	36	58.3
Hydrochloric acid	11	54.5	10	60.0	36	61.1	31	71.0
Isopropanol	11	54.5	10	60.0	39	46.2	33	48.5
Isopropyl acetate	11	36.4	10	40.0	40	47.5	36	50.0
Methane	8	62.5	7	57.1	33	69.7	25	60.0
Methanol	10	40.0	9	44.4	39	71.8	33	66.7
Methyl ethyl ketone	11	36.4	10	40.0	34	32.4	31	41.9
Methyl isobutyl ketone	11	36.4	10	40.0	34	32.4	31	41.9
Monogethanolamine	10	40.0	9	44.4	37	62.2	32	62.5
Propylene	9	44.4	8	37.5	36	75.0	26	61.5
Sodium carbonate	10	50.0	9	55.6	34	52.9	30	66.7
Sodium hydroxide	12	83.3	10	80.0	41	85.4	36	91.7
Styrene	11	36.4	10	40.0	35	51.4	30	46.7
Sulphuric acid	10	80.0	8	75.0	35	82.9	25	80.0
Toluene	11	36.4	10	40.0	35	51.4	31	48.4
Vinyl acetate	11	54.5	10	60.0	38	42.1	34	50.0
Tergitols	10	40.0	9	44.4	39	66.7	32	62.5
Mesityl oxide	9	33.3	8	37.5	33	60.6	25	56.0
Chlorine	9	44.4	7	42.9	30	36.7	22	40.9
Trichloroethane	9	44.4	7	42.9	30	36.7	23	43.5
Sodium sulphite	9	44.4	7	42.9	30	36.7	22	40.0

¹Chemicals listed are those to which at least 4 cases could have been "exposed".

²N - designate number of employees whose exposure status could be determined

³% - Refers to percent exposed

UCC 096835

Table 7

PROPORTIONS OF CASES AND HOURLY CONTROL
"EVER EXPOSED" BY CHEMICAL

CHEMICALS ¹	ALL CASES		GLIOMAS		HOURLY CONTROL I		HOURLY CONTROL II	
	N ²	% ³	N	%	N	%	N	%
Ethylene	9	88.9	8	87.5	31	80.6	25	72.0
Acetaldehyde	10	50.0	9	44.4	29	51.7	29	51.7
Acetic acid	11	36.4	10	40.0	34	58.8	33	57.6
Acetone	11	72.7	10	80.0	37	86.5	34	82.4
Butadiene	9	44.4	7	42.9	26	76.9	23	73.9
CO ₂	10	70.0	9	77.8	31	74.2	28	71.4
Diethanolamine	10	40.0	9	44.4	28	57.1	23	52.2
Ethane	8	37.5	7	28.6	27	59.3	23	26.1
Ethanol	9	33.3	8	25.0	30	43.3	30	36.7
Ethylene glycol	11	54.5	10	50.0	33	54.5	33	57.6
Hydrochloric acid	11	54.5	10	60.0	31	67.7	28	71.4
Isopropanol	11	54.5	10	60.0	33	48.5	30	46.7
Isopropyl acetate	11	36.4	10	40.0	34	50.0	33	48.5
Methane	8	62.5	7	57.1	28	82.1	24	62.5
Methanol	10	40.0	9	44.4	34	79.4	31	67.7
Methyl ethyl ketone	11	36.4	10	40.0	29	34.5	28	39.3
Methyl isobutyl ketone	11	36.4	10	40.0	29	34.5	28	39.3
Monoethanolamine	10	40.0	9	44.4	32	68.8	30	63.3
Propylene	9	44.4	8	37.5	30	83.3	24	62.5
Sodium carbonate	10	50.0	9	55.6	29	62.1	28	67.9
Sodium hydroxide	12	83.3	10	80.0	35	91.4	33	93.9
Styrene	11	36.4	10	40.0	30	56.7	27	44.4
Sulphuric acid	10	80.0	8	75.0	29	89.7	23	82.6
Toluene	11	36.4	10	40.0	30	56.7	28	46.4
Vinyl acetate	11	54.5	10	60.0	33	45.5	31	48.4
Tergitols	10	40.0	9	44.4	33	72.7	30	63.3
Mesityl oxide	9	33.3	8	37.5	28	67.9	23	56.5
Chlorine	9	44.4	7	42.9	25	40.0	21	42.9
Trichloroethane	9	44.4	7	42.9	25	40.0	22	45.5
Sodium sulphite	9	44.4	7	42.9	25	40.0	21	42.9

¹Chemicals listed are those to which at least 4 cases could have been "exposed".

²N - Designate number of employees whose exposure status could be determined

³% - Refers to percent exposed

UCC 096836

Table 8

PROPORTIONS OF CASES AND CONTROLS "EVER EXPOSED"
15 YEARS OR MORE PRIOR TO DEATH BY CHEMICAL

CHEMICALS ¹	ALL CASES		GLIOMAS		CONTROL I		CONTROL II	
	N ²	% ³	N	%	N	%	N	%
Ethylene	9	88.9	8	87.5	34	55.9	25	52.0
Acetaldehyde	9	22.2	8	25.0	33	30.3	29	44.8
Acetic acid	10	20.0	9	22.2	35	45.7	31	41.9
Acetone	10	70.0	9	77.8	37	73.0	32	71.9
Butadiene	9	44.4	7	42.9	32	59.4	24	58.3
CO ₂	9	55.6	8	62.5	35	42.9	28	57.1
Diethanolamine	9	33.3	8	37.5	31	38.7	24	37.5
Ethane	8	37.5	7	28.6	32	37.5	24	16.7
Ethanol	8	25.0	7	14.3	32	31.3	28	25.0
Ethylene glycol	10	30.0	9	33.3	33	39.4	31	48.4
Hydrochloric acid	10	50.0	9	55.6	35	48.6	28	57.1
Isopropanol	10	40.0	9	44.4	35	37.1	29	37.9
Isopropyl acetate	10	20.0	9	22.2	35	42.9	31	41.9
Methane	8	62.5	7	57.1	33	54.5	25	52.0
Methanol	9	33.3	8	37.5	33	66.7	28	57.1
Methyl ethyl ketone	10	30.0	9	33.3	33	27.3	27	29.6
Methyl isobutyl ketone	10	20.0	9	22.2	33	27.3	27	29.6
Monoethanolamine	9	33.3	8	37.5	33	48.5	28	46.4
Propylene	9	33.3	8	37.5	34	61.8	25	48.0
Sodium carbonate	9	33.3	8	37.5	35	40.0	28	57.1
Sodium hydroxide	11	81.8	9	77.8	37	81.1	32	78.1
Styrene	10	20.0	9	22.2	33	42.4	27	29.6
Sulphuric acid	10	80.0	8	75.0	34	70.6	25	64.0
Toluene	10	20.0	9	22.2	33	42.4	27	33.3
Vinyl acetate	10	50.0	9	55.6	33	36.4	30	36.7
Tergitols	9	33.3	8	37.5	35	51.4	29	48.3
Mesityl oxide	9	33.3	8	37.5	32	50.0	24	41.7
Chlorine	9	44.4	7	42.9	31	25.8	23	26.1
Trichloroethane	9	44.4	7	42.9	31	29.0	24	29.2
Sodium sulphite	9	44.4	7	42.9	31	25.8	23	35.3

¹Chemicals listed are those to which at least 4 cases could have been "exposed"

²N - designate number of employees whose exposure status could be determined

³% - Refers to percent exposed

UCC 096837

DRAFT

sodium sulfite, cases were exposed more frequently than controls. When salaried employees were removed from the control groups, cases were exposed more frequently than controls to only three chemicals: ethylene, isopropanol and vinyl acetate.

Tables 8 and 9 show the comparison of exposure frequencies among cases and controls for those persons who were employed at UCC Texas City a minimum of fifteen years prior to death. For fifteen of the thirty chemicals listed, both "all cases" and "gliomas" were exposed less frequently than either of the control groups. The same result was found when cases were compared with only hourly controls.

For nine chemicals, ethylene, isopropanol, methane, methyl ethyl ketone, sulphuric acid, vinyl acetate, chlorine, trichloroethane and sodium sulfite, cases were exposed more frequently than either Control Group I or Control Group II. When the comparison was restricted to hourly controls, only methane was dropped from this list.

A comparison of the proportion of gliomas and non-cancer hourly controls exposed to these remaining eight chemicals is shown in Table 10. Due to the small differences between these proportions and the small numbers on which

UCC 096838

Table 9

PROPORTIONS OF CASES AND HOURLY CONTROLS
 "EVERY EXPOSED" 15 YEARS OR MORE PRIOR TO DEATH BY CHEMICAL

CHEMICALS ¹	ALL CASES		GLIOMAS		HOURLY CONTROL I		HOURLY CONTROL II	
	N ²	% ³	N	%	N	%	N	%
Ethylene	9	88.9	8	87.5	30	60.0	24	54.2
Acetaldehyde	9	22.2	8	25.0	29	34.5	27	44.4
Acetic acid	10	20.0	9	22.2	31	48.4	29	41.4
Acetone	10	70.0	9	77.8	33	78.8	30	73.3
Butadiene	9	44.4	7	42.9	28	64.3	23	60.9
CO ₂	9	55.6	8	62.5	31	48.4	26	57.7
Diethanolamine	9	33.3	8	37.5	27	40.7	23	39.1
Ethane	8	37.5	7	28.6	28	42.9	23	17.4
Ethanol	8	25.0	7	14.3	28	35.7	27	25.9
Ethylene glycol	10	30.0	9	33.3	29	41.4	29	48.3
Hydrochloric acid	10	50.0	9	55.6	31	51.6	26	57.7
Isopropanol	10	40.0	9	44.4	31	38.7	27	37.0
Isopropyl acetate	10	20.0	9	22.2	31	45.2	29	41.4
Methane	8	62.5	7	57.1	29	62.1	24	54.2
Methanol	9	33.3	8	37.5	29	72.4	27	59.3
Methyl ethyl ketone	10	30.0	9	33.3	29	27.6	25	28.0
Methyl isobutyl ketone	10	20.0	9	22.2	29	27.6	25	28.0
Monoethanolamine	9	33.3	8	37.5	29	51.7	27	48.1
Propylene	9	33.3	8	37.5	30	66.7	24	50.0
Sodium carbonate	9	33.3	8	37.5	31	45.2	26	57.7
Sodium hydroxide	11	81.8	9	77.8	33	84.8	30	80.0
Styrene	10	20.0	9	22.2	29	44.8	25	28.0
Sulphuric acid	10	80.0	8	75.0	30	73.3	24	66.7
Toluene	10	20.0	9	22.2	29	44.8	25	32.0
Vinyl acetate	10	50.0	9	55.6	29	37.9	28	35.7
Tergitols	9	33.3	8	37.5	31	54.8	28	50.0
Mesityl oxide	9	33.3	8	37.5	28	53.6	23	43.5
Chlorine	9	44.4	7	42.9	27	25.9	22	27.3
-Trichloroethane	9	44.4	7	42.9	27	29.6	23	30.4
Sodium sulphite	9	44.4	7	42.9	27	25.9	22	27.3

¹ Chemicals listed are those to which at least 4 cases could have been "exposed"

² N - Designate number of employees whose exposure status could be determined

³ % - Refers to percent exposed

UCC 096839

Table 10

PERCENT EXPOSED BETWEEN GLIOMAS AND
HOURLY NON-CANCER CONTROLS FOR EIGHT CHEMICALS
15 YEAR LATENCY ANALYSIS

Chemical	GLIOMAS		CONTROL GROUP I	
	Total	Percent Exposed	Total	Percent Exposed
Ethylene	8	87.5	30	60.0
Isopropanol	9	44.4	31	38.7
Methyl ethyl ketone	9	33.3	29	27.6
Sulphuric acid	8	75.0	30	73.3
Vinyl acetate	9	55.6	29	37.9
Chlorine	7	42.9	27	25.9
Trichloroethane	7	42.9	27	29.6
Sodium sulphite	7	42.9	27	25.9

DRAFT

these proportions are based, none of the differences are statistically significant.

A separate analysis was performed in which an employee was assumed to have been exposed to all chemicals if he had ever worked in a department for which no specific chemicals could be determined ("unknown"). The results of this analysis (not shown) indicated higher exposure frequencies^{among both Cases and Controls} for all chemicals but again no statistically significant differences between cases and controls were found.

DISCUSSION

The results of this study do not identify any specific associations between brain tumors and exposure to five known or suspect carcinogens^{used} at the UCC Texas City plant. This conclusion is based on the finding that employees who did not have malignant brain tumors were exposed to these carcinogens as frequently as employees who had primary brain tumors. This same result was found when a minimum fifteen year latent period was required between the date of first exposure and the date of death.

The examination of an additional thirty (30) chemicals resulted in identification of eight (8) for which exposure frequencies among cases were

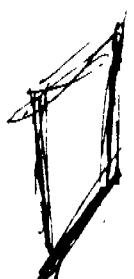
CONFIDENTIAL

higher than among controls. With the exception of one of these eight, ethylene, the differences in exposure frequencies were less than twenty percent (20%) and none of the differences achieved statistical significance.

For six of these chemicals, ethylene, isopropanol, sulphuric acid, vinyl acetate, chlorine and trichloroethane, carcinogenic potential has been investigated to some extent. Of these six, only chlorine and trichloroethane have yielded positive findings. For chlorine, several epidemiologic studies have reported a link between chlorinated drinking water and cancer of the rectum, colon and bladder. For trichloroethane, one of the two isomers (112) has shown positive results, only in mice (not in rats). The other isomer (111) has shown no evidence of carcinogenicity in mice or rats and this is the isomer that has been handled almost exclusively at the Texas City plant.

For the other two chemicals, methyl ethyl ketone and sodium sulfite, no toxicological or epidemiological studies have been reported to date.

One limitation of this study is that the control groups were selected from former employees whose deaths were known to the company. As a result, former UCC- Texas City employees who voluntarily terminated employment before retirement, or were laid off were underrepresented among controls. It can be



UCC 096842

DRAFT

argued that this restriction may have biased the study results since those employees not represented among the controls would have had shorter lengths of employment in general and consequently less opportunity for exposure. However, there is no reason to suspect that employees who continue working with a company will be less affected by such exposures than employees who terminate. In addition, the observation that a high percentage of the cases had relatively few (less than ten) years of company service, draws attention to the fact that employment and potential exposures outside of UCC Texas City has not been considered in this investigation.

A second limitation of this study is the problem of accurately determining exposures among the Cases and Controls. Because of the nature of the Texas City plant (and all chemical plants in general) which requires a high percentage of the work force to be employed in maintenance activities, worker mobility is extremely high and very difficult to trace from day to day. As a result of this constraint, exposures to specific chemicals could be determined for only approximately half of the employees.

For this reason and because of the extremely small numbers involved, the results of this study must be interpreted cautiously. However, to the extent

UCC 096843

that employee exposures were known, no evidence of a significant association between exposures to specific chemicals and employment at Texas City were found.

UCC 096844

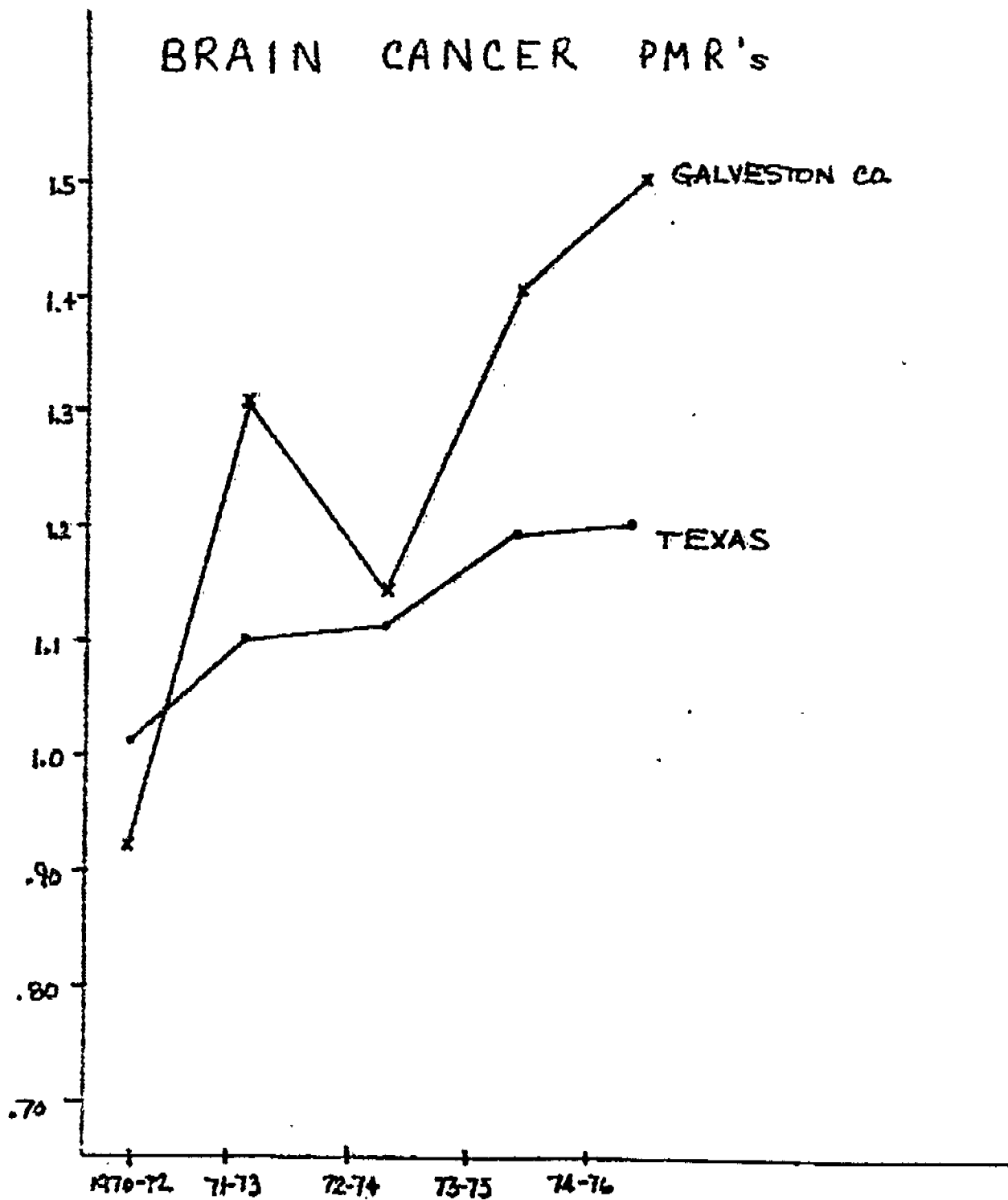
REFERENCES

1. Carcinogenic Factors, Report No. 2, Regulatory Technical Information Center, April 1979.
2. Fleiss, J.L. - Statistical Methods For Rates and Proportions, Wiley 1973.
P. 18

UCC 096845

To D.D.G. - from Dr. Austin 4/24/81 -

OIC: DLE ✓



UCC 096846

SMRs BY LENGTH OF EMPLOYMENT
TEXAS CITY COHORT

	< 15 Years		≥ 15 Years	
	<u>†</u>	<u>SMR</u>	<u>†</u>	<u>SMR</u>
All MN		83		71
Pancreas	2	75	7	169
Respiratory	13	79	8	64
Kidney	0	0	4	202
Brain	2	68	7	273
NM Respiratory Disease	10	81	6	32

FROM MMNR REPORT

<u>Cause</u>	<u>SMRs</u>		
	<u>< 10</u>	<u>10-20</u>	<u>> 20</u>
Brain	95	131	304

UCC 096847

PROPORTIONS OF UCC BRAIN TUMOR DEATHS AND EMPLOYEES
AMONG GALVESTON COUNTY RESIDENTS 1956-1977

	GALVESTON COUNTY	UCC	PROPORTION FROM UCC
PRIMARY BRAIN CANCER DEATHS	47	10	21%
NO. AT RISK	35,988*	3700*	10%
ESTIMATED			

UCC 096848

OBSERVED AND EXPECTED DEATHS IN
A COHORT OF 5113 WHITE MALE HOURLY EMPLOYEES
(TEXAS CITY 1941-1977)

<u>CAUSE OF DEATH</u>	<u>OBS.</u>	<u>EXP.</u>	<u>SMR</u>
All Causes	649	769.0	0.84*
All Malignant Neoplasms	122	146.3	.83
MN-Digestive System	32	38.6	.83
Large Intestine	9	11.9	.75
Pancreas	9	7.8	1.14
MN-Respiratory System	44	50.7	.87
Lung	43	47.8	.90
MN-Skin	4	3.2	1.22
MN-Genito Urinary System	9	14.2	.63
Kidney	5	3.9	1.27
MN-Lymphopoeitic System	13	16.6	.78
Leukemia	6	6.3	.94
MN-Brain & Other CNS	10	6.1	1.64
All Benign Neoplasms	8	2.4	3.24*
Allergic Metab. and Nutr. Diseases	9	12.1	.74
All Circulatory Diseases	296	357.3	.83*
All Respiratory Diseases	23	37.9	.61*
All Digestive Diseases	18	44.7	.40*
All Genito-Urinary Diseases	9	10.2	.88
All External Causes	134	115.7	1.16

*Indicates statistical significance at .05 level

OBSERVED AND EXPECTED DEATHS IN
A COHORT OF 6585 WHITE MALES
(TEXAS CITY 1941-1977)

<u>CAUSE OF DEATH</u>	<u>OBS.</u>	<u>EXP.</u>	<u>SMR</u>
All Causes	728	898.1	0.81*
All Malignant Neoplasms	138	169.4	0.81*
MN-Digestive System	37	44.4	0.83
Large Intestine	11	13.8	0.80
Pancreas	10	9.0	1.11
MN-Respiratory System	48	58.4	0.82
Lung	46	55.1	0.83
MN-Skin	5	3.9	1.28
MN-Genito Urinary System	9	16.3	0.55
Kidney	5	4.5	1.10
MN-Lymphopoeitic System	16	19.6	0.81
Leukemia	6	7.5	0.80
MN-Brain & Other CNS	10	7.2	1.39
All Benign Neoplasms	8	2.9	2.76*
Allergic Metab. and Nutr. Diseases	10	14.1	0.71
All Circulatory Diseases	334	410.8	0.81*
All Respiratory Diseases	24	43.7	0.55*
All Digestive Diseases	20	52.4	0.38*
All Genito-Urinary Diseases	9	11.9	0.75
All External Causes	155	143.0	1.08

*Indicates statistical significance at .05 level

UCC TEXAS CITY EXPOSURE DATA

	Exposed Cases	Exposed Control 1	Exposed Control 2
Benzene	9% (11)	28%	10%
Diethyl Sulfate	27% (11)	39%	30%
Ethylene	73% (11)	59%	53%
Ethylene Dichloride	27% (11)	33%	38%
Ethylene Oxide	10% (10)	20%	30%
Polyethylene	30% (10)	10%	6%
Vinyl Chloride	25% (12)	30%	26%

These 6 sheets
should go to Dr. Glenn!