

**APPLIED  
EPIDEMIOLOGY  
INC.**



February 27, 1998

Ms. Wendy K. Sherman  
Manager, Vinyl Chloride Health Committee  
Chemical Manufacturers Association  
1300 Wilson Blvd.  
Arlington, VA 22209

Dear Ms. Sherman:

Enclosed please find our "baseline" results for the CMA Vinyl Chloride Study cohort. Specifically, these results reflect our re-calculation of all causes of death reported by Dr. Wong through 1982, as well as several additional causes of death not previously analyzed or reported (due to limitations of the available analytical packages of the time) and with at least two observed or two expected deaths. Our cohort differs from that analyzed by Dr. Wong in that we have identified and corrected numerous errors, restored several hundred cohort members not included in Dr. Wong's analyses and discovered some additional deaths. The details of these differences have been presented in earlier progress reports, and the final description will be detailed in our final report to CMA.

Three columns of results are presented in the accompanying table: the first column contains results based on our cleaned and expanded cohort using the United States mortality rates as the reference (methodologically most comparable to Dr. Wong's results); the second set contains results using rates for the states in which each plant was/is located; and the third reflects Dr. Wong's results.

Almost universally, our results mirror those of Dr. Wong. Most exceptions are due to some re-arrangement of specific causes of death within broader disease categories, often reflecting the way deaths are coded over different time periods and in different states (e.g., liver cancers and cardiovascular disease deaths).

The one result which might be considered a "new" finding is the elevated SMR for "connective and soft tissue" cancers (three-fourths of the way down on page two), with SMR=381 using the United States reference rates (95% confidence interval 153 to 785) and SMR=367 using state referent rates (95% confidence interval 147 to 755), based on seven observed deaths due to these cancers.

*(continued)*

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(Ms. Sherman, page 2)

Biologically, this observed excess might be related to the well-known association between vinyl chloride exposure and angiosarcoma of the liver, as angiosarcomas (tumors of the blood vessels) occurring outside of the liver are classified as soft tissue sarcomas. On the other hand, deaths due to angiosarcoma of the liver but erroneously recorded on a death certificate simply as "angiosarcoma" without specifying "of the liver" will be classified as a soft tissue sarcoma as well. Unfortunately, it is not possible to determine from the death certificate whether this has occurred.

Nevertheless, this association has not been reported elsewhere to date; therefore, we believe that you may have some obligation to report this finding to EPA under the Toxic Substances Control Act.

Please feel free to call if you have any questions about these baseline results. Thank you.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Kenneth A. Mundt". The signature is fluid and cursive, with a long horizontal stroke at the end.

Kenneth A. Mundt, Ph.D.

enclosure

UCC 109073

Applied Epidemiology, Inc. baseline study results and Wong et al., 1992 results: Observed (Obs) and expected (Exp) deaths, standardized mortality ratios (SMR's) and ninety-five percent confidence intervals (95% CI's) using U.S. white male mortality rates, plant state-specific white male mortality rates, for follow-up through December 31, 1982

| Cause of death                           | Applied Epidemiology, Inc. baseline analysis |         |     |         |                       |     |         | Wong et al., 1992    |         |     |         |
|------------------------------------------|----------------------------------------------|---------|-----|---------|-----------------------|-----|---------|----------------------|---------|-----|---------|
|                                          | U.S. reference rates                         |         |     |         | State reference rates |     |         | U.S. reference rates |         |     |         |
|                                          | Obs                                          | Exp     | SMR | 95% CI  | Exp                   | SMR | 95% CI  | Obs                  | Exp     | SMR | 95% CI  |
| <b>All causes</b>                        | 1569                                         | 1734.92 | 90  | 86-95   | 1876.87               | 84  | 80-88   | 1536                 | 1705.27 | 90  | 86-95   |
| <b>All malignant neoplasms</b>           | 389                                          | 363.09  | 107 | 97-118  | 380.46                | 102 | 92-113  | 359                  | 341.73  | 105 | 94-117  |
| <b>Cancer of:</b>                        |                                              |         |     |         |                       |     |         |                      |         |     |         |
| <b>Buccal cavity &amp; pharynx</b>       | 13                                           | 11.81   | 110 | 59-188  | 11.61                 | 112 | 60-192  | 12                   | 11.55   | 104 | 54-181  |
| Tongue                                   | 4                                            | 2.74    | 146 | 40-374  | 2.56                  | 156 | 43-400  | 4                    | nr      | --  |         |
| Other parts buccal cavity                | 3                                            | 3.15    | 95  | 20-278  | 2.98                  | 101 | 21-294  | 3                    | nr      | --  |         |
| Pharynx                                  | 5                                            | 5.66    | 88  | 29-206  | 5.79                  | 86  | 28-202  | 4                    | nr      | --  |         |
| <b>Digestive organs &amp; peritoneum</b> | 106                                          | 94.82   | 112 | 92-135  | 91.43                 | 116 | 95-140  | 99                   | 89.21   | 111 | 90-135  |
| Esophagus                                | 7                                            | 8.59    | 81  | 33-168  | 8.37                  | 84  | 34-172  | 7                    | 8.07    | 87  | 35-179  |
| Stomach                                  | 11                                           | 16.10   | 68  | 34-122  | 14.78                 | 74  | 37-133  | 10                   | 16.01   | 63  | 30-115  |
| Intestine, except rectum                 | 21                                           | 31.44   | 67  | 41-102  | 29.57                 | 71  | 44-109  | 20                   | 28.79   | 70  | 42-107  |
| Rectum                                   | 5                                            | 9.71    | 51  | 17-120  | 8.89                  | 56  | 18-131  | 5                    | 9.91    | 50  | 16-118  |
| Liver & biliary tract                    | 39                                           | 8.11    | 481 | 342-657 | 9.11                  | 428 | 304-585 | 37                   | 5.77    | 641 | 450-884 |
| Pancreas                                 | 18                                           | 19.21   | 94  | 55-148  | 18.89                 | 95  | 56-151  | 16                   | 18.40   | 87  | 50-141  |

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| Cause of death                      | Applied Epidemiology, Inc. baseline analysis |        |     |         |                       |     |         | Wong et al., 1992    |        |     |         |
|-------------------------------------|----------------------------------------------|--------|-----|---------|-----------------------|-----|---------|----------------------|--------|-----|---------|
|                                     | U.S. reference rates                         |        |     |         | State reference rates |     |         | U.S. reference rates |        |     |         |
|                                     | Obs                                          | Exp    | SMR | 95% CI  | Exp                   | SMR | 95% CI  | Obs                  | Exp    | SMR | 95% CI  |
| Peritoneum & other digestive organs | 5                                            | 1.65   | 302 | 98-706  | 1.82                  | 274 | 89-640  | 4                    | nr     | --  |         |
| Respiratory system                  | 128                                          | 132.71 | 96  | 80-115  | 151.35                | 85  | 71-101  | 115                  | 122.25 | 94  | 78-113  |
| Larynx                              | 3                                            | 5.44   | 55  | 11-161  | 5.94                  | 50  | 10-148  | 3                    | 5.24   | 57  | 12-168  |
| Trachea, bronchus & lung            | 122                                          | 125.56 | 97  | 81-116  | 143.58                | 85  | 71-101  | 111                  | 115.87 | 96  | 79-116  |
| Other respiratory system            | 3                                            | 1.71   | 176 | 36-513  | 1.83                  | 164 | 34-480  | 1                    | nr     | --  |         |
| Prostate                            | 15                                           | 16.55  | 91  | 51-149  | 15.59                 | 96  | 54-159  | 15                   | 15.20  | 99  | 55-163  |
| Kidney                              | 11                                           | 9.53   | 115 | 58-207  | 9.73                  | 113 | 56-202  | 11                   | 9.06   | 121 | 61-217  |
| Bladder                             | 6                                            | 8.58   | 70  | 26-152  | 8.34                  | 72  | 26-157  | 5                    | 8.46   | 59  | 19-138  |
| Skin                                | 7                                            | 8.28   | 85  | 34-174  | 8.34                  | 83  | 33-171  | 6                    | 7.36   | 82  | 30-178  |
| Eye                                 | 2                                            | 0.32   | 628 | 76-2269 | 0.42                  | 475 | 58-1717 | 0                    | 0.31   | 0   |         |
| Brain & other nervous system        | 22                                           | 13.61  | 162 | 101-245 | 13.05                 | 169 | 106-255 | 23                   | 12.76  | 180 | 114-271 |
| Thyroid                             | 2                                            | 0.74   | 269 | 33-972  | 0.73                  | 274 | 33-989  | 2                    | 0.68   | 293 | 36-1059 |
| Bone                                | 2                                            | 1.66   | 120 | 15-434  | 2.19                  | 91  | 11-330  | 2                    | 1.81   | 111 | 13-399  |
| Connective & soft tissue            | 7                                            | 1.84   | 381 | 153-785 | 1.91                  | 367 | 147-755 | 6                    | nr     | --  |         |
| Lymphatic & hematopoietic           | 37                                           | 36.91  | 100 | 71-138  | 37.29                 | 99  | 70-137  | 37                   | 36.28  | 102 | 72-141  |
| Lymphosarcoma/reticulosarcoma       | 10                                           | 7.77   | 129 | 62-237  | 7.72                  | 130 | 62-238  | 11                   | 7.98   | 138 | 69-247  |
| Hodgkin's disease                   | 3                                            | 5.16   | 58  | 12-170  | 5.31                  | 57  | 12-165  | 3                    | 5.45   | 55  | 11-161  |
| Leukemia & aleukemia                | 12                                           | 14.73  | 81  | 42-142  | 15.03                 | 80  | 41-139  | 13                   | 13.94  | 93  | 50-159  |

| Cause of death                                          | Applied Epidemiology, Inc. baseline analysis |                      |     |        |                       |     |        | Wong et al., 1992    |       |     |        |
|---------------------------------------------------------|----------------------------------------------|----------------------|-----|--------|-----------------------|-----|--------|----------------------|-------|-----|--------|
|                                                         | Obs                                          | U.S. reference rates |     |        | State reference rates |     |        | U.S. reference rates |       |     |        |
|                                                         |                                              | Exp                  | SMR | 95% CI | Exp                   | SMR | 95% CI | Obs                  | Exp   | SMR | 95% CI |
| Other lymphatic & hematopoietic                         | 12                                           | 9.25                 | 130 | 67-227 | 9.23                  | 130 | 67-227 | 10                   | 8.37  | 119 | 57-220 |
| Unspecified                                             | 29                                           | 22.37                | 130 | 87-186 | 25.13                 | 115 | 77-166 | 23                   | nr    | --  |        |
| Benign & unspecified nature neoplasms                   | 7                                            | 5.70                 | 123 | 49-253 | 5.54                  | 126 | 51-260 | 4                    | 5.08  | 79  | 21-201 |
| Unspecified nature of eye, brain & other nervous system | 4                                            | 2.68                 | 149 | 41-382 | 2.80                  | 143 | 39-365 | 1                    | nr    | --  |        |
| Other                                                   | 3                                            | 2.07                 | 145 | 30-424 | 2.01                  | 149 | 31-436 | 3                    | nr    | --  |        |
| Diabetes mellitus                                       | 23                                           | 23.89                | 96  | 61-144 | 25.38                 | 91  | 57-136 | 22                   | 23.52 | 94  | 59-142 |
| Diseases of the blood & blood forming organs            | 2                                            | 4.17                 | 48  | 6-173  | 4.37                  | 46  | 6-165  | 2                    | 3.76  | 53  | 6-192  |
| Mental, psychoneurotic & personality disorders          | 7                                            | 12.74                | 55  | 22-113 | 13.15                 | 53  | 21-110 | 4                    | 11.80 | 34  | 9-87   |
| Alcoholism                                              | 4                                            | 8.86                 | 45  | 12-116 | 9.20                  | 43  | 12-111 | 3                    | nr    | --  |        |
| Other mental disorders                                  | 3                                            | 3.87                 | 77  | 16-226 | 3.94                  | 76  | 16-222 | 1                    | nr    | --  |        |

| Cause of death                                           | Applied Epidemiology, Inc. baseline analysis |        |     |        |                       |     |         | Wong et al., 1992    |        |     |        |
|----------------------------------------------------------|----------------------------------------------|--------|-----|--------|-----------------------|-----|---------|----------------------|--------|-----|--------|
|                                                          | U.S. reference rates                         |        |     |        | State reference rates |     |         | U.S. reference rates |        |     |        |
|                                                          | Obs                                          | Exp    | SMR | 95% CI | Exp                   | SMR | 95% CI  | Obs                  | Exp    | SMR | 95% CI |
| <b>Diseases of the nervous system &amp; sense organs</b> | 14                                           | 17.29  | 81  | 44-136 | 17.40                 | 80  | 44-135  | 15                   | nr     | --  |        |
| Multiple sclerosis                                       | 3                                            | 2.31   | 130 | 27-380 | 1.87                  | 161 | 33-470  | 3                    | nr     | --  |        |
| Other diseases of nervous system & sense organs          | 11                                           | 14.98  | 73  | 37-131 | 15.53                 | 71  | 35-127  | 12                   | nr     | --  |        |
| <b>Diseases of the heart</b>                             | 642                                          | 680.17 | 94  | 87-102 | 735.95                | 87  | 81-94   | 601                  | nr     | --  |        |
| Rheumatic heart disease                                  | 12                                           | 18.71  | 64  | 33-112 | 16.46                 | 73  | 38-127  | 14                   | 19.33  | 72  | 40-122 |
| Ischemic heart disease                                   | 535                                          | 583.71 | 92  | 84-100 | 630.80                | 85  | 78-92   | 488                  | 597.73 | 82  | 75-89  |
| Chronic disease of endocardium                           | 5                                            | 3.55   | 141 | 46-329 | 3.17                  | 158 | 51-368  | 3                    | nr     | --  |        |
| Other myocardial degeneration                            | 3                                            | 7.89   | 38  | 8-111  | 5.84                  | 51  | 11-150  | 31                   | nr     | --  |        |
| Hypertension with heart disease                          | 23                                           | 15.20  | 151 | 96-227 | 14.50                 | 159 | 101-238 | 23                   | nr     | --  |        |
| Other heart diseases                                     | 64                                           | 51.12  | 125 | 96-160 | 65.17                 | 98  | 76-125  | 42                   | nr     | --  |        |
| <b>Other diseases of the circulatory system</b>          | 109                                          | 129.73 | 84  | 69-101 | 143.51                | 76  | 62-92   | 103                  | nr     | --  |        |
| Hypertension without heart disease                       | 3                                            | 4.53   | 66  | 14-193 | 5.06                  | 59  | 12-173  | 8                    | nr     | --  |        |
| Cerebrovascular disease                                  | 78                                           | 86.64  | 90  | 71-112 | 96.46                 | 81  | 64-101  | 70                   | 91.93  | 76  | 60-96  |
| Diseases of arteries, veins & pulmonary circulation      | 28                                           | 38.55  | 73  | 48-105 | 41.99                 | 67  | 44-96   | 25                   | nr     | --  |        |

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| Cause of death                                              | Applied Epidemiology, Inc. baseline analysis |       |     |        |                       |     |        | Wong et al., 1992    |       |     |         |
|-------------------------------------------------------------|----------------------------------------------|-------|-----|--------|-----------------------|-----|--------|----------------------|-------|-----|---------|
|                                                             | U.S. reference rates                         |       |     |        | State reference rates |     |        | U.S. reference rates |       |     |         |
|                                                             | Obs                                          | Exp   | SMR | 95% CI | Exp                   | SMR | 95% CI | Obs                  | Exp   | SMR | 95% CI  |
| <b>Diseases of the respiratory system</b>                   | 70                                           | 91.93 | 76  | 59-96  | 111.60                | 63  | 49-79  | 70                   | 87.61 | 80  | 62-101  |
| Pneumonia                                                   | 16                                           | 31.54 | 51  | 29-82  | 34.41                 | 47  | 27-76  | 15                   | 31.94 | 47  | 26-78   |
| Chronic & unspecified bronchitis                            | 2                                            | 4.38  | 46  | 6-165  | 5.44                  | 37  | 4-133  | 2                    | nr    | --  |         |
| Emphysema*                                                  | 17                                           | 20.12 | 84  | 49-135 | 23.45                 | 72  | 42-116 | 17                   | nr    | --  |         |
| Asthma                                                      | 1                                            | 3.00  | 33  | 1-185  | 3.76                  | 27  | 1-148  | 1                    | 2.89  | 35  | 1-192   |
| Pneumoconioses & other respiratory diseases (includes COPD) | 33                                           | 30.30 | 109 | 75-153 | 41.21                 | 80  | 55-112 | 35                   | nr    | --  |         |
| <i>Emphysema &amp; COPD*</i>                                |                                              |       |     |        |                       |     |        | 41                   | 22.83 | 180 | 129-244 |
| <b>Diseases of the digestive system</b>                     | 63                                           | 97.55 | 65  | 50-83  | 93.36                 | 67  | 52-86  | 60                   | 95.58 | 63  | 48-81   |
| Diseases of stomach & duodenum                              | 9                                            | 12.11 | 74  | 34-141 | 12.02                 | 75  | 34-142 | 8                    | 11.15 | 72  | 31-414  |
| Hernia & intestinal obstruction                             | 2                                            | 3.81  | 53  | 6-190  | 3.83                  | 52  | 6-189  | 2                    | nr    | --  |         |
| Cirrhosis of the liver                                      | 38                                           | 56.70 | 67  | 47-92  | 50.91                 | 75  | 53-102 | 35                   | 56.06 | 62  | 43-87   |
| Other digestive system diseases                             | 14                                           | 24.93 | 56  | 31-94  | 26.60                 | 53  | 29-88  | 14                   | nr    | --  |         |
| <b>Diseases of the genitourinary system</b>                 | 8                                            | 19.80 | 40  | 17-80  | 21.55                 | 37  | 16-73  | 9                    | 20.41 | 44  | 20-84   |
| Chronic/unspecified nephritis                               | 4                                            | 9.41  | 43  | 12-109 | 10.11                 | 40  | 11-101 | 4                    | 8.29  | 48  | 13-123  |
| Other genitourinary diseases                                | 3                                            | 3.77  | 79  | 16-232 | 4.33                  | 69  | 14-203 |                      | nr    | --  |         |

| Cause of death                                         | Applied Epidemiology, Inc. baseline analysis |        |     |        |                       |     |        | Wong et al., 1992    |        |     |        |
|--------------------------------------------------------|----------------------------------------------|--------|-----|--------|-----------------------|-----|--------|----------------------|--------|-----|--------|
|                                                        | U.S. reference rates                         |        |     |        | State reference rates |     |        | U.S. reference rates |        |     |        |
|                                                        | Obs                                          | Exp    | SMR | 95% CI | Exp                   | SMR | 95% CI | Obs                  | Exp    | SMR | 95% CI |
| Diseases of musculoskeletal system & connective tissue | 1                                            | 3.15   | 32  | 1-177  | 3.28                  | 30  | 1-170  |                      |        | --  |        |
| Symptoms & ill-defined conditions                      | 7                                            | 21.51  | 33  | 13-67  | 26.68                 | 26  | 11-54  | 10                   | 21.79  | 46  | 22-84  |
| All external causes                                    | 183                                          | 226.58 | 81  | 69-93  | 256.67                | 71  | 61-82  | 168                  | 225.97 | 74  | 64-87  |
| Accidents                                              | 117                                          | 153.26 | 76  | 63-91  | 175.92                | 67  | 55-80  | 108                  | 150.16 | 72  | 59-87  |
| Violence                                               | 66                                           | 73.32  | 90  | 70-114 | 81.75                 | 81  | 62-103 | 60                   | nr     | --  |        |
| Suicide                                                | 49                                           | 53.89  | 91  | 67-120 | 55.51                 | 88  | 65-117 | 46                   | 52.78  | 87  | 64-116 |
| Homicide                                               | 17                                           | 19.43  | 87  | 51-140 | 26.24                 | 65  | 38-104 | 14                   | nr     | --  |        |
| Other causes                                           | 15                                           | 25.00  | 60  | 34-99  | 25.49                 | 59  | 33-97  | 7                    | nr     | --  |        |
| Unknown                                                | 28                                           |        |     |        |                       |     |        | 97                   |        |     |        |

nr=no rates available for category of death

\* In the NIOSH categories of death (used in AEI baseline analysis), deaths from emphysema (ICD-7 527.1; ICD8 492; ICD9 492) are included in *Emphysema* and deaths from COPD (ICD-7 527.2; ICD-8 519.2; ICD-9 496) are included in *Pneumoconioses & other respiratory diseases*. In the Monson categories of death (used in Wong et al. analysis), *Emphysema & COPD* includes deaths from any of the following: Pulmonary collapse (ICD-7 527.0); Emphysema without mention of bronchitis (ICD-7 527.1); Other diseases of the lung (includes COPD) (ICD-7 527.2).