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July 28, 1983

Dr. J. Donald Millar
Director, NIOSH
Center for Disease Control
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Dear Dr. Millar:

Shell Oil Company, through its Corporate Medical Department, routinely collects and evaluates health information on Shell employees. Included in this information is mortality data. A recent evaluation was made of mortality data for active employees and retirees from manufacturing locations whose date of death was between January 1, 1973, and December 31, 1982. This evaluation indicates a greater number of deaths due to leukemia than expected for two Shell locations, the Wood River Manufacturing Complex (WRMC) and the Deer Park Manufacturing Complex (DPMC). These observed excesses are predominantly of the Acute Myelogenous type.

To assist us in evaluating this excess, we contracted with Dr. Phillip Cole, Professor and Chairman, Dept. of Epidemiology at the University of Alabama. He has reviewed our Wood River data, evaluated the involved methodologies, and has confirmed our findings. Copies of two of his reports on this matter are attached (Attachments I and II). We believe these findings to be of sufficient interest as to warrant this notification to the National Institute for Occupational Safety and Health.

The specific determinations, along with comments on forward planning, are as follows:

I. At the Shell Wood River Manufacturing Complex (WRMC) Wood River, Ill.

A. A Standardized Mortality Ratio (SMR) for leukemia mortality covering the period 1973-1982 was conducted[1]. The mortality data includes all known deaths among active employees and pensioners who retired from that location, but does not include any data on terminees. Quality assurance monitoring indicates our mortality data to be 98% complete.

[1]In the SMR analyses referred to in this document terminees ("leavers") were considered lost-to-follow-up at the time of their termination.

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The SMR derived from this analysis was 2.13 and was statistically significant at the .05 level.

Data pertinent to this analysis was as follows:

(a) Total no. of Wood River deaths = 640
(b) Total no. of Wood River deaths due to leukemia = 14
(c) Expected no. = 6.56
(d) SMR = 2.13 ($p<0.05$)

B. To further refine the leukemia death data by cell type, a SMR for acute myelogenous leukemia (AML) was conducted on the 1973-1982 data utilizing for comparison two separate sources of cell-type distribution currently available in the scientific literature. These were: (1) Selvin, Steve, et al., "Selected Epidemiologic Observations of Cell-Specific Leukemia Mortality in the United States, 1969-1977," Amer. Jour. of Epidemiology, Vol. 117, No. 2, 1983, and (2) Surveillance Epidemiology End Results (SEER) white males, total SEER population.

When the Selvin data was used for comparison the SMR observed for AML was 4.54. ($p<0.01$, Bailar-Ederer test.) Using the SEER data for comparison, the observed SMR for AML was 3.94. ($p<0.01$, Bailer-Ederer test.)

These two SMR values apparently form the basis for Dr. Cole's conclusion (in the attached reports) that "...there was an approximately four-fold increased risk of death due to AML among men employed at Wood River..."

Further detail is provided in the Wood River Summary Sheet, Attachment III.

C. A number of other studies have been conducted in an effort to isolate a possible cause for the observed leukemia excess. These include:

1. Review of the employment histories of all leukemia decedents prior to employment at Shell.

2. Review of individual work-histories of all leukemia decedents while employed at Shell.

3. Review of familial histories of decedents (as available in Shell medical records).

4. Review of residential history of decedents in the Wood River community.

5. Analysis of each decedent's date of first employment, and duration of employment.

6. Latency period analysis based on time of first employment to date of death.

7. Statistical analysis of the probability that the observed excesss might be a non-specific "cluster" occurrence.

8. Review of death certificates to determine if certain specific physicians might have signed an inordinate proportion of the documents.

9. Comparison of leukemia mortality in the Wood River and St. Louis area with that of U.S. white males to assess geographic bias.

Regrettably, these studies have thus far failed to provide us with significant direct correlations which might be useful in drawing conclusions with respect to causality. Additional details of each of these investigations will be made available to you on request.

II. At the Shell Deer Park Manufacturing Complex (DPMC) Deer Park, Tx.

A. Similar mortality studies have been conducted at this facility covering the period 1973-1981.

The Deer Park Manufacturing Complex (DPMC) consists of a refinery operation and a petrochemical operation which are geographically and environmentally somewhat separable.

Seven deaths at this location were attributable to leukemia as an underlying cause during the period under study. (An eighth death was identified with leukemia as a contributing cause.) Of the seven leukemia deaths, six occurred in the refinery operation and one in the chemical plant. Of the six cases occurring in the refinery, three were classified as acute myelogenous (ICDA 205.0).

Because of the preponderance of cases in the refinery it was decided to conduct a SMR study for leukemia mortality on that data subset.

The SMR thus derived was 2.30 and was not statistically significant. Data pertinent to this analysis was as follows:

(a) Total no. of deaths, Deer Park Refinery = 237
(b) No. of Refinery deaths due to leukemia = 6
(c) Expected No. of Refinery deaths due to leukemia = 2.60
(d) SMR = 2.30 (Not Stat. Sig.)

B. To further refine the 1973-1981 data, a SMR for Acute Myelogenous Leukemia was conducted utilizing leukemia mortality from the Refinery only. The results of this analysis are as follows:

Total No. Leukemia deaths at Deer Park Refinery = 6
No. of Acute Myelogenous Leukemia deaths = 3
Expected No. Acute Myelogenous Leukemia deaths from Selvin reference = .78
Expected No. Acute Myelogenous Leukemia deaths from SEER reference = .83

SMR (Selvin reference) = 3.86 (Not Stat. Sig.)
SMR (SEER reference ) = 3.60 (Not Stat. Sig.)

Further detail is provided in the Deer Park Summary Sheet, Attachment IV.

III. Other Shell Refinery Locations

A. PMR studies have been conducted on 3 other Shell refineries on data from 1973 to 1981. No statistically significant elevations in leukemia mortality have been observed in these facilities.

IV. Evaluation of the Most Important Question: Do These Findings Reflect a Current Hazard in the Workplace?

Since the cause of the excess leukemia has not yet been established directly, one must deal with the facts at hand. With respect to Wood River, Dr. Cole surmises that "...benzene is the most likely cause..." but acknowledges the possibility of other causal factors.

Our current industrial hygiene monitoring indicates that routine exposures to benzene in all manufacturing locations are typically below 1.0 ppm as an 8-hr. Time Weighted Average. This, while it says nothing about exposures which may have occurred in the distant past, should provide reassurance to all concerned that a current hazard is highly unlikely. The small amount of anecdotal information so far in hand indicates that exposures were likely to have been higher two decades and more ago.

Additionally, we have recently completed a review of benzene worker blood counts generated in the 15 months ending April, 1983 at both Wood River and Deer Park among participants in Shell's Benzene Medical Surveillance Program. Results of these analyses show no consistent group differences in hematological values suggesting marrow-suppressant effects in the benzene workers when compared to all participants in the voluntary periodic examination program (those not under special medical surveillance.) Full reports on these group analyses are available to you on request. We plan further review of individual hematology records.

It is currently our view that if the leukemia excess observed is indeed attributable to benzene exposure, it most likely would reflect only those exposures in the distant past, for which we, like most industry, have little reliable monitoring data.

We will be pleased to provide you with further details relating to benzene exposure profiles among Shell employees should you wish to have them.

V. Forward Planning

Our current plans for future actions include:

A. Notification of employees.

Employees and unions at Wood River and Deer Park will be notified of our findings concurrently with this notification to NIOSH. A copy of the employee communication to be used is attached (Attachment V). In addition, Shell employees at other locations will receive appropriate communications in the immediate future. Plans are underway to advise pensioners who retired from Wood River and Deer Park of our findings by letter.

B. Notification of government agencies.

This communication to NIOSH is being copied to the Occupational Safety and Health Administration and to the Office of Toxic Substances of the Environmental Protection Agency.

C. Notification of industry and trade associations.

Our findings will be forwarded by letter to the American Petroleum Institute, the Chemical Manufacturers Association, the American Industrial Health Council, and other appropriate organizations.

D. Future studies.

Firm decisions regarding the full nature and scope of additional studies have not been made. We will give serious consideration to the research options suggested by Dr. Cole in his report of July 6, 1983. Further, we propose to convene a panel of experienced, long-term employees at both Wood River and Deer Park for the purpose of attempting to reconstruct insofar as possible a qualitative and quantitative assessment of the exposure history of all leukemia decedents. Dr. Cole will be assisting us in these endeavors as will Knowlton Caplan, former Professor of Occupational and Environmental Health at the University of Minnesota.

It should be noted that there is already underway at DPMC an all-cause historical prospective cohort mortality study being

conducted under contract with Dr. Phillip Enterline, Ph.D., Director of the Center for Environmental Epidemiology at the University of Pittsburg. It is expected that this study will be completed in 1986 and should shed considerable light on the mortality patterns at that location in years prior to 1973. Protocols for this study are available for your review if you so desire.

We will advise you as new developments occur.

In conclusion, we would like to request your assistance and cooperation in evaluating the significance and implications of our observations. We fully recognize the difficulties inherent in attributing causal connections to anomalies encountered in epidemiological studies. We recognize also the necessity for additional work which might produce a useful contribution toward the resolution of these issues.

We would sincerely welcome suggestions from you which might aid us in clarification of the questions which our ongoing research has raised.

Very truly yours,

R E Joyner

R. E. Joyner

REJ/jas

Attachments: I-VII

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