ESTIMATION OF THE ENVIRONMENTAL CONTRIBUTION OF URANIUM IN THE DOSE ASSESSMENTS OF LOS ALAMOS WORKERS

D. Lewis and J.N.P.Lawrence
Dose Assessment Team, Los Alamos National Laboratory
Los Alamos, New Mexico 87545

Introduction:
New Mexico and the area surrounding Los Alamos National Laboratory is rich in natural deposits of uranium[1]. Due to these natural deposits, it is not surprising that New Mexico has the third highest population- weighted average concentration of uranium in domestic waters in the U.S.[2]. Prior to 1992, our uranium in urine analysis technique, Delayed Neutron Activation Analysis, was not sensitive enough to detect these environmental levels of uranium. In 1992, an alpha spectrometry analysis (RAS) technique was implemented to meet the performance criteria in draft ANSI 13.30. This RAS technique met the performance criteria of an isotope specific analysis with an acceptable MDA of 0.03pCi/sample for urine.

We are currently determining the best method to estimate the background exposure to natural occurring uranium in drinking water for the population of occupationally exposed uranium workers at Los Alamos National Laboratory. Many Los Alamos workers live in rural areas between Los Alamos, Santa Fe, and Espanola, and have home well water sources. To study the environmental background of uranium in uranium workers, we began collecting home water samples from the uranium workers in an effort to determine the background exposure to natural uranium from home drinking water.

From the literature[3,4,5], we selected a conservative gut absorption factor of 1% to estimate the fractional absorption of uranium from the gastrointestinal tract to the blood. Total daily intake of drinking water and percentage of water ingested from the home water source versus other sources for each individual have not been considered in this study. This estimate of

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[1]Chenoweth, W.L., "Uranium in the Santa Fe Area, New Mexico", in New Mexico Geol. Soc. Guidebook, 30th Field Conference, Santa Fe Country, 1979, 261-264.

[2]Drury J.S., Reynolds S., Owen P.T., Ross R.H., and Ensminger J.T., "Uranium in the U.S. Surface, Ground, and Domestic Waters", EPA-570/9-81-0001, 1981, 140-144.

[3]Spencer H., Osis D., Fisenne I. M., Perry P. M.,and Herley N. H., "Measured Intake and Excretion Patterns of Naturally Occurring ^{234}U, ^{238}U, and Calcium in Humans", Radiat. Res. 124, 1990, 90-95.

[4]Wrenn M. E., Durbin P. W., Howard B., Lipsztein J., Rundo J., Still E. T., and Willis D. L., "Metabolism of ingested U and Ra", Health Phys. 48, 1985, 601-633.

[5]Welford G. A., and Baird R., "Uranium levels in human diet and biological materials," Health Phys. 13, 1967, 1321-1324.

fractional absorption was used in correcting urine results to reflect the excretion of uranium from drinking water sources.

Experimental:
The routine uranium workers provided a urine sample every two weeks. To ensure continuous monitoring of the areas, half of the workers were monitored one week, and the other half were monitored the next. All workers on the routine uranium monitoring program were requested to submit a home water sample, and to complete a questionnaire on the location of his/her home. These samples were submitted to the lab for analysis with the urine samples. The location of the home water sample was entered into the database, and used as a comparison with the other home water samples.

One percent of the U-234, U-235, and U-238 activity result from the home water sample was subtracted from each urine sample submitted by the workers. The corrected urine data was then used in the dose calculations.

Results and Discussion:
The average total uranium activities, graph 1, for all home water locations showed a range of average uranium activities from less than 1 pCi/l in the Jemez Mountains to 79.4 pCi/l in the area south of Espanola. The Los Alamos/White Rock average, assumed to be solely from the municipal water system, was 1.13pCi/l, and was the location for the majority of the workers (71 samples). The Santa Fe average was 17.5 pCi/l. This value was higher than expected, and indicated that some workers in the Santa Fe area were on home well water supplies.

Graph 2 compared the CEDE calculations with and without the home water correction for the those workers having a CEDE greater than 0.010 rem in 1994. Workers 1, 5, 6, 7, and 9 showed little change with the water correction. Workers 2, 3, 4, 8, and 10 showed fairly large changes with the water correction.

Graphs 3-7 compared the "baseline" water value, or 1% of the total activity of the home water sample, versus one year of urine data for workers 1-5 in the previous graph. In all except worker #4, the baseline water value was roughly equal to baseline urine values. For workers 1, 3, and 5, acute exposures were observed by the urine data points exceeding the baseline values. Therefore, the following conclusion were made regarding the data used to calculate CEDE's for these 5 workers:

> Worker 1's CEDE of 0.058 rem was validated by the data showing at least 3 acute exposures. This worker's baseline water data were in agreement with his baseline urine values, indicating that the water correction was accurate.
>
> Worker 2's data showed a substantial decrease in his CEDE with the water correction. His baseline water data were in agreement with his baseline urine data, though there was variability in the baseline urine data. There was only one urine data point that indicated a low level acute exposure. The decrease from 0.055 rem to 0.019 rem may have been an overcorrection, due to the high level of uranium in this workers home water sample (134.4pCi/l).

Worker 3's data showed a slightly decreased CEDE due to the water correction. His baseline water data were in agreement with his baseline urine data, indicating agreement with the water correction. Two urine data points indicated two potential acute exposures. For this worker, the water correction was considered valid.

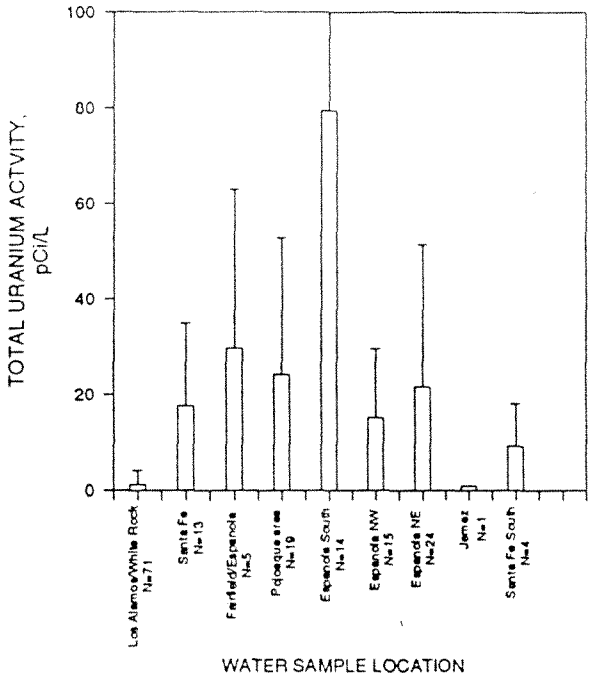
Worker 4's data indicated that the water correction was an overestimate for this individual, due to the extremely high level of uranium in this home water sample (191.0pCi/l). The reduction from 0.021 rem to 0.00 may have been an overestimate, but there was no indication of an acute exposure.

Worker 5's data indicated an increase in CEDE after the water correction, which was probably a rounding artifact. His baseline water data and baseline urine data were in agreement. One data point indicated an acute exposure to uranium early in the year, substantiating the 0.022 rem CEDE.

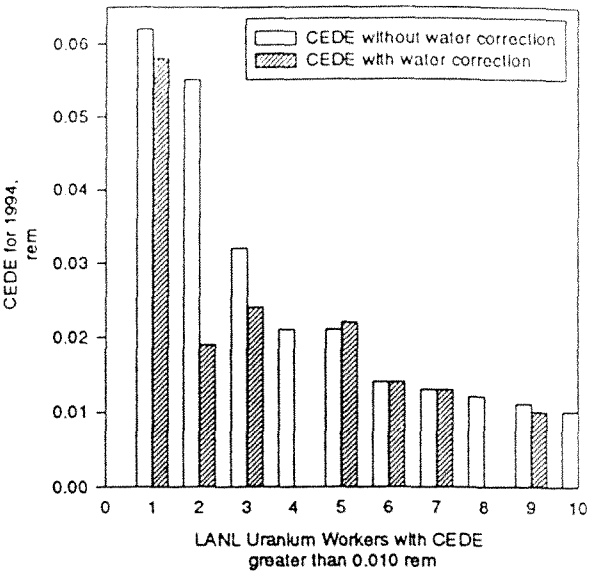
Conclusion:

In summary, the use of home water data to establish a baseline for urine excretion of environmental levels of uranium can be useful in preventing an over-estimate of occupational exposures. Further study of the water correction in cases where home water is greater than 100 pCi/l in total uranium activity is warranted.

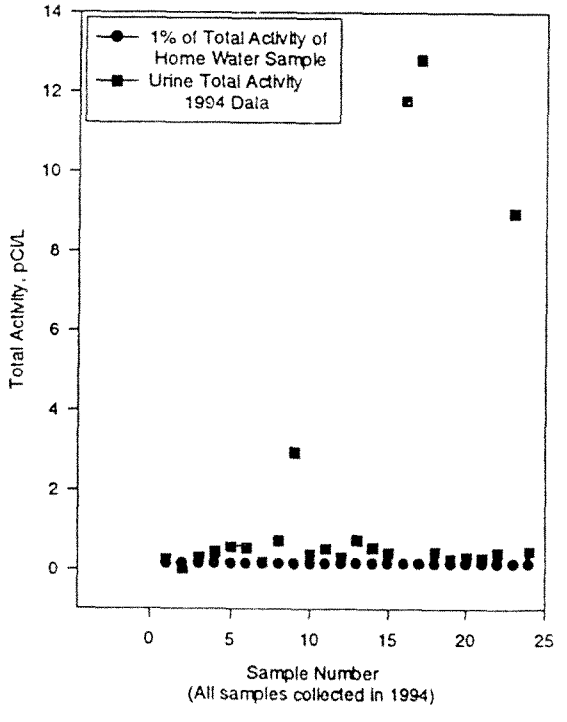
GRAPH 1:
AVERAGE TOTAL URANIUM
ACTIVITY FOR ALL LOCATIONS



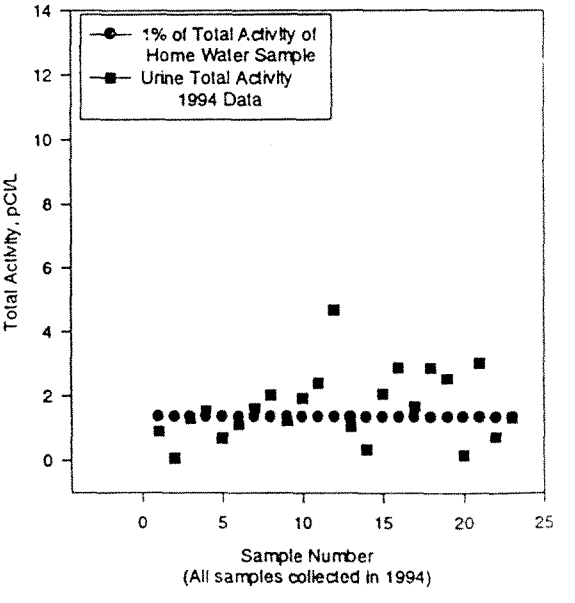
GRAPH 2:
CEDE Calculations With and Without
Water Correction



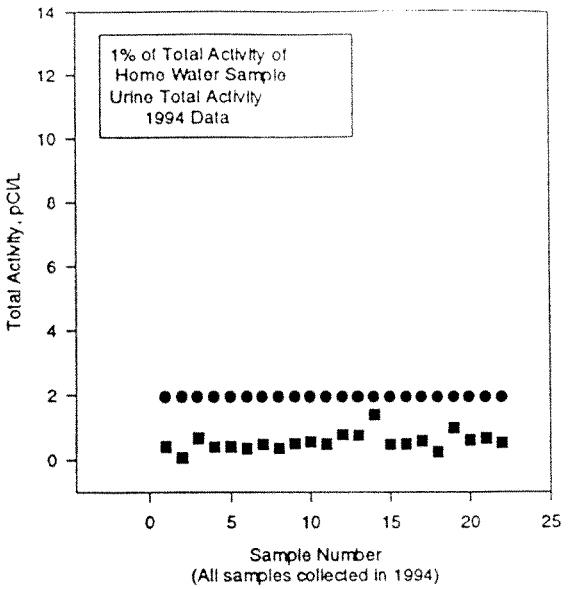
GRAPH 3:
Uranium Worker #1
0.062 rem CEDE before correction
0.058 rem CEDE after correction
Total activity of Home Water = 13.7 pCi/l



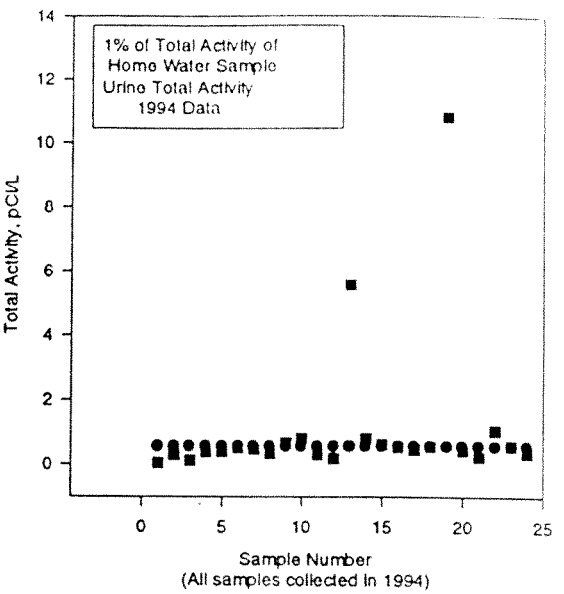
GRAPH 4:
Uranium Worker # 2
0.055 rem CEDE before correction
0.019 rem CEDE after correction
Total activity of Home Water = 134.4 pCi/L



GRAPH 6:
Uranium Worker #4
0.021 rem CEDE before correction
0.000 rem CEDE after correction
Total activity of Home Water = 191.0 pCi/l



GRAPH 5:
Uranium Worker #3
0.032 rem CEDE before correction
0.024 rem CEDE after correction
Total activity of Home Water = 55.0 pCi/l



GRAPH 7:
Uranium Worker #5
0.021 rem CEDE before correction
0.022 rem CEDE after correction
Total activity of Home Water = 0.143 pCi/L