working lifetime are about 300 to 400 per thousand based on data from the Gibb cohort. The best estimates of excess lung cancer risks to workers exposed to other TWA exposure concentrations are presented in Table VI–2. These estimates are consistent with predictions from Environ, NIOSH and Exponent models that applied linear relative and additive risk models based on the full range of cumulative Cr(VI) exposures experienced by the Gibb cohort and used appropriate adjustment terms for the background lung cancer mortality rates.

D. Quantitative Risk Assessments Based on the Luippold Cohort

As discussed earlier, Luippold *et al.* (Exs. 35–204; 33–10) provided information about the cohort of workers employed in a chromate production plant in Painesville, Ohio. Follow-up for the 482 members of the Luippold cohort started in 1940 and lasted through 1997, with accumulation of person-years for any individual starting one year after the beginning of his first exposure. There were 14,048 total person-years of follow-up for the cohort. The person-years were then divided into five exposure groups that had approximately equal numbers of expected lung cancers in each group. Ohio reference rates were used to compute expected numbers of deaths. White male rates were used because the number of women was small (4 out of 482) and race was known to be white for 241 of 257 members of the cohort who died and for whom death certificates were available. The 1960–64 Ohio rates (the earliest available) were assumed to hold for the time period from 1940 to 1960. Rates from 1990–94 were assumed to hold for the period after 1994. For years between 1960 and 1990, rates from the corresponding five-year summary were used. There were significant trends for lung cancer SMR as a function of year of hire, duration of employment, and cumulative Cr(VI) exposure. The cohort had a significantly increased SMR for lung cancer deaths of 241 (95% C.I. 180 to 317).

Table VI-4

Dose-Response Data From Luippold Cohort as cited by Environ (2002, Ex. 33-15): Observed and Expected Numbers of Lung Cancer Deaths Grouped by Five Cumulative Cr(VI) Exposure Categories

Cumulative Cr(VI) Exposure ($\mu g/m^3$ -yrs)	Mean Cr(VI) Exposure ($\mu g/m^3$ - yrs)	Observed Lung Cancers	Expected Lung Cancers[b]	Person-Years
<0.0002	0.0001	3	4.5	2952
0.0002–0.00049	0.00036	8	4.4	2369
0.00049–0.00105	0.00074	4	4.4	3077
0.00105–0.0027	0.00179	16	4.4	3220
0.0027–0.0278	0.00481	20	4.3	2482

[b] Expected lung cancer deaths derived using Ohio state mortality rates

Environ conducted a risk assessment based on the cumulative Cr(VI) exposure-lung cancer mortality data from Luippold *et al.* and presented in Table VI–4 (Ex. 33–15). Cumulative Cr(VI) exposures were categorized into five groups with about four expected lung cancer deaths in each group. In the absence of information to the contrary, Environ assumed Luippold *et al.* did not employ any lag time in determining the cumulative exposures. The calculated