were not available at the time this study was published. Workers were classified as having worked less than 1 month, 2 months, 3–5 months, 6–11 months, 1 year, or 2 or more years. Workers in all of these exposure categories had excessive mortality from lung cancer. This study demonstrates that workers with exposures of relatively short duration are at excess risk of lung cancer.

This mortality study was updated to include both a longer followup period and exposure estimates (Seidman, Ex. 261–A). The updated analysis included an additional 593 cases involving deaths occurring during the period from 5 to 40 years after onset of work. To increase the comparability of this study with others, Seidman re-analyzed the results of the earlier study by using death rates for white males from New Jersey to calculate Standardized Mortality Ratios (SMRs). Cumulative exposure to asbestos was estimated for each worker using work history records and exposure measurements taken in 1967, 1970, and 1971 from two similar amosite insulation production plants. These exposure data were collected and reported by NIOSH (Ex. 2–12). Workers were progressively assigned to the following cumulative exposure categories during the 35-year followup period: less than 6.0 f/cc-years, 6.0–11.9 f/cc-years, 12.0–24.9 f/cc-years, 25.0–49.9 f/cc-years, 50.0–99.9 f/cc-years 100.0–149.9 f/cc-years, 150.0–249.9 f/cc-years, and 250 or more f/cc-years. The use of exposure data from plants other than that from which the cohort was derived is appropriate in this study since the exposure measurements were from "plants of the same company where the same products were made utilizing the same machinery, fiber and production processes" (Ex. 261–A, p. 5). The investigators indicated that their exposure estimates may be on the high side for two reasons: (1) Dustier areas tend to be sampled more often than other areas, and (2) a concerted effort was made to have respiratory protection used by workers in the plant from which the study cohort was taken. Furthermore, Dr. Morton Corn, former Assistant Secretary for OSHA and testifying on the behalf of the Building and Construction Trades Department, commented that the Tyler, Texas plant, where some of the exposure data were obtained, was ". . . one of the most contaminated asbestos facilities I've ever been in" (Tr. 7/3, p. 67). Therefore, it is likely that the exposure estimates were overestimated, leading to an underestimate of excess risk for workers in each of the cumulative exposure categories.

Overall deaths were significantly (p less than 0.001) elevated (SMR–167), as were deaths from all cancers (SMR–287), from all "asbestos" diseases (SMR–396), from noninfectious lung disease (SMR–489), and from lung cancer (SMR–541). Colorectal cancer mortality was also significantly (p less than 0.05) increased (SMR–185). In addition, 17 deaths from mesothelioma were observed, a finding of great significance given the rarity of ths disease. A strong cumulative dose-response relationship was evident for both lung cancer mortality and mortality from all "asbestos" diseases.

Dement et al. (Exs. 84–036, 84–037) estimated individual cumulative exposures for 768 workers employed at a chrysotile textile plant during 1930–1975. Mean exposure levels were estimated for these workers on the basis of 5,952 industrial hygiene samples. The following exposure categories were defined: less than 1,000 f/cc-days, 1,000–10,000 f/cc-days and 10,000–40,000 f/cc-days. As explained in the November proposal, OSHA calculated that these categories of cumulative exposure are roughly equivalent to the following exposure categories: less than 2.7 f/cc-years; 2.7–27.4 f/cc-years, 27.4–109.6 f/cc-years, 109.6–274 f/cc-years, and greater than 274 f/cc-years. The first three of these exposure categories fall within at or below the lifetime cumulative exposure permitted by the 2-f/cc standard. Fifteen or more years after the onset of exposure, standardized mortality ratios (SMRs) for lung cancer among white males were 140, 279 (p less than 0.05), and 352 (p less than 0.05) in the first three exposure categories, respectively, demonstrating the existence of a dose-response relationship. Dement et al. (Ex. 84–037, p. 432) concluded that: "Based on data from this study, significantly elevated mortality risks are predicted for lung cancer and for asbestosis at cumulative exposures of 100 fibers/cc-years in the textile industry." OSHA considers that these observations of excess risk from low cumulative exposures are well-supported because of the careful estimation of exposure histories for members of the cohort in this study.

Henderson and Enterline (Ex. 84–048) studied the mortality of 1,075 retired asbestos production workers. Mean estimated exposures for the cumulative exposure categories were 62, 182, 352, 606, and 976 mpcf-years. Based on the recommended conversion factor of 1:1.4 for asbestos production (discussed in the November proposal), 62 mpcf-years is roughly equal to 87 f/cc-years, a cumulative exposure permitted by the 2 f/cc standard. An SMR of 197.7 for respiratory cancer was observed for workers in this cumulative exposure category. This observed excess mortality risk is not as high as that observed by Dement et al. (Exs. 84–036, 84–037); however, the authors of the Dement et al. study suggested that this difference may be the result of the fact that Henderson and Enterline studied retirees, which constitute a select group of survivors; only 8 of the 35 lung cancer deaths observed by Dement et al. (Ex. 84–37) occurred among persons 65 or older.

McDonald et al. (Ex. 84–065) studied the mortality of 11,379 workers exposed to chrysotile mining and milling. Based on a conversion factor for these operations of 1:3 for mpcf to f/cc, the exposure classifications developed by the authors would correspond to the following exposure categories: less than 90 f/cc-years, 90–899 f/cc-years, and 900 or more f/cc-years. Although they did observe an increased incidence of pneumoconiosis (SMRs 298, 1081, and 5400, respectively), McDonald et al. (Ex. 84–065) observed less lung cancer risk for these exposure categories than other investigators (SMRs were 93, 118, and 225, respectively). Regarding the different findings between the studies by McDonald et al. (Ex. 84–065) and Dement et al. (Exs. 84–036, 84–037) on lung cancer risk from low exposures, Dement et al. suggested that differences in the characteristics of airborne fibers, as well as the presence of a competing risk of pneumoconiosis among miners in the McDonald et al., study, could account for the differences in lung cancer mortality reported in these two studies.

Finkelstein (Ex. 84–240) studied the mortality of 339 men who had been employed at an Ontario asbestos cement factory for 9 or more years. Each cohort member was classified as having accumulated 8–69 f/cc-years, 70–121 f/cc-years, or 122–420 f/cc-years of asbestos exposure during the 18 years following onset of exposure. Cohort mortality was analyzed by cumulative exposure, starting 20 years after onset of exposure, and was compared to that of non-exposed Ontario men. Approximate relative risks for lung cancer mortality for the three exposure categories were 8.5, 16.3, and 7.4, respectively. Mesothelioma mortality rates per 1000 man-years were 1.9, 4.9, and 11.9, respectively, showing a clear dose-response relationship between asbestos exposure and mesothelioma. Finkelstein suggested several explanations for the unexpected decrease in excess lung cancer mortality in the highest exposure category: he argued that statistical