Table 6

Estimated Asbestos Related Cancer Mortality per 100,000 by Number of Years Exposed and Exposure Level [1]

| Asbestos fiber concentration (f/ml) | Cancer mortality /100,000 exposed | | | |
|---|---|---|---|---|
| | Lung | Mesothelioma | Gastrointestinal[2] | Total |
| | 1 year exposure | | | |
| 0.1 | 7.2 | 6.9 | 0.7 | 14.8 |
| 0.2 | 14.4 | 13.8 | 1.4 | 29.6 |
| 0.5 | 36.1 | 34.6 | 3.6 | 74.3 |
| 2.0 | 144 | 138 | 14.4 | 296.4 |
| 4.0 | 288 | 275 | 28.8 | 591.8 |
| 5.0 | 360 | 344 | 36.0 | 740.0 |
| 10.0 | 715 | 684 | 71.5 | 1470.5 |
| | 20 year exposure | | | |
| 0.1 | 139 | 73 | 13.9 | 225.9 |
| 0.2 | 278 | 146 | 27.8 | 451.8 |
| 0.5 | 692 | 362 | 69.2 | 1123.2 |
| 2.0 | 2713 | 1408 | 271.3 | 4392.3 |
| 4.0 | 5278 | 2706 | 527.8 | 8511.8 |
| 5.0 | 6509 | 3317 | 650.9 | 10476.9 |
| 10.0 | 12177 | 6024 | 1217.7 | 13996.7 |
| | 45 years exposure | | | |
| 0.1 | 231 | 82 | 23.1 | 336.1 |
| 0.2 | 460 | 164 | 46.0 | 670.0 |
| 0.5 | 1143 | 407 | 114.3 | 1664.3 |
| 2.0 | 4416 | 1554 | 441.6 | 6411.6 |
| 4.0 | 8441 | 2924 | 844.1 | 12209.1 |
| 5.0 | 10318 | 3547 | 1031.8 | 14896.8 |
| 10.0 | 18515 | 6141 | 1851.5 | 26507.5 |

[1] Assumes exposure begins at age 25. Risks are calculated using U.S. male lung cancer background rates for 1977.

[2] Estimated as 10% of lung cancer risk rather than calculated using dose-response information.

Several comments should be made regarding the results in Table 6. Though excess relative risk in linear in dose, the excess mortality rates given in Table 6 are not strictly linear in dose. Therefore, for example, the risk at 2 f/cc is not exactly 4 times the risk at 0.5 f/cc, though there is a close approximation. It should also be noted that the risks for longer periods of exposures do not appear to be a straight forward multiplication of the risks of shorter duration. In the longer exposure categories, where exposures will affect older workers, some adjustments have been made for competing risks which are likely to affect the death rate from lung cancer. In addition, when looking at total cancer risks, it must be remembered that these include the risk of mesothelioma, which is related to time in an exponential fashion.

As can be seen from Table 6, the predicted risk from mesothelioma is approximately equal to the lung cancer risk for one year of exposure and to about half of the risk value for lung cancer in the 20-year exposure group. The excess risk of mesothelioma after a lifetime exposure (45 years) to asbestos is approximately one-third the lifetime excess lung cancer risk. These predictions comport with observations in several populations, where mortality from mesothelioma is observed to comprise approximately 50% of the excess mortality from lung cancer.

Using the equations given earlier, and based on the calculations in Table 6, OSHA predicts a lifetime excess risk of total cancer for a lifetime exposure (45 years) to 2 f/cc as 6411 excess deaths per 100,000 workers, or approximately 64 per 1000. Since risk from a 20 year exposure to asbestos may also be of interest, the models predict an excess cancer mortality of 4392 deaths per 100,000 workers exposed at 2 f/cc for 20 years.

Reducing in the PEL from 2 f/cc to 0.2 f/cc reduces the risk from lifetime exposure from 64 per 1000 to 6.7 per 1000. Similarly, for a 20 year exposure, the risk is reduced from 44 per 1000 to 4.5 per 1000, representing a 90% reduction in risk. The lifetime risk from one year of exposure follows a similar course. The risk reduces from 296 per 100,000 at 2 f/cc to 30 per 100,000 at 0.2 f/cc.

Lastly, Table 6 contains risks for levels higher than 2 f/cc because OSHA believes some industrial areas (such as construction) may still be at these higher level. This population of workers would consequently experience a much greater reduction in risk by reducing exposures to 0.2 f/cc or less. Moreover, to the extent that the controls that are installed to meet the new PEL result in exposures below 0.2 f/cc, cancer risks will be reduced to a greater extent than indicated in the table.

### V. Quantifying the Excess Risk From Asbestosis

The November proposal included a quantification of the excess risk of asbestosis. Asbestosis is a type of pulmonary fibrosis diagnosed on the basis of a history of exposure to asbestos; it is characterized by radiologic changes to the lung, breathlessness, impaired lung function, and other clinical features of fibrosing lung disease. Asbestosis can be manifested in a range of degrees of severity and can result in disability and death.

An early response by the lung to asbestos exposure is formation of plaques, which are opaque patches visible on chest X-rays. The presence of plaques may indicate an increased risk of future development of asbestosis, but this is not certain. Although the significance of pleural plaques in terms of disease is not clear, the presence of plaques is not normal.

Asbestosis has been known to progress or worsen after cessation of exposure to asbestos, probably due to irreversible injury and/or the retention of asbestos fibers in the lung. In addition to lung function impairment, asbestosis contributes to increased asbestos-related mortality. Increased resistance created by the lung obstruction can lead to heart failure.