Table 3 summarizes the results of the goodness-of-fit tests for OHSA's model and the multistage model with one, two or three stages, for each of the data sets used by OSHA and for two additional sets of data. Consideration of the results in Table 3 show that, in fact, in four of the six cohorts, the best fitting model was linear with asbestos concentration (i.e., either the OSHA model or the multistage model with one stage showed the best fit. For the Finkelstein data, the multistage model with two stages fit only slightly better than the linear model, P=0.99 versus P=0.97). For three of the six data sets, the OSHA model fit as well or better than the multistage model. Although the fit of the OSHA model was adequate for the Finkelstein data, the OSHA model did not fit as well as the multistage model (P=0.39 [OSHA] versus P=0.99 [Crump]). And with regard to the Weill data, the fit of the OSHA model was inadequate (P=0.001) and the three-stage multistage model provided an excellent fit to the data (P=0.90). Similarly, as reported by Dr. Crump, the fit of the OSHA model to the Selikoff et al. data was "marginal", and the multistage model with one dose-related stage provided a very good fit to the data (P=0.76). Implications of the goodness-of-fit tests on the selection of the individual estimates of K_M will be discussed in the next section.

On the basis of these results, OSHA believes its choice of a risk model for mesothelioma is scientifically responsible. As discussed above, the model has received support from a large number of regulatory agencies, scientific bodies, and individual experts in risk assessment. Moreover, as will be seen in the next section, estimates of the individual K_M derived from this model are reasonable (and perhaps low), and represent the best estimate of the mesothelioma risk posed by exposure to asbestos.

B. *Data Used for the Calculation of Individual K_M's.* In the November proposal, OSHA used four studies judged by the Agency to have data adequate for the quantification of mesothelioma risk (Selikoff et al., Exs. 84-170, 84-90; Seidman et al., Ex. 84-87, 84-170; Peto et al., Ex. 84-170, and Finkelstein, Ex. 84-240). As Dr. Nicholson pointed out at the hearings:

> These were the four studies that did provide sufficient information that could be utilized.
>
> What is necessary is not simply the number of deaths in a particular study, but one has to know the time of those deaths; because the (fit) that was made involves the matching of the equation that's given there, risk according to time per months of exposure, with data on mesothelioma risk at different times from onset of exposure in a defined population.
>
> We had to know the number of cases per person-years of risk (Tr. 6/19, p. I-121-122).

OSHA believed that these four studies were particularly appropriate studies for inclusion in the calculation of K_M because of the large numbers of mesothelioma deaths observed in these four studies (180, 14, 7, and 11, respectively). It should be noted that these four studies are the same four studies employed by CHAP in its analysis of mesothelioma risk from asbestos exposure (Ex. 83-256, II-119-120).

OSHA acknowledged in the preamble to the November proposal that its estimates of K_M were derived from studies with four of the five highest K_L values. OSHA noted that there may be "some bias in examining the value of K_M independent of the K_L in the same studies because it is likely that these K_M would tend to be slightly higher than those derived from other studies, due to the demonstrated high power of these studies to detect risk" (48 FR 51125). To account for this bias in its analysis, OSHA arrived at an average K_M by examining the ratios of K_M to K_L. This gave an estimate of K_M of 1×10^{-8} rather than the higher central values of 4.98×10^{-8} rather than the higher central values of 4.98×10^{-8} (the arithmetic mean) and 2.91×10^{-8} (the geometric mean). OSHA believed this adjustment to the K_M value to be appropriate to avoid serious overestimation of the risk of mesothelioma.

Dr. Crump raised a number of issues regarding the calculation of K_M from these studies. As he had for the calculation of K_M, Dr. Crump noted that the Seidman et al. and Selikoff et al. studies are "particularly inappropriate for risk assessment because of the lack of exposure data" (Ex. 237A, p. 39). OSHA's reasons for accepting the data from these two studies and the justification for their use in quantitative risk assessment have already been discussed in Section I. In light of the new data received from the Seidman cohort, OSHA has revised its estimates of K_M. Using the data in Table 1 (Ex. 267A) and four points of observation, the K_M from the updated study is 2.4×10^{-8}, somewhat lower than the value for K_M put forth in the proposal for the original Seidman study. This is not unexpected, particularly in light of the higher average exposure found upon reexamination of the data.

Dr. Crump's second major objection to the use of these studies relateds to the issue of differential risk by fiber type. At the hearing, Dr. Crump noted that—

> * * * [T]urning to the risk specifically due to mesothelioma, I feel there is strong evidence that the risk in humans at least is less from chrysotile exposure than from amphibole exposures. OSHA estimated risks from four studies, each of which involved either exclusive or considerable exposures to amphiboles.
>
> Although these estimates were adjusted downwards somewhat by comparing them with lung cancer estimates, they still are considerably larger than estimates made from populations exposed predominantly to chrysotile which I have made (Tr. 7/9, p. 84).

In his written testimony, Dr. Crump elaborated on this position:

> * * * I believe there is considerable data to indicate that chrysotile is less risky (than the amphiboles). OSHA has already omitted from its risk calculation data from mining and milling operations, on the grounds that these exposures are not representative of those in the populations of workers OSHA has responsibility to protect. I believe this principle should also be applied to the chrysotile-amphibole question, and that risk to modern day workers, who are exposed almost exclusively to chrysotile, should be estimated from studies in which chrysotile exposures predominate (Ex. 237A, p. 47).

In an effort to expand the data from which to calculate an overall K_M, Dr. Crump calculated K_M's for two additional studies "for which exposures were predominantly to chrysotile. Theses are the Dement *et al.* study, where exposures were to only chrysotile, and the Weill *et al.* study, in which 77% of the workers were exposed exclusively to chrysotile" (Ex. 237A, p. 40). The mesothelioma data for these two studies are found in Tables D and E. The K_M calculations for various models are found in Table 3.

For the Dement et al. data found in Table 4, the model used by OSHA provided a much better fit to the data (P=0.67) than any of the multistage models, and gave a K_M of 2.2×10^{-9}, approximately five times lower than the K_M of 1×10^{-8} K given in the proposal. Of the multistage models, all of which allowed showed good fit, the three-stage model gave a K_M of 3.1×10^{-8}, more than 10 times larger than that estimated by the OSHA model and three times larger than OSHA's expressed preferred estimate of risk. Dr. Crump calculated the ratio of K_M/K_L for the Dement et al. study ($K_M/K_L = 2.2 \times 10^{-9}/0.042 = 5.2 \times$

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