

studies were presented, supporting the selection of Attfield and Seixas (1995) as the study that provides the best available estimate of material health impairment with respect to CWP. Two strengths of this study are its quantitative description of exposure-response among both miners and examiners (who had worked as miners for approximately 13–40 years) and the fact that it reflects recent conditions experienced by coal miners in the U.S. Using the exposure-response relationship it is possible to estimate the health impact of bringing dust concentrations down to or below the applicable standard on every shift. This is the only contemporary epidemiological study of CWP in U.S. miners providing such a relationship.

Attfield and Seixas (op cit) used two or three B readers to identify the profusion of opacities based on the ILO classification scheme.<sup>4</sup> The most inclusive category defined in their paper was CWP 1+, which include simple CWP categories 1, 2, and 3, as well as PMF. The second category CWP 2+, does not include simple CWP, category 1, but does include the more severe simple CWP categories, 2 and 3, as well as PMF. The third category used in their report was PMF, denoting any category (A, B, or C) of large opacities. The authors applied logistic regression models to the prevalence of CWP 1+, CWP 2+, and PMF as a function of accumulated coal mine exposure calculated for each miner included in the study. In the absence of data differentiating the inhalation rates of individual miners, the accumulated exposures in these models were expressed in units of mg-yr/m<sup>3</sup>.

At the MMUs being considered (those exhibiting a pattern of recurrent overexposures), bringing dust concentrations down to no more than the applicable standard on each and every production shift would reduce DO exposures on the affected shifts by an average of 1.04 mg/m<sup>3</sup>. Assuming this average reduction applies to only 19.3 percent of the shifts, the effect would be to reduce cumulative exposure, for each miner exposed at or above the DO level, by 0.20 mg-yr/m<sup>3</sup> over the course of a working year (i.e., 19.3 percent of shifts in one year, times 1.04 mg/m<sup>3</sup> per shift). Therefore, over a 45-year working lifetime, the benefit to each affected miner would, on average, amount to a reduction in accumulated exposure of approximately 9.0 mg-yr/m<sup>3</sup> (i.e., 45

years times 0.20 mg-yr/m<sup>3</sup> per year). If, as some miners have testified, operator dust samples submitted to MSHA tend to under-represent the frequency or magnitude (or both) of individual full-shift excursions above the applicable standard, then eliminating such excursions would provide a lifetime reduction of even greater than 9.0 mg-yr/m<sup>3</sup> for each affected miner.

The Attfield-Seixas models predict the prevalence of CWP 1+, CWP 2+, and PMF for miners who have accumulated a given amount of exposure, expressed in units of mg-yr/m<sup>3</sup>, by the time they attain a specified age. Benefits of reducing cumulative exposure can be estimated by calculating the difference between predictions with and without the reduction. For example, suppose a miner at one of the MMUs under consideration begins work at age 20 and retires at age 65. At these MMUs, the mean DO concentration reported in 2001 was 1.15 mg/m<sup>3</sup>; so, after 45 years, a miner exposed at this level can be expected to have accumulated a total exposure of nearly 52 mg-yr/m<sup>3</sup> (i.e., 45 yr × 1.15 mg/m<sup>3</sup>). By the year of retirement, such a miner is expected to accumulate, on average, 9.0 mg-yr/m<sup>3</sup> less exposure if individual shift excursions are eliminated. For 65-year-old miners, reducing an accumulated total dust exposure of 52 mg-yr/m<sup>3</sup> by 9.0 mg-yr/m<sup>3</sup> reduces the predicted prevalence of “CWP 1+” by more than 16 per thousand (see the entry for affected DO miners in Table VI–1).<sup>5</sup>

This result, however, applies only to DO miners at age 65. The Attfield-Seixas models provide different predictions for each year of age that a miner attains. The predicted benefit turns out to be smaller for younger miners and larger for older miners. This is partly because younger miners will have accumulated less exposure reduction as a result of the single sample and plan verification proposals, and partly because the Attfield-Seixas models depend directly on age as well as on cumulative exposure. The health effects of recurrent overexposures can occur long after the overexposures occurred. Even after a

miner retires and is no longer exposed to respirable coal mine dust, the additional risk attributable to an extra 9.0 mg-yr/m<sup>3</sup>, accumulated earlier, continues to increase with age. Consequently, the benefit to be gained from eliminating individual shift excursions also continues to increase after a miner is no longer exposed. For example, assuming no additional exposure after age 65, the predicted reduction in average prevalence of CWP 1+ increases from 16.6 per thousand at age 65 to 21.4 per thousand at age 70. Presumably, the increasingly greater predicted reduction in risk of disease after age 65 is due to the latent effects of the reduction in earlier exposure and the progressive nature of CWP.

To quantify benefits expected from eliminating overexposures on each and every shift, MSHA applied the Attfield-Seixas models to a hypothetical population of miners who, on average, begin working at age 20 and retire at age 65, assuming different lifetimes.<sup>6</sup> To show the range of potential reductions in risk depending on a miner's lifetime, Table VI–1 presents the risk reductions predicted at three different attained ages: 65, 73, and 80 years. The projected benefit increases with attained age. However, MSHA's best estimate of the benefit to exposed miners is expressed by the reduction in prevalence of disease predicted at age 73.<sup>7</sup> Since not all underground coal miners are overexposed to dust with the same frequency or at the same level, Table VI–1 shows the risk reductions projected for three different categories of affected miners: (1) DO miners, (2) NDO miners who are faceworkers neither classified as a DO nor subject to a separate dust standard applicable to a RB–DA, and (3) DA roofbolters. The reduction in risk predicted for each of these three categories will now be discussed in turn.

#### (1) DO Miners

As explained earlier, for DO miners the predicted lifetime exposure reduction accumulates at a rate of 0.20 mg/m<sup>3</sup> of reduced exposure per year during the 45 “working years” between

<sup>5</sup> The Attfield-Seixas model predicts a higher prevalence of CWP, and consequently a greater risk reduction (35 per thousand DO miners at age 65), after 45 years of occupational exposure to coal mine dust in central Pennsylvania or southeastern West Virginia. (Attfield and Seixas attribute this effect to the type of coal mined in those geographic areas.) However, few underground coal mines in central Pennsylvania or southeastern West Virginia are still operating. In fact, only about 29 of the 716 MMUs exhibiting a pattern of recurrent overexposures in 2001 were from those areas. Therefore, the risk assessment presented here, along with projected benefits of the rule, are based on the lower risks predicted for miners working outside central Pennsylvania and southeastern West Virginia.

<sup>6</sup> Appendix VI.2 contains a technical description of the Attfield-Seixas models and an explanation of how MSHA applied them to obtain the results shown in Table VI–1. The method used in applying the models differs slightly from that used in the previous proposed rule, and Appendix VI.2 also explains this difference. In addition, an EXCEL workbook entitled “RiskRdxn.xlw” showing the formulas used in the calculations has been placed into the public record for these proceedings.

<sup>7</sup> The expected lifetime for all American males, conditional on their having reached 20 years of age, is 73 years (calculated from U.S. Census, March 1997, Tables 18 and 119).

<sup>4</sup> If three readings were available, the median value was used. If two readings were available, the higher of the two ILO categories was recorded. Eighty radiographs were eliminated because only one reading was available.