

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 today's final changes, 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-year/m³, 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.²¹ 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

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.

²¹ 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.

by the reduction in prevalence of disease predicted at age 73.²²

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 applicable 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/m³ of reduced exposure per year during the 45 "working years" between 20 and 65, reaching a maximum of 9.0 mg-yr/m³ upon retirement at age 65. Between ages 65 and 80, the accumulated reduction in dust exposure remains at an estimated average of 9.0 mg-yr/m³, but (as also explained previously) the benefit in terms of both simple CWP and PMF risk continues to increase.

The first row of Table VI-1 presents the reductions in risk expected among affected DO miners who work at a MMU exhibiting a pattern of recurrent overexposures. For this group of miners, the calculation at an average lifetime of 73 years shows that bringing dust concentrations down to no more than the applicable dust standard on each shift would:

- Reduce the combined risk of simple CWP and PMF by 24.4 cases per 1000 affected DO miners;²³
- Reduce the combined risk of simple CWP (category 2 and 3) and PMF by 15.5 cases per 1000 affected DO miners;
- Reduce the risk of PMF by 7.6 cases per 1000 affected DO miners.

When the dust concentration measured for the DO exceeds the applicable dust standard, measurements for at least some of the other miners in the same MMU may also exceed the standard on the same shift, though usually by a lesser amount. Furthermore, although the DO represents the occupation most likely to receive the highest exposure, one or more of these other miners may be exposed to even higher concentrations

than the DO on some shifts. Therefore, the second category of affected miners addressed in Table VI-1 is the population of non-DO faceworkers other than those working in roofbolter DAs (who are addressed as a separate, third category).

(2) *NDO Miners.* This category covers all faceworkers other than the DO, except those roofbolters for which a separate DA applicable dust standard has been established. (Roofbolters *not* coming under a DA standard are included in the NDO category). To estimate how NDO miners (other than those subject to a DA standard) would be affected by the proposed rules, MSHA examined the results from all valid dust samples collected by MSHA in underground MMUs during 2001 (MSHA, data file: Insp2001.zip). Within each MMU, MSHA typically takes one sample on the DO and, on the same shift, four or more additional samples representing other occupations. In 2001, there was an average of 1.0 NDO measurement in excess of the standard on shifts for which the DO measurement exceeded the standard.²⁴ For NDO measurements that exceeded the standard on the same shift as a DO measurement, the mean excess above the standard was approximately 0.6 mg/m³.²⁵

Combining these results with the 19.3 percent rate of excessive exposures observed for the DO on individual shifts, it is reasonable to infer that, at the MMUs under consideration, an average of 1 other miner, in addition to the 1 classified as DO, is currently overexposed on at least 19 percent of all production shifts. In 2001, the mean of the highest dust concentration reported for any non-DO miner on sampled shifts was 1.08 mg/m³. Over the course of each working year, the reduction in exposure expected for such miners as a result of implementing the proposed rules is 0.12 mg-yr/m³ (*i.e.*, 19.3 percent of one year, times 0.6 mg/m³).

To assess the reduction in risk expected from eliminating all single-shift exposures for these NDO miners, MSHA again applied the Attfield and Seixas models to miners who begin working at age 20 and retire at age 65, assuming lifetimes of 65, 73, and 80 years. This time, however, the resulting decrease in predicted prevalence was multiplied by 1.0/6 = 0.167, to reflect the fact that the assumed rate of overexposure applies, on average, to

²² 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).

²³ "Affected DO miners" include all miners who work at MMUs with a pattern of recurrent overexposures and who are exposed to dust concentrations similar to the DO over a 45-year working lifetime.

²⁴ With 95-percent confidence, on shifts for which the DO measurement exceeds the standard, the mean number of other occupational measurements also exceeding the standard is at least 0.91.

²⁵ With 95-percent confidence, the mean excess is at least 0.59 mg/m³.