

**Analysis of the OSHA Half-Mask WPF Database According to Techniques Described in “Field Performance Measurements of Half-Facepiece Respirators: Developing Probability Estimates to Evaluate the Adequacy of an APF of 10” by W.R. Myers and Z. Zhuang, *Am. Ind. Hyg. Assoc. J.* 59:796-801 (1998).**

Gerry Wood, Ph.D., CIH  
Revised August 16, 2004

The OSHA database (Mtx1Data-5-21-2004.xls) used in this study contains 1339 Workplace Protection Factors (WPFs) reported and calculated from studies with both filtering facepiece half-mask respirators (760 data) and elastomeric-sealing half-mask respirators with cartridge filters (579 data). This database also contains reported or calculated outside-the-mask concentrations ( $C_o$  in  $\mu\text{g}/\text{m}^3$ ) of the various challenge agents. Asbestos fiber counts were converted to concentration units by  $1 \text{ fiber}/\text{cm}^3 = 30 \mu\text{g}/\text{m}^3$ .

The following current values of 8-hour TWA PELs were used to calculate Hazard Ratios ( $\text{HR} = C_o/\text{PEL}$ ) for this study:

Analyte	PEL ( $\text{mg}/\text{m}^3$ )
Benzo(a)pyrene	0.2
Lead	0.05
Zinc	15
Iron	10
Chromium	0.5
Titanium	15
Manganese	5
Aluminum	15
Asbestos	0.003 (0.1 fiber/ $\text{cm}^3$ )
Silica	10
Cadmium	0.005
Calcium	15

WPFs were plotted against HRs as illustrated in the figures of the Myers and Zhuang reference. The same reference lines and labels were used; but the scales were expanded to include all data in the OSHA database.

Figure 1. All Half Mask Respirators

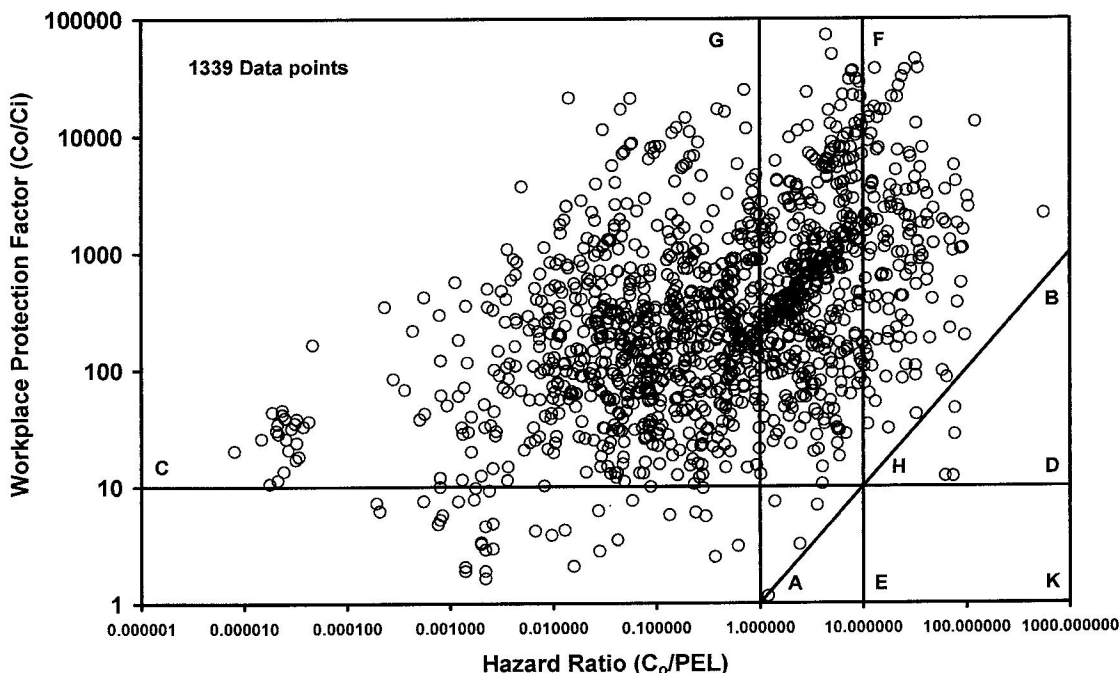
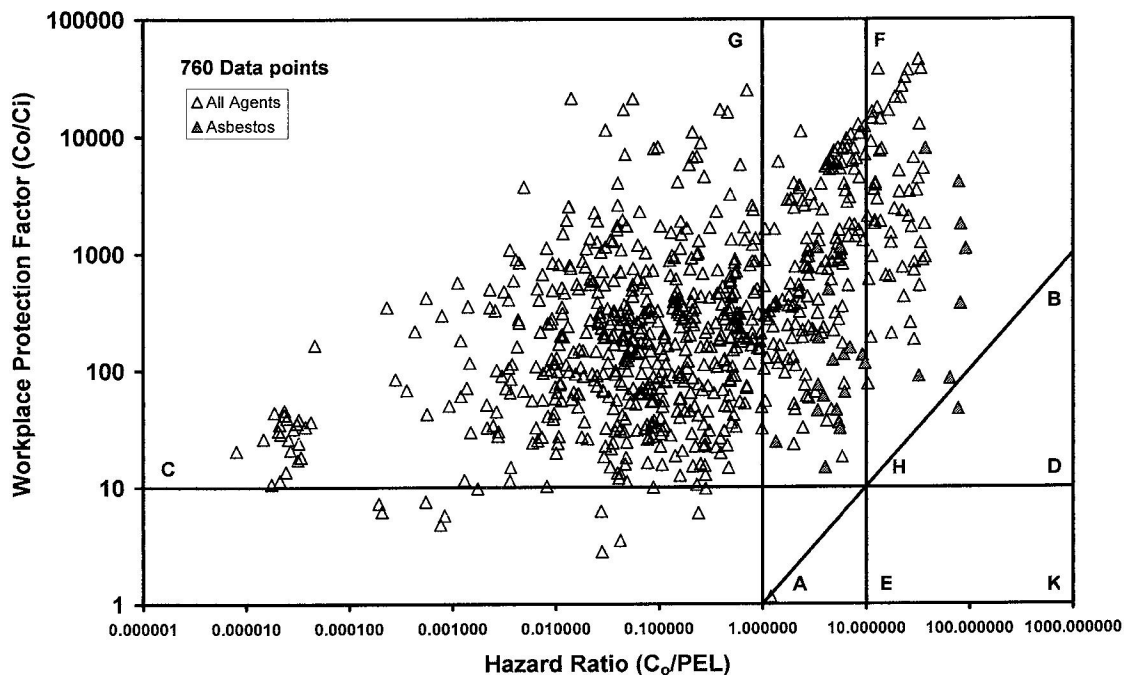


Figure 1 shows the plot of all data for both Filtering Facepieces and Elastomerics. The line labeled CD represents WPF = 10. Only 38 (2.8%) of 1339 data fall below this line. Only 5 (0.37%) data fall within the Triangle ABK, which Myers and Zhuang label as “Inadequate Protection, Overexposure.”

Figure 2 shows the same plot for the studies with Filtering Facepieces only. Only 12 (1.6%) data are below the WPF = 10 line. Two of these equal WPF = 10 when rounded off to the nearest whole number. Only 2 (0.26%) are within the ABK overexposure region. The data in the A corner from a study by Colton (CL4.15.Pb) represents an environment just above the lead PEL (HR = 1.20), but no significant exposure occurred even with a respirator/user combination resulting in virtually no protection (WPF = 1.15). The one significant overexposure data (WPF = 47, HR = 77 for PEL = 0.1 fiber/cm<sup>3</sup>) is from the asbestos study of Dixon (CL1.2.Asb).

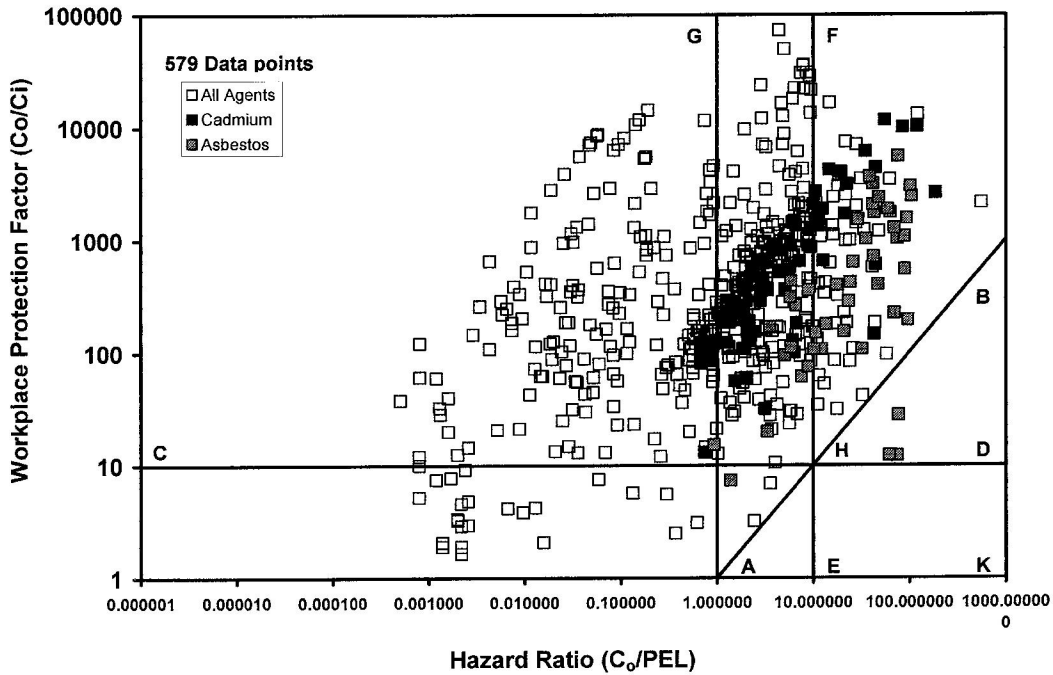
Figure 2. Filtering Facepiece Respirators  
(PELs since August 1994)



If the Maximum Use Concentration (MUC) is defined as  $MUC = APF \times PEL$  and  $APF = 10$  is assumed, then no data in the AHE triangle imply a “success (no overexposure during the wear period)” by Myers and Zhuang’s terminology. Even if one were to consider the data in the A corner a significant exposure, the “probability of success” (as defined by Myers and Zhuang) of an  $APF = 10$  with an  $MUC = 10 \times PEL$  for Filtering Facepieces would be 99.4% (160 out of 161 data in the AGFE region of HR from 1 to 10 are above AH).

Figure 3 shows the same plot for the Elastomerics. Of these 579 data 26 (4.5%) fall below  $WPF = 10$ . The 3 (0.5%) data in the ABK overexposure region are from the Dixon asbestos (CL5.2.Abs) study. However, no points of 265 in the AGFE region fall within the AHE region, demonstrating a 100% “success” of an  $APF = 10$  with an  $MUC = 10 \times PEL$ .

Figure 3. Elastomeric Respirators  
(PELs since August 1994)



The 8-hour TWA PEL for asbestos was reduced from  $0.2 \text{ fiber/cm}^3$  to  $0.1 \text{ fiber/cm}^3$  on August 10, 1994. The 8-hour TWA PEL for cadmium was reduced from  $0.10 \text{ mg/cm}^3$  to  $0.005 \text{ mg/cm}^3$  on April 23, 1993. Figures 4 and 5 show the same plots as Figures 2 and 3, but using the earlier values. For filtering facepieces only one data out of 160 between  $HR = 1$  and  $HR = 10$  is (insignificantly) an overexposure. For elastomeric facepieces there are still three overexposures (asbestos), but none of the now 241 points in the AGFE region is below AH.

Figure 4. Filtering Facepiece Respirators  
(PELs before August 1994)

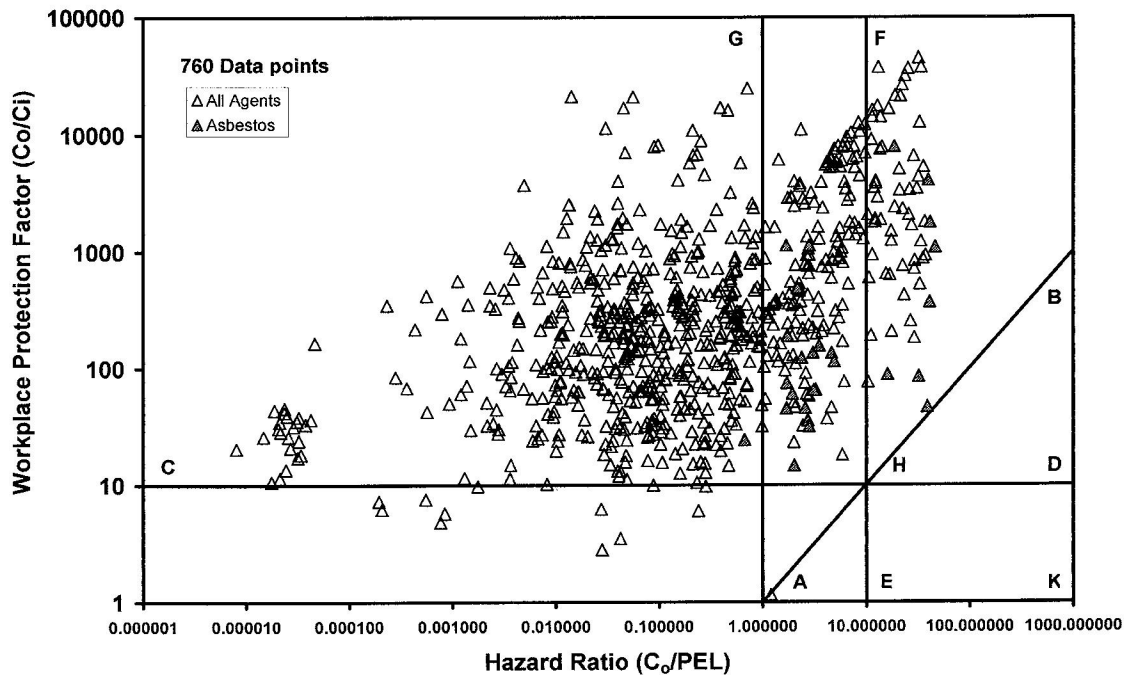


Figure 5. Elastomeric Respirators  
(PELs before April 1993)

