

B(a)P analysis followed Alcan Method #1223-84. The ambient B(a)P particle size distribution was determined by collecting four samples, as close as possible to the workers, using an 8-stage Anderson cascade impactor (Model 296). Impactor samples were collected for two to five hours at a flow rate of 2 Lpm. The average percent of B(a)P mass (across four samples) per impactor stage (defined by an aerodynamic diameter cut point, in micrometers) was reported. About 93% of the B(a)P mass was associated with particles having diameters of ≤ 9.8 micrometers. A total of 20 pairs of inside and outside sample concentrations, with associated WPFs, were provided by job category (but not for individual employees), and whether the employee had a beard. An overall GM, GSD, and 95% confidence interval on the mean were also provided for the inside and outside concentrations and WPFs, along with an overall fifth percentile WPF. The authors stated that some employees participated more than once during the study. They did not mention adjusting inside-the-facepiece values for particle retention in the respiratory tract. The authors found no significant relationship between B(a)P concentrations inside and outside of the facepiece, but they did find a correlation between WPF and outside B(a)P concentrations. The authors stated that, while the data were limited, they recommended testing PAPRs at relatively high concentrations to obtain an accurate measure of their performance. The inside B(a)P concentration ranged from 0.006 to 0.072 $\mu\text{g}/\text{m}^3$, with a GM of 0.012 $\mu\text{g}/\text{m}^3$. The outside B(a)P concentration ranged from 246 to 111.48 $\mu\text{g}/\text{m}^3$ with a GM of 16.73 $\mu\text{g}/\text{m}^3$. WPFs ranged from 371 to 8658, with a GM of 1,414. The two-sided 95% confidence interval limits around the overall GM WPF were 918 and 2,173; the fifth percentile was 275. The authors cautioned that these results WPFs achieved under conditions of good worker compliance and tight administrative control; however, without these conditions, WPFs may be less because: close surveillance of workers is not usually performed; cleaning during rest periods is not done prior to returning to the workplace; visor locking clips are not routinely used; and no respirator is used 100% of the time while in the workplace.

Study 26. At the 2001 AIHCE, D.V. Collia, *et al.* presented a study on the workplace performance of a PAPR against exposure to cadmium (Cd) for seven workers, over three days, in a nickel-cadmium battery manufacturing facility (Ex. 3-5). The respirator studied

was the 3M Breathe-Easy 12 (BE-12), a loose-fitting facepiece PAPR equipped with high-efficiency filters; the employees were using this PAPR prior to the study. During a preliminary visit, the investigators discussed the study with the union, management and workers. The authors also evaluated the worksite and took area samples to identify areas with the highest exposures. Prior to sampling, they informed the employees about their role in the study, as well as the study's purpose and procedures. The investigators continuously observed the employees during sampling, and used field blanks to identify contamination from handling. The study contained no additional information on sampling protocols (e.g., donning and doffing procedures).

Inside-the-facepiece samples were gathered using 25 mm three-piece cassettes containing an unspecified membrane filter and a porous plastic back-up pad. A nylon Liu probe was used, and the samplers were positioned directly across from the midline between the employee's nose and mouth. Outside-the-facepiece samples used 25 mm three-piece cassettes containing an unspecified membrane filter, backed with a cellulose pad. Outside samples were positioned close to the employee's breathing zone (the investigators provided no further details). All samples were collected at 2 Lpm for approximately one and one-half hours (range: 67-156 minutes).

Inside-the-facepiece samples and blanks were analyzed by flame atomic absorption spectroscopy and heated graphite furnace atomizer (AAS-HGA). Analysis of outside-the-facepiece samples was by AAS. The analytical methodology used OSHA's method for Cd in workplace atmospheres (OSHA ID-189). The authors provided the mean mass for inside and outside blanks, but made no mention of data adjustments for blanks or pulmonary retention. They also reported minimum and maximum concentrations of inside- and outside-the-facepiece samples for each employee. Supplemental data contained 41 individual measurements of inside and outside concentrations, tabulated by employee, job area, sample period and set, sample time, pump flow rate, and sampled air volume.

WPFs were calculated for 33 of the sample sets (8 of the 41 inside-the-facepiece samples had no detectable Cd). The calculated GM WPFs ranged from 1,460 to 9,440. The fifth percentile WPF was calculated in three different ways: the traditional approach yielded a fifth percentile WPF of 315; an analysis of variance (ANOVA) model, yielded a

fifth percentile of 280; and the Monte Carlo simulation model approach resulted in a fifth percentile of 220 when the non-detected inside values had a value of 0.002, a fifth percentile of 303 with the non-detected values excluded, and a fifth percentile of 103 with Employee C excluded. The authors concluded that the BE-12 PAPR provided a level of protection consistent with an APF of 25.

Study 24. D.W. Stokes, A.R. Johnston, and H.E. Mullins determined exposure to silica (Si) dust for five workers in a roofing granule production plant (Ex. 1-64-66). The participants were involved in cleanup of silica dust byproduct by sweeping, brushing walls, and shoveling. The respirator studied was the 3M Airhat, a loose-fitting PAPR with helmet, equipped with dust/mist or high-efficiency filters, and worn with and without a Tyvek shroud. The investigators assisted the participants were assisted with donning the sampling equipment; however, they did not mention training the employees. They observed the employees during sampling, and used field blanks to determine the effects of handling on sample contamination. They did not mention determining the particle size of the contaminant.

Inside-the-facepiece samples were collected through a Liu probe inserted into the faceshield (they did not provide the probe's specific location). A 25 mm cassette containing a 0.8 micron pore size polycarbonate filter was used, and sampling airflow rate was 1.5 Lpm. Outside-the-facepiece samples were gathered as both total and respirable dust. Respirable dust samples were collected at 1.8 Lpm using a 37 mm 0.8 micron pore size polycarbonate filter placed in a cyclone that attached to the employee's lapel. Total dust samples also used a 37 mm 0.8 micron pore size polycarbonate filter. Sampling airflow rate was 2 Lpm, with the sampling cassette attached to the employee's lapel. The investigators calibrated the sampling pumps each day, and checked proper airflow rate three times throughout the day. They collected samples over a four-day period, with sampling times ranging from 30 minutes to 1 hour. At the beginning and end of each sample, the authors confirmed that each PAPR's airflow rate was in excess of 6 cfm.

The authors used proton induced x-ray emission (PIXE) to analyze the samples. They adjusted the inside- and outside-the-facepiece concentrations by subtracting the mean blank value, but did not mention adjustments for pulmonary retention of particles. They also did not provide individual inside-