

250, the GSD was 6.9, and the best estimate of the fifth percentile was 11.

Since the WPFs for respirators equipped with DFM and high-efficiency filters were similar, and were well below the protection expected if filter efficiency alone was the determining performance factor, the authors concluded that “* * * filter efficiency was not as significant a factor in determining the relative workplace performance against asbestos as the face fit”. The authors also noted comparable performance between disposable and elastomeric respirators. With regard to this, the authors noted that perspiration and wetting solutions led to the elastomeric facepieces slipping on the participants’ faces, something that was not noted with the fibrous disposable respirators. The authors postulate that the effect of this slippage could be a reason why the two types of respirators had similar performance.

Study 3. In 1993, A. Gaboury and D.H. Burd performed a WPF study by measuring exposure to benzo(a)pyrene [B(a)P] on particles among 22 workers in a primary aluminum smelter (Ex. 1–64–24). The participants were rack raisers, stud pullers, and rod raisers on anode crews. The following three brands of elastomeric half-mask respirator devices were studied: Willson, Survivair, and American Optical. (**Note:** Respirator model numbers were not provided) The respirators were equipped with combination organic vapor/acid gas cartridges and DFM pre-filters, with the exception that dust/mist pre-filters were used on the American Optical respirator. The study also examined the performance of a powered air-purifying respirator (PAPR), but only the negative-pressure, air-purifying half-mask respirator data are presented here (the PAPR results are discussed below). The participants had used respirators for several years, had been previously trained in the use of the particular respirator under study, and had used it for more than six months. All participants in half-mask respirators were clean-shaven and were quantitatively fit tested using the TSI Portacount. The minimum acceptable fit factor was 100. Industrial hygiene technologists assisted participants with donning and doffing respirators, cleaned and maintained the respirators at the end of each work cycle, and observed participants on a one-to-one basis throughout the sampling period. Participants were directed not to tamper with the respirator or sampling equipment. Due to the high heat in the work area, the employer required that employees rest in a cool environment for one-half hour during each hour.

The inside-the-facepiece sampling train consisted of a closed-face three-piece cassette with a 25 mm organic binder free glass fiber filter, backed with a cellulose ester pad. The sampling cassettes were connected to a tapered Liu probe inserted into the respirator between the nose and mouth. The outside-the-facepiece sampling train was identical to the inside-the-facepiece sampling train; however, no mention is made of connecting the cassette to a Liu probe. All filters were pre-calcined at 400 degrees Centigrade for 24 hours. Both inside and outside samples were collected at a flow rate of 2 Lpm for approximately 300 minutes, or one-half of the 10-hour work shift. Respirators and sampling trains were worn and operated until the employee entered the rest area; they were donned and started prior to leaving the rest area for the next work cycle. Sampling cassettes were plugged when not in use and the respirators were cleaned after each work cycle. Field blanks were used to identify possible contamination due to handling. Sampling train airflow rates were checked at the beginning, middle (*i.e.*, after lunch), and end of the work day; on changing the cassettes; and when a problem was suspected. Sampling occurred over a five-day period. Only stud pullers and rod raisers used the elastomeric half-mask respirators.

B(a)P analysis followed the 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 less than 9.8 micrometers. A total of 18 pairs of inside and outside sample concentrations, with associated WPFs, were provided by brand of respirator and job category, but were not linked to specific participants. Overall GM, GSD, and 95% confidence interval on the mean were also provided for the inside and outside concentrations and WPF, along with an overall fifth percentile WPF. The authors stated that some employees participated more than once during the study. No mention is made of adjusting inside-the-facepiece concentrations for particle retention in the respiratory tract. The half-masks had WPF ranging from 13 to 410, with a GM of 47. The two-sided 95% confidence

intervals were 30 and 74 for the dual cartridge respirators. The fifth percentile was 9. The authors found no significant relationship between B(a)P concentrations inside and outside the facepiece. Also, while the data were limited, the authors believed no correlation existed between WPF and quantitative fit factor. The authors concluded that the fifth percentile for the half-masks they tested were in agreement with the APF of 10 recommended by the NIOSH RDL.

Study 6. S.W. Lenhart and D.L. Campbell reported in 1984 on a WPF study in which they measured protection against exposure to particulate lead (Pb) for 25 primary lead smelter workers; seven of whom worked in the sinter plant and eighteen of whom were in the blast furnace area (Ex. 1–64–42). The predominant aerosol forms of lead were dust in the sinter plant and fume in the blast furnace. In both areas, lead comprised about 50% of the total aerosol particulate with composition of the remaining 50% being unknown. All participants wore an MSA elastomeric half-mask with high-efficiency filters. (**Note:** No respirator model number was provided) The study also examined the performance of an MSA PAPR, but only data for the negative-pressure, air-purifying half-mask respirator are presented here (the PAPR results are discussed below). The employees routinely used respirators; however, no mention is made of them with respirator training. Participants were quantitatively fit tested using an unspecified method, and had to achieve the employer’s required fit factor of 250. Workers were instructed not to remove or manipulate the respirator during sampling, and were observed by the researchers throughout the sampling period.

The inside-the-facepiece sampler consisted of a closed-face 37 mm cassette containing an AA filter and AP10 support pad. This cassette was connected to a tapered Liu probe that was inserted into the respirator between the nose and upper lip. In-mask samples were collected at 2 Lpm. The outside-the-facepiece sampling train was a closed-face 37 mm cassette containing an AA filter and AP 10 support pad; no tapered Liu probe was used. The outside sample cassette was attached to the worker’s lapel. Outside samples were gathered at 2 Lpm. The authors collected samples for as much of each 8-hr work shift as possible. Respirators and sampling trains were donned and doffed, and samplers were started and stopped, in a lead-free area. Respirator facepieces were wiped clean inside