

PIXE in-facepiece values, the GM WPF was 10,344, the GSD was 2.5, and the fifth percentile WPF was 2290. The authors stated that the loose-fitting hood performed differently than a loose-fitting PAPR, and this difference should be reflected in the APF assigned. In addition, they briefly discussed a comparison of the study results with the results of several other PAPR and air-line respirator studies.

*Study 25.* In 2001, T.J. Nelson, T.H. Wheeler, and T.S. Mustard published a WPF study of a supplied-air hood (Ex. 3–6). They measured exposure to strontium (Sr) for 19 painters and helpers involved in sanding and painting operations on several types of aircraft. They judged the work rate to be light to moderate. Prior to sampling, they informed the employees about the study, and instructed them to remain connected to the air supply during calibration and sampling. The participants used a 3M H–422 series supplied-air hood, equipped with an outer bib with an inner shroud and hard hat, H–420 hood, W–3258 hard hat, W–2878 suspension, 50 feet of W–9435 hose, and either the W–2862 vortex cooling assembly or the W–2863 vortex heating assembly. The investigators regulated the supply air pressure to between 60 and 80 psi. Employees donned the hoods in the work area, but investigators did not attach the sampling cassettes until after the employees connected the hood to the air supply and airflow began. They used field blanks to identify possible contamination due to handling, storage or shipment. In addition, they used manufacturer's blanks to detect contamination from manufacture of the filter, and a system blank to determine if contamination was present in the air supply.

The investigators collected inside- and outside-the-facepiece samples using 37 mm or 25 mm three-piece cassettes containing mixed cellulose ester filters. The first 19 samples (*i.e.*, collected during sanding) utilized 37 mm cassettes/filters, but half of the outside samples had no detectable Sr. To increase analytical sensitivity, they collected the remaining 18 samples with 25 mm cassettes and filters. Once the employee was connected to the air supply, they attached a sampling cassette inside the hood at a point midway between the nose and mouth, and to the side of the face. They then uncapped the cassette and connected a Liu probe to the cassette inlet. The authors placed the outside cassette in the lapel area and pointed it forward and down. They started the sampling pumps simultaneously, and performed

in-line calibration. They collected samples at an airflow rate of 2 Lpm, for a period consisting of 2 hours for sanding and 90 minutes for painting. At the end of sampling period, they in-line calibrated the pumps, stopped the pumps, capped and removed the cassettes, and the employees disconnected and doffed the hood. They collected the system blank by mounting a cassette in an operating hood that was located away from the work area, and sampled air from inside the hood at 2 Lpm for 2 hours. The authors did not mention making a particle size determination.

The investigators analyzed the outside-the-facepiece samples and one of the manufacturer's blanks using NIOSH Method 7300. They used PIXE analysis for the inside-the-facepiece samples, field blanks, system blank, and the other manufacturer's blank. They tabulated the sampling results by date, activity, employee, sample time, inside and outside sampled volumes, inside and outside concentrations, and WPF. The authors reported thirty-one individual inside- and outside-the-facepiece concentrations. However, the results of the outside samples obtained during sanding operations were only 30 times greater than the inside sample values. Therefore, the authors did not consider the data from the sanding operations to be a very useful indicator of respirator performance, and they did not calculate WPFs for the initial 19 sanding samples. Of the remaining 18 painting samples, they calculated WPFs for only 15 samples, after discarding 3 samples due to sampling errors. The Sr levels measured outside of the respirator ranged from 340 to 24,529  $\mu\text{g}/\text{m}^3$ , but the investigators found no detectable amounts of Sr on any inside-the-facepiece sample. Therefore, the authors could not directly determine WPFs for the respirator. However, they estimated WPFs by substituting the limit of detection for the inside concentration values. This procedure resulted in estimated WPFs that ranged from more than 920 to 52,000. The authors concluded that their study was “ \* \* \* consistent with other simulated and WPF studies in that the ANSI Z88.2 WPF of 1000 is supported.”

#### 8. SWPF Studies—Type CE Abrasive Blasting Respirators

*Bullard: 1995 LLNL Evaluation.* During the development of the Interim Final Standard for Lead (Pb) in Construction (1926.25; 1996) and the Final Respiratory Protection Standard (63 FR 1152; 1998), the E.D. Bullard Company (Bullard) expressed concern about the APF of 25 for Type CE

respirators. The concern was that the interim final lead rule, as issued, went far beyond the HUD guidelines by assigning a different and lower protection factor to Type CE respirators than the HUD guidelines, which incorporated the general industry standard at 29 CFR § 1910.1025. Bullard maintained that its Model 77 and 88 respirators provide much greater protection, and sought to have the APF for these models elevated to 1,000 in the Lead in Construction Standard. OSHA agreed to provide Bullard with the relief sought only if it contracted with an acceptable third party to design, monitor, and interpret the results of a simulated workplace study of these models under an appropriate and acceptable test protocol. As a condition for granting that relief, the study had to demonstrate that the abrasive blasting respirators achieved, at a minimum, a protection factor rating of at least 20,000 and maintained positive pressure throughout the testing.

Bullard contracted with Lawrence Livermore National Laboratory (LLNL) which designed, conducted, and interpreted the results of the SWPF study, based on a protocol that was acceptable to OSHA. The LLNL informal report resulting from the testing indicated (based on computerized data backed up by strip chart recordings) that the two Bullard abrasive blast respirators achieved a minimum protection factor of 40,000 and maintained positive pressure throughout the testing.

Therefore, the SWPF study conducted by LLNL demonstrated that, if used properly, the Bullard respirators were acceptable for lead exposures that are less than or equal to 1,000 times the PEL (50,000  $\mu\text{g}/\text{m}^3$ ). In an August 30, 1995 memo to its Regional Administrators, OSHA recognized that the SWPF study results indicated that an APF greater than 25 was appropriate for the Bullard Model 77 and Model 88 respirators, and the Agency granted these models an interim APF of 1,000 when used for lead in construction (Ex. 3–8–4; memo to RAs dated 8/30/95). However, the memo also noted that the Agency was aware of other data and at least one field study showing that in the workplace these respirators may provide considerably less protection when used in ways that do not conform to the manufacturer's specifications (*e.g.*, the air supply hose is too long; the hose diameter is incorrect; the manufacturer's specified air pressure is not maintained) or that do not comply with the requirements of paragraphs (b), (d), (e) and (f) of 1910.134 (*e.g.*, the respirator is not inspected frequently enough for