

WPF studies for full facepiece PAPRs (by name of authors and model of respirator tested)	Sample size	Geometric mean	Geometric standard deviation	5th percentile WPF
Study 2 .....	55	8,843	3.2	1,335
Myers and Peach (Ex. 1–64–46) Full facepiece PAPR (manufacturer and model not specified) .....	10	54	2.44	.....
<sup>1</sup> Study 1 consisted of 20 samples with C <sub>i</sub> values over the detection limit, while Study 2 consisted of 34 samples that had C <sub>i</sub> values below the detection limit; for analytic purposes, the investigators assigned these 34 samples a C <sub>i</sub> value equal to the detection limit.				
WPF studies for PAPRs with hoods or helmets (by name of authors and model of respirator tested)	Sample size	Geometric mean	Geometric standard deviation	5th percentile WPF
Keys <i>et al.</i> (Ex. 1–64–40):				
Racal Breathe Easy 10 (hood, double bib, HEPA filter) .....	29	11,137	3.9	1,197
Bullard Quantum (hood, double bib, HEPA filter) .....	9	9,574	3.1	1,470
3M Whitecap II (helmet, double bib, HEPA filter) .....	22	42,260	9.8	997
SWPF studies for PAPRs with hoods or helmets (by name of authors and model of respirator tested)	Range of SWPFs	Geometric median SWPF	5th percentile SWPF	
ORC–LLNL SWPF Study (Ex. 3–4):				
3M Whitecap (helmet with bib and HEPA filter) .....	140,000–>250,000	>250,000	>250,000	
3M Snapcap (Tyvek hood with bib and HEPA filter) .....	11,000–>250,000	>250,000	>170,000–210,000	
Racal BE–5 Clear PVC (hood with bib and HEPA filter) .....	11,000–>250,000	>250,000	>250,000	
Racal BE–10 (Tyvek hood with bib and HEPA filter) .....	94,000–>250,000	>250,000	246,000–>250,000	

OSHA is proposing an APF of 1,000 for full facepiece PAPRs and PAPRs with hoods or helmets. With regard to full facepiece PAPRs, the corrected fifth percentile protection factor of 1,335 reported by Colton and Mullins in their WPF study fully supports the proposed APF. The WPF study of PAPRs with hoods or helmets by Keys, Guy, and Axon justifies the proposed APF of 1,000 for this respirator class. These authors reported that the average fifth percentile protection factor for the three respirators tested in their study was well over 1,000. Moreover, the ORC–LLNL SWPF Study (Ex. 3–4), in which this class of respirators received extremely high fifth percentile protection factors, lends substantial validation to OSHA's proposed APF. In addition, the proposed APFs for full facepiece PAPRs and PAPRs with hoods or helmets corresponds with the APFs assigned to these respirator classes in the 1992 ANSI standard; ANSI made these APF determinations only after a careful review and discussion of the available research by a panel of respirator experts. While the proposed APF for these respirators is much higher than the APF recommended in the 1987 NIOSH RDL, the Agency believes that the WPF and SWPF studies conducted on these respirators since publication of the RDL justify the proposed increase.

Footnote 4 of the proposed APF table states that “\* \* \* only helmet/hood respirators that ensure the maintenance of a positive pressure inside the facepiece during use, consistent with performance at a level of protection of

1000 or greater, receive an APF of 1,000.” The footnote continues, “All other helmet/hood respirators are treated as loose-fitting facepiece respirators and receive an APF of 25.” OSHA is proposing that respirators from this class be able to demonstrate that they maintain a positive pressure inside the facepiece during use and achieve a level of protection of 1000 or greater. Available WPF and SWPF studies have found that some of these respirators were shown to only achieve protection factors well below 1,000 (Exs. 3–4, 3–5). In all likelihood, the burden of conducting any testing would fall on respirator manufacturers, but the employer would be responsible for selecting a properly tested respirator, thereby assuring employees that they will receive adequate protection against toxic hazards.

*OSHA's proposed APFs for loose-fitting PAPRs.* A number of WPF and SWPF studies are available for loose-fitting facepiece PAPRs. An important purpose of these studies was to determine if APFs differed between loose-fitting facepiece PAPRs and PAPRs with tight-fitting hoods or helmets. The NIOSH WPF study by Myers, Peach, Cutright, and Iskander (Ex. 1–64–47) was the first to report that loose-fitting facepiece PAPRs did not perform at an APF of 1,000, the value determined by Ed Hyatt in 1976 after quantitatively fit testing a panel of respirator users. A follow-up study by Myers, Peach, Cutright, and Iskander (Ex. 1–64–48) reported a fifth percentile

protection factor of 25 for this respirator class.

A WPF study conducted later by Albrecht, Gosselink, Wilmes, and Mullins (Ex. 1–64–23) reported a fifth percentile protection factor of 42 for the 3M Airhat, a loose-fitting facepiece PAPR with a helmet. Stokes, Johnston, and Mullins (Ex. 1–64–66) performed a WPF study in a roofing granule production plant using the 3M Airhat; they found a fifth percentile protection factor of 95. However, when employees used the respirator with a Tyvek shroud, the fifth percentile protection factor increased to 1,615. Gaboury and Burd (Ex. 1–64–24) reported a fifth percentile protection factor of 275 in a WPF study in which employees in an aluminum smelter wore a Racal Breathe Easy loose-fitting facepiece PAPR with a helmet. Collia, Colton, and Bidwell (Ex. 3–5) found a fifth percentile protection factor of 315 in a WPF study performed on the 3M Breathe Easy 12 PAPR with a loose-fitting head cover.

OSHA evaluated three SWPF studies addressing the performance of loose-fitting facepiece PAPRs with hoods or helmets. Skaggs, Loibl, Carter, and Hyatt (Ex. 1–38–3) reported geometric mean protection factors ranging from 1,900 to 5,600 for the 3M Airhat, and from 1,200 to 3,500 for the Racal AH3 PAPR with a loose-fitting helmet. A study by da Roza, Cadena-Fix, and Kramer (Ex. 1–64–94) found geometric mean protection factors ranging from 10 to 10,000, and from 100 to 20,000, for the two loose-fitting facepiece PAPRs with helmets they tested.