

(Ex. 1–64–42). For the entire sample, the authors reported a geometric mean protection factor of 380 and a fifth-percentile protection factor of 58.

Two SWPF studies also evaluated tight-fitting half-mask PAPRs. Skaggs, Loibl, Carter, and Hyatt (Ex. 1–38–3) used fit testing to assess the performance of the respirators in a test

chamber under variable temperature and humidity conditions. They found that the geometric mean protection factor for the entire sample ranged from 14,200 to 20,000. In the second SWPF study, da Roza, Cadena-Fix, and Kramer tested a panel of respirator users who exercised on a treadmill at different

work rates (Ex. 1–64–94). The geometric mean protection factor for the entire sample (*i.e.*, combining respirator performance at all work rates) was 5,000.

The following table provides a summary of the WPF and SWPF studies for tight-fitting half-mask PAPRs.

WPF studies for half-mask PAPRs (by name of authors and type/model of respirator tested)	Sample size	Geometric mean	Geometric standard deviation	5th percentile WPF
Lenhart and Campbell (Ex. 1–64–42), MSA	25	380	2.6	58
Myers and Peach (Ex. 1–64–46), PAPR (manufacturer and model not specified)	10	54	2.44
SWPF studies for half-mask PAPRs (by name of authors and type/model of respirator tested)	Sample size	Geometric mean	Geometric standard deviation	5th percentile SWPF
Skaggs <i>et al.</i> (Ex. 1–38–3), MSA with Comfo II facepiece	60	14,200–20,000
da Roza <i>et al.</i> (Ex. 1–64–94), MSA with Comfo facepiece	16	2 5,000

¹ The six respirator users of the test panel exercised on a treadmill.

² The geometric mean is for all exercise rates combined.

In arriving at a proposed APF of 50 for tight-fitting half-mask PAPRs, OSHA relied to a large extent on the WPF study conducted by Lenhart and Campbell. This study was well controlled and collected data under actual workplace conditions; these conditions ensure that the results are reliable and represent the protection employees likely would receive under conditions of normal respirator use. The Agency did not consider the Meyers and Peach WPF study for this purpose because of problems involving filter assembly leakage and poor facepiece fit reported by the authors; consequently, the abnormally high levels of silica measured inside the mask would most likely underestimate the true protection afforded by the respirator. The two SWPF studies reported much higher geometric mean protection factors than did the WPF study performed by Lenhart and Campbell. However, OSHA believes that the higher protection factors reported for these SWPF studies are consistent with the proposed APF of 50 based on data obtained for this respirator class in the Lenhart and Campbell WPF study because SWPF studies typically report significantly higher protection factors than WPF studies of the same respirator. In addition, the proposed APF duplicates

the APFs assigned to tight-fitting half-mask respirators by the 1987 NIOSH RDL and the 1992 ANSI standard, both of which based their APF determinations on data reported in the existing scientific literature, as well as the opinions of well known experts on respiratory protection.

OSHA's proposed APFs for full facepiece PAPRs and PAPRs with hoods or helmets. Two WPF studies determined protection factors for tight-fitting full facepiece PAPRs. Myers and Peach conducted the first of these studies in 1983 (Ex. 1–64–46); OSHA described this study in its earlier discussion of tight-fitting half-mask PAPRs. As noted in this discussion, the Agency did not use the results of this study because of problems involving filter assembly leakage and poor facepiece fit reported by the authors. The second WPF study, by Colton and Mullins, reported a geometric mean protection factor of 4,226, and a fifth percentile protection factor of 728 for employees in a secondary lead smelter (Ex. 1–64–12). Thirty-four samples in this study had no detectable lead inside the respirators; therefore, the authors used the limit of detection for lead as a proxy for the concentration of lead inside the facepiece. When the authors corrected their data analysis by

including these samples, the geometric mean protection factor increased to 8,843, and the fifth percentile protection factor rose to 1,335. No SWPF studies on full facepiece PAPRs were available.

One WPF study and one SWPF study are available for tight-fitting PAPRs with hoods or helmets. In the WPF study, Keys, Guy, and Axon, determined the protection afforded to employees in a pharmaceutical manufacturing plant by three different respirators in this class (Ex. 1–64–40). The fifth percentile protection factors for these respirators were 997, 1,197, and 1,470. Johnson, Biermann, and Foote of LLNL and Cohen, Hecker, and Mattheis of the Organization Resources Counselors (ORC) performed the single SWPF study (referred to here as “the ORC-LLNL SWPF Study”) in which they collected 576 test samples from four different PAPRs with hoods or helmets, and equipped with bibs (Ex. 3–4–2). The lowest protection factor among the 576 test samples was 11,000; overall, the 576 test samples had a fifth percentile protection factor greater than 250,000.

The following tables summarize the WPF studies for tight-fitting full facepiece PAPRs, and the WPF and SWPF studies involving PAPRs with hoods or helmets.

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
Colton and Mullins (Ex. 1–64–12) 3M W–3205 Whitecap (with 3M 7800 full facepiece and HEPA filter): Study 1 ¹	20	4,226	2.9	728