

WPF studies for filtering facepieces (by name of authors and model of respirator tested)	Sample size	Geometric mean	Geometric standard deviation	5th percentile WPF
Survivair 2000 and MSA Combo II (with HEPA filter)	14	94	3.0	16
North 7700 (with HEPA filter)	14	250	6.9	11
Dixon and Nelson (Ex. 1-64-19):				
Survivair 2000 (with HEPA or OV filter)	37	3,400	3.8	390
Colton <i>et al.</i> (Ex. 1-64-13):				
3M 6000 (with HEPA filter and cadmium particulate)	25	333	4.18	32
3M 6000 (with HEPA filter and lead fume)	31	129	3.15	19
Colton and Bidwell (Ex. 4-10-4):				
3M 7000 (with 7255 HEPA mechanical filter)	21	1,006	4.65	80
3M 7000 (with 2040 HEPA electrostatic filter)	22	562	3.5	71

OSHA found only one SWPF study on half-mask air-purifying respirators. In 1987, Skaggs, Loibl, Carter, and Hyatt (Ex. 1-38-3) of LANL performed a SWPF study that included laboratory testing of the MSA Comfo II half-mask air-purifying elastomeric respirator. The geometric mean fit factors they measured during simulated work exercises ranged from 800 to 5,700 for this half-mask. These results appear to complement the WPF results discussed in the following paragraph.

The summary statistics for WPF studies of filtering facepieces and elastomeric half-masks presented in the previous tables show little difference between these two major subclasses of half-mask respirators. Most importantly, the estimated protection factors for these two subclasses evidence considerable overlap. In addition, both tables show that many respirators in each class received estimated protection factors above 10, while a few respirators performed below that level. Accordingly, the WPF studies overall support assigning an APF of 10 for this respirator class (*i.e.*, half-masks), which consists of quarter masks, filtering facepieces, and elastomeric half-mask respirators. OSHA could find no studies on the performance of quarter masks, but just as in the 1992 ANSI standard (Ex. 1-50) has included quarter masks with half-masks.

The statistical analyses of these studies performed by Dr. Kenneth Brown (see section IV above)

corroborate these conclusions. These analyses could not differentiate between filtering facepieces and elastomeric half-masks, which justifies combining the study data for these two subclasses into a single class for a subsequent APF determination. This determination showed that nearly 96% of the WPF data in these combined studies were at or above an APF of 10.

3. Full Facepiece Air-Purifying Respirators

Historical development of APFs for full facepiece air-purifying respirators. In 1976, Ed Hyatt of LANL developed an APF table that included this respirator class (Ex. 2). In this report, Hyatt used the results from quantitative fit testing to assess six models of full facepiece negative pressure air-purifying respirators equipped with HEPA filters. Five of these respirators achieved a protection factor of at least 100 for 95% of the respirator users; the sixth respirator attained this level of protection for 70% of the users. Based on the results for the sixth respirator, Hyatt recommended an APF of 50 for the respirator class as a whole.

The 1980 ANSI standard listed an APF of 100 for full facepiece air-purifying respirators with DFM filters. ANSI increased the APF for this respirator class from 50 to 100 because the poorly performing respirator in Hyatt's study was no longer in production. Using the 1976 LANL quantitative fit-testing results, the 1980

ANSI standard increased this APF to a maximum of 1,000 when the respirator used HEPA filters and the respirator users received quantitative fit testing.

Based on Hyatt's 1976 data, the 1987 NIOSH RDL recommended that this respirator class receive an APF of 50 when equipped with a HEPA filter, and an APF of 10 when using DFM filters. NIOSH developed the lower APF of 10 for respirators equipped with DFM filters after it tested the efficiency of these filters. In the absence of workplace protection factor studies of full facepiece respirators, NIOSH based these APFs on results from earlier quantitative fit testing performed by LANL on panels of respirator users.

The 1992 ANSI standard retained the 1980 ANSI standard's APF of 100 for full facepiece air-purifying respirators, but required that respirator users perform fit testing and achieve a minimum fit factor of 1,000 prior to using the respirators; in this regard, quantitative fit testing was necessary because no qualitative fit test could achieve a fit factor of 1,000. The ANSI standard kept this APF because the ANSI committee found that no new WPF or SWPF studies had been performed for this respirator class since it last issued APFs in 1980.

The following table summarizes the previous APFs assigned to full facepiece air-purifying respirators, beginning with Hyatt's studies at LLNL in 1976 through the 1992 ANSI standard.

Full facepiece air-purifying respirators	APFs			
	LANL (1976)	1980 ANSI standard	NIOSH RDL (1987)	1992 ANSI standard
All respirators in the class	50 (with HEPA filter)	10 (with QLFT) 100 max. (with QNFT) ...	10 (with DFM filter) 50 (with HEPA filter).	100

OSHA's proposed APFs for full facepiece air-purifying respirators. Although the 1992 ANSI standard assigned an APF of 100 to full facepiece air-purifying respirators, OSHA believes

that studies completed after 1992 indicate that an APF of 100 is too high. Colton, Johnston, Mullins, and Rhoe (Ex. 1-64-14) assessed the protection afforded to 13 employees over a four

day period by the 3M 7800 full facepiece air-purifying respirator equipped with a HEPA filter. In this WPF study, the employees performed their regular tasks in the blast furnace,