

Johnson, Biermann, and Foote of LLNL and Cohen, Hecker, and Mattheis of ORC (Ex. 3-4) assessed the performance of one loose-fitting facepiece PAPR with a Tyvek head

cover as part of the ORC-LLNL SWPF Study; the results of this study reported three APFs below 10,000, with the lowest value being 240. The fifth percentile protection factor for this

respirator ranged from 150,000 to 230,000.

The following tables summarize the WPF and SWPF studies for loose-fitting facepiece PAPRs with hoods or helmets.

WPF studies for loose-fitting facepiece PAPRs with hoods or helmets (by name of authors and model of respirator tested)	Sample size	Geometric mean	Geometric standard deviation	5th percentile WPF
Myers <i>et al.</i> (Ex. 1-64-47):				
3M W-344 (helmet with HEPA filter)	23	165	3.57	26
Racal AH 3 (helmet with HEPA filter)	23	205	2.83	26
Albrecht <i>et al.</i> (Ex. 1-64-23) 3M Airhat (helmet with HEPA filter)	7	199	2.36	42
Myers <i>et al.</i> (Ex. 1-64-48):				
3M W-316 (helmet with DM filter)	22	135	1.89	25
Racal AH 5 (helmet with DM filter)	24	120	2.64	25
Gaboury and Burd (Ex. 1-64-24) Racal Breathe Easy I (helmet with HEPA or OV filter)	20	1,414	2.51	275
Collia <i>et al.</i> (Ex. 3-5) 3M Breathe Easy 12 (Tyvek head cover with HEPA filter)	41	2,523	.....	315
Stokes <i>et al.</i> (Ex. 1-64-66):				
3M Airhat (helmet) with:				
HEPA filter (total) ¹	12	5,370	3.0	762
DM filter (without shroud)	27	877	5.2	53
DM filter (with shroud)	18	11,792	3.1	1,615
DM filter (total)	45	2,480	7.0	95

¹ The total consists of the shroud and no-shroud samples combined.

SWPF studies for loose-fitting facepiece PAPRs with hoods or helmets (by name of authors and model of respirator tested)	Sample size	Geometric mean	Geometric median	5th percentile SWPF
Skaggs <i>et al.</i> (Ex. 1-38-3):				
3M Airhat W-344 (helmet)	60	1,900-5,600	.....	.....
Racal AH3 Airstream (helmet)	60	1,200-3,500	.....	.....
da Roza <i>et al.</i> (Ex. 1-64-94):				
3M Airhat W-344 (helmet)	16	10-10,000	.....	.....
Racal Breathe-Easy 1 (helmet)	6	100-20,000	.....	.....
ORC-LLNL SWPF Study (Ex. 3-4):				
Racal BE-12 (Tyvek head cover)	144	240-250,000	250,000	150,000-230,000

¹ Used same panel of six respirator users for both respirators; panel exercised on treadmill at 80% cardiac capacity.

OSHA is proposing an APF of 25 for loose-fitting PAPRs with hoods or helmets, which is consistent with both WPF studies conducted by Myers, Peach, Outright, and Iskander (Ex. 1-64-47 and 1-64-48), as well as the APFs for this respirator class established by the 1987 NIOSH RDL and by the 1992 ANSI standard. The extreme variability of the fifth percentile protection factors in the WPF studies warrants a conservative approach in proposing an APF for this respirator class. In this regard, seven of the 11 WPF studies found fifth percentile protection factors of less than 100, and five of these APFs were below 50. The Agency believes that a proposed APF of 25 would provide employees who use these respirators with an adequate safety margin in view of the unreliability of the protection factors found for this respirator class.

The geometric means reported by Skaggs, Loibl, Carter, and Hyatt (Ex. 1-38-3) were low for a SWPF study, as were a number of the geometric means determined by de Rosa, Cadena-Fix, and

Kramer (Ex. 1-64-94) in their SWPF assessments. In the workplace, these low geometric mean SWPFs likely would translate into fifth percentile WPFs of less than 50. Therefore, the limited and highly variable data in the SWPF studies support OSHA's conclusion that a conservative APF of 25 would afford employees an adequate and consistent level of respirator protection in the workplace.

5. Supplied-Air Respirators (SARs)

Historical development of APFs for SARs. SARs operate in one of three modes—demand, continuous flow, or pressure demand. Demand or pressure demand respirators have either a tight-fitting half-mask or a tight-fitting full facepiece, while continuous flow respirators have either a tight-fitting, or a loose-fitting, hood or helmet, or a tight-fitting half-mask or full facepiece.

In 1976, Ed Hyatt of LANL published the initial protection factors for SARs (Ex. 2). In making these determinations, Hyatt gave an APF of 10 to half-mask SARs operated in the demand mode,

while full facepiece SARs received an APF of 50 in the demand mode. These APFs are the same APFs that Hyatt assigned to negative pressure half-masks, and full facepiece, air-purifying respirators. Hyatt based the APF of 10 for half-mask SARs operating in the demand mode on LANL studies performed in 1971 and 1972 on a respirator test panel wearing eight half-mask air-purifying respirators equipped with HEPA filter. In determining an APF of 50 for full facepieces, Hyatt relied on LANL studies in which a respirator test panel consisting of 31 firemen wore full facepiece SCBAs operating in the demand mode.

Hyatt regarded SARs that operate in a positive pressure mode to be more protective than SARs used in a negative pressure mode; therefore, he assigned half-mask and full facepiece SARs that function in the continuous flow, pressure demand, or other positive pressure modes APFs of 1,000 and 2,000, respectively; the half-mask respirators received a lower APF than the full facepiece respirators because