

**Peak Inhalation Air Flow and Minute Volumes  
Measured in a Bicycle Ergometer Test**

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**ABSTRACT**

There are many important physical and physiological factors to consider when designing, testing and certifying respiratory protective devices. In 1943, Leslie Silverman identified two of the most important factors to be the maximum rate at which air flows during each inspiration and the length of time during which this maximum air flow continues. Despite his finding, there are few papers in the literature that have actually reported the inhalation flow rate. Mostly when flow rates are reported they had been arrived at by a formula. This paper reports respiratory data measured for various respiratory protective devices (RPD) at various metabolic rates, with and without speech. As particle filters are velocity-dependent, the flow rate through the filter will dictate the overall performance of the RPD. Thus, we were specifically interested in the minute volume and the peak inhalation airflow (that is, the highest flow reached during each breath) measured at the work rates applicable to tasks performed by first responders.

Seven test subjects participated in this study pedaling a bicycle ergometer at various work rates between 50 and 200 W. Five full-face masks with different inhalation and exhalation characteristics were used. The average minute volume inhaled was 55.3 L/min (n=203) without speech. When subjects were asked to read aloud as when talking normally, the value was significantly lower 45.1 L/min (n=203). The average PIAF without speech was 169 L/min, and with speech 266 L/min. The high PIAF values observed in this study can have a significant impact on the performance of respirators. Thus, we perhaps need to reconsider how respiratory protective devices should be tested.