

# LIMITATIONS TO TREADMILL RUNNING FROM AN APPROVED AIR PURIFYING RESPIRATOR

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This IRB approved study investigated changes in exercise performance caused by an approved military issue air purifying respirator (APR) and the adequacy of current APR standards. Fifteen subjects ran to volitional termination both with and without APR on a treadmill as slope was increased. Oxygen consumption minute ventilation (VE) tidal volume (VT) end-tidal CO<sub>2</sub> (FetCO<sub>2</sub>) mask pressure peak airflow and related variables were recorded. Inspiratory work of breathing per volume (WOB<sub>i</sub>/VT) was calculated as 20 With APR, subjects were unable to reach cardiovascular limits. Ten acknowledged that they were stopped by difficulty in breathing. At the highest workload with APR, mean VE was 74 L/min (SD 13) and FetCO<sub>2</sub> was 6.4% (SD 0.7). At the same workload without APR, VE was 101 L/min (SD 15) and FetCO<sub>2</sub> was 5.7% (SD 0.6) with  $p < 0.01$  for both. The APR induced WOB<sub>i</sub>/VT was up to 2.97 J/L (kPa). Both VT and breathing frequency were reduced. Peak airflow measured at hard work greatly exceeded the current testing value of 85 L/min. Inspiratory resistance forces respiratory muscles to work harder (higher WOB<sub>i</sub>/VT) to maintain ventilation. If VE drops FetCO<sub>2</sub> climbs. For comparison, the current U.S. Navy limit for total WOB/VT in underwater breathing apparatus is 3.0 J/L at sea level if inspiratory and expiratory resistances match; the inspiratory only limit would be 1.5 J/L. Most subjects exceeded this WOB<sub>i</sub>/VT with moderate work. At heavy exercise flows greatly exceeding the 85 L/min acceptance criterion were required. WOB<sub>i</sub>/VT increased disproportionately with ventilation at those flows. Current standards do not reflect flows of heavy exercise.