

Work of breathing imposed by a respiratory protective device: the ISO approach to judge acceptability of a respiratory protective device

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The concept of work of breathing (WOB) has been used in respiratory physiology research since the 1950s. WOB, and the factors influencing it, can be visualized from a plot of volume and pressure where a breath forms a complete loop, the area of which is the WOB. Similar plots can be made for the volumes and pressures seen in a breathing apparatus when a breathing machine breathes on it at any minute ventilation. The dynamic performance of the breathing apparatus can thus be judged with real breathing. A designer or tester can typically determine where a potential performance limitation is. WOB measurements take an entire breath into account, not just the peak pressures. In the 1970s the performance of respiratory apparatus for diving began using WOB values to judge acceptability. Limits are set by civilian (CEN, NORSOK) and military organizations (NATO, U.S. Navy) world wide. The values obtained are repeatable. Standard verification orifices exist that can be used to check the measurements. ISO (International Standards Organization) has accepted the use of WOB to judge respiratory protective devices [1]. WOB limits are based on people's tolerances. For minute ventilations up to 105 L/min neither inspiratory nor expiratory WOB per volume (i.e. the volume-averaged pressure) should exceed 0.9 kPa (J/L). At a minute ventilation of 135 L/min the limits are 1.6 kPa. Historically, peak pressures were used to judge acceptability. For minute ventilations up to 105 L/min the peak pressures should be within ± 1.2 kPa. At a minute ventilation of 135 L/min the peak pressures should be within ± 2.0 kPa.

Reference: 1. Respiratory protective devices — Human factors — Part 4: Work of breathing and breathing resistance: Physiologically based limits. ISO/TS 16976-4:2012(E).