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54 Ventlilatory responses and perceived respiratory effort of divers working at maximal physical capacity

J.B. Morrison and I. Wood. School of Kinesiology, Simon Fraser University, Burnaby, Briiish Columbia, Canada

Respiratory problems facing the working diver are complex and include carbon dioxide retention, dyspnea, increased work of breathing and respiratory insufficiency. These problems can be compounded by inadequate design of breathing apparatus. The objective of this study was to evaluate proposed physiological acceptance criteria for underwater breathing apparatus. (Morrison and Reimers, ***1982)*** by measuring the physiological responses of divers to a known work of breathing imposed by a selected breathing apparatus.

An underwater swimming ergometer was designed which allows divers to swim within the confines of a hyperbaric chamber. The ergometer allows work load to be increased by increments determined by a restraining force acting on the diver. Compressed air is supplied to the diver's breathing apparatus from two calibrated cylinders connected alternately by means of a four port, two position, valve. The cylinders are recharged at one minute intervals and ventilation is derived from a timed pressure drop within the supply cylinder.

Results obtained from unmanned testing of underwater breathing apparatus were used to select a breathing apparatus with characteristics which were closely representative of the recommended limit of work of breathing (Morrison and Reimers, 1982) at a depth of 50 meters. The performance of each diver was calibrated in terms of aerobic work (ml 0_2+kg^{-1} min^{-1}) per ergometric load (kg). Twelve divers performed graded exercise at depths of 0.5,30 and 50 meters (seawater equivalent). Ergometric load was increased such that divers reached their aerobic capacity within 7 to 9 minutes. At each minute, the diver indicated perceived respiratory effort using a scale of 0 to 5 (where 2 = limit of comfort and 4 = lima of tolerance). Data were analysed to obtain ventilation, tidal volume, breathing frequency, heart rate, end tidal **$PC0_2$,** 1st stage and 2nd stage (mouth) pressures at each depth.

In general divers could achieve their aerobic capacity at each depth. Perceived respiratory effort increased with both depth and workload, from "light" (score = 0.5) at moderate ventilations (33L/min) and 0.5 metres depth to "heavy" (score **3.25)** at high ventilations (70L/min) and 50 metres depth. Divers were subject to hypoventilation and hypercapnia at 50 metres. At the highest workload attained by most divers, ventilations ranged from 61 to 84L/min at 50 metres compared with 81 to 120Umin at 0.5 metres for the same workload. The corresponding end tidal PC+ values were elevated to 48 to 62 mmHg at 50 metres compared with 33 to 40 mmHg at 0.5 metres.