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55 Performance characteristics of open circuit demand regulators from 0.5 to 50 metres seawater

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A limiting factor in underwater work is the design and performance of breathing apparatus. In sport diving few manufacturers provide performance data. The objectives of this study were to measure work of breathing imposed by open circuit demand regulators and to compare regulator performance with recommended standards for underwater breathing apparatus.

A respiratory simulator was designed for unmanned testing of breathing apparatus in hyperbaric environments. The simulator operates inside a diving chamber, and is driven by a hydraulic pump and adjustable-frequency controller. Ventilation can be controlled at frequencies of 0 to 40 breaths/min and volumes of 1.0 to 3.5 litres. Volume and pressure measurements are transmitted via underwater connectors to a signal conditioning unit and microcomputer.

Seven open circuit demand regulators were selected from those currently in use in Canada. Each model was tested at a series of tidal volumes and respiratory frequencies to provide a ventilatory range of 15 to 75 L/min. Regulators were tested from 0.5 to 50 metres seawater depth. Ventilation and work of breathing relationships were calculated at each depth. The work of breathing was partitioned into inspiratory and expiratory work, and both positive and negative (i.e. apparatus assisted) components of work were identified.

The performance of each open circuit demand regulator was compared with the recommended standards for underwater breathing apparatus of Morrison & Reimers (1) which have been adopted as guidelines by British and Norwegian authorities (2). Resuits indicated that only two of the seven models were capable of meeting proposed acceptance criteria in the range 0.5 to 50 metres and only one achieved the recommended ideal characteristics over the complete test range. In general, breakdown occurred at moderate to high levels of ventilation (40 - 75 L/min) and at depths in excess of 20 to 30 metres. In most cases breathing characteristics remained good up to the point of failure due to flow limitation at the demand regulator, when air supply became restricted and independent of additional breathing effort.

References

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