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Not All are Created Equal: Operational Variability in 49 Models of Diving Computer

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Abstract

Diving computers marketed in Europe must comply with European Standard EN 13319:2000. Some EU occupational divers employ diving computers to calculate and manage decompression schedules; they have also been used as depth and temperature measurement tools. This on-going study is evaluating and validating the performance of diving computers in relation to realistic operational requirements. Depth measurement and recording from 49 models of diving computer were analysed at pressures of 203 to 608 kPa; temperature measurement was assessed over ranges relevant for polar, temperate and tropical environments. Decompression isopleths for single square-wave profiles were constructed and compared with tables; occurring unit faults were recorded. Depth conversions, temperature measurements and decompression schedules varied markedly between different models of diving computer; units may not conform fully to EN 13319:2000. A total of 49 "faults" of varying seriousness were recorded over a total of 2009 operational hours. Occupational divers need to risk-manage the use of some computers for decompression management and be aware of the potential for battery or unit failure. The accuracy levels of depth and temperature recordings made by diving computers may not be acceptable for some scientific and forensic studies.

Keywords: depth, decompression, diving computers, EN 13319:2000, temperature

Introduction

Diving computers marketed in Europe must comply with European Standard EN 13319:2000. However, the standard only details the measurement and recording of time and pressure. Some EU occupational divers employ diving computers to calculate and manage decompression schedules; they have also been used as depth and temperature measurement tools. This on-going study is evaluating and validating the performance of diving computers in relation to realistic operational requirements of various diving industry sectors.

Methods

Forty-nine models of diving computer with download capability were purchased from independent suppliers. The rates and methods of recording and display, and claimed accuracies for each unit were reviewed. Depth measurement and recording were analysed at "depths" equivalent to pressures of 203 to 608 kPa; temperature measurement was assessed over ranges relevant for polar, temperate and tropical environments. Decompression isopleths for single square-wave profiles to maximum depths of 50msw and staged decompressions to maxima of 30 minutes were constructed and compared with tables; occurring unit faults were recorded.

Results

Data frequency (1-180sec), resolution (0.1-0.5m), recording method (max, min, average, final point) and storage varied greatly between models (Azzopardi and Sayer, 2010). Pressure measurements to displayed depth conversions were markedly inaccurate for some computers (though nearly all read deep); displayed temperatures were highly unreliable. There was wide inter-model variability in permitted bottom times per depth/time profile but, in general, computer-generated values tended to be more conservative than tables at depths shallower than 30m, but less at 30-50m. Battery replacement occurred once every 49h of operation (n=41), a major fault once every 251h (n=8; one was terminal).

Depth

Diving computers only measure pressure; depth is estimated. EN 13319:2000 only details the levels of accuracy of the pressure and time measurements that diving computers make. Although many computers have freshwater or seawater mode settings, these will be generic values for the two modes and so all computed conversions to "depth" must make some assumption of water density. Very few of the computers gave accurate estimates of depth across the range tested (10-50m); nearly all gave depth estimates that were deeper than the assumed pressure measurement (Figure 1). In some cases, the variance appeared to be relatively standard for certain models and makes of computer, possibly suggesting that the offset was a deliberate design criterion. Pressure is used for decompression calculations; geometric depth may only be relevant for scientific measurement, forensic examinations of dive computers and/or for divers using standard decompression tables.

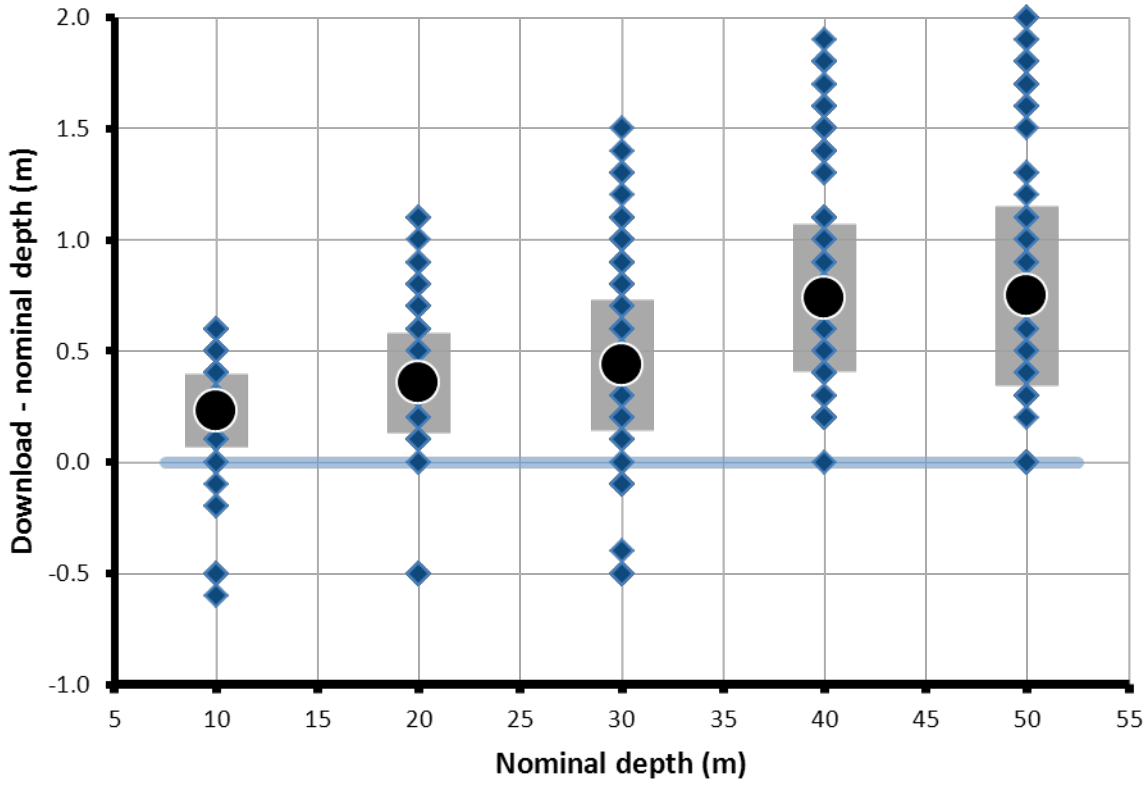

Figure 1. Variance between nominal and downloaded depths in seawater from 46 models of diving computer showing range ♦ and mean ● ± SD (■; n=276 in each case).

Temperature

EN 13319:2000 does not outline how diving computers must record or display water temperature. Apart from some form of temperature measurement being required to compensate the method for recording pressure, the downloaded or displayed temperatures that a diver can access may be of low priority in the overall design of a diving computer. Direct comparisons of performance were compromised by the marked variation in the methods for displaying and/or downloading temperature information (Azzopardi and Sayer, in press). Temperature "measurement" ranged by +4.6/-7.0°C, +1.1/-4.6°C and +3.7/-11.9°C against nominal representative polar, temperate and tropical temperature regimes, respectively (Figure 2). Diving computers are not designed nor intended to be reliable or accurate temperature measurement devices and their use for scientific study should be avoided.

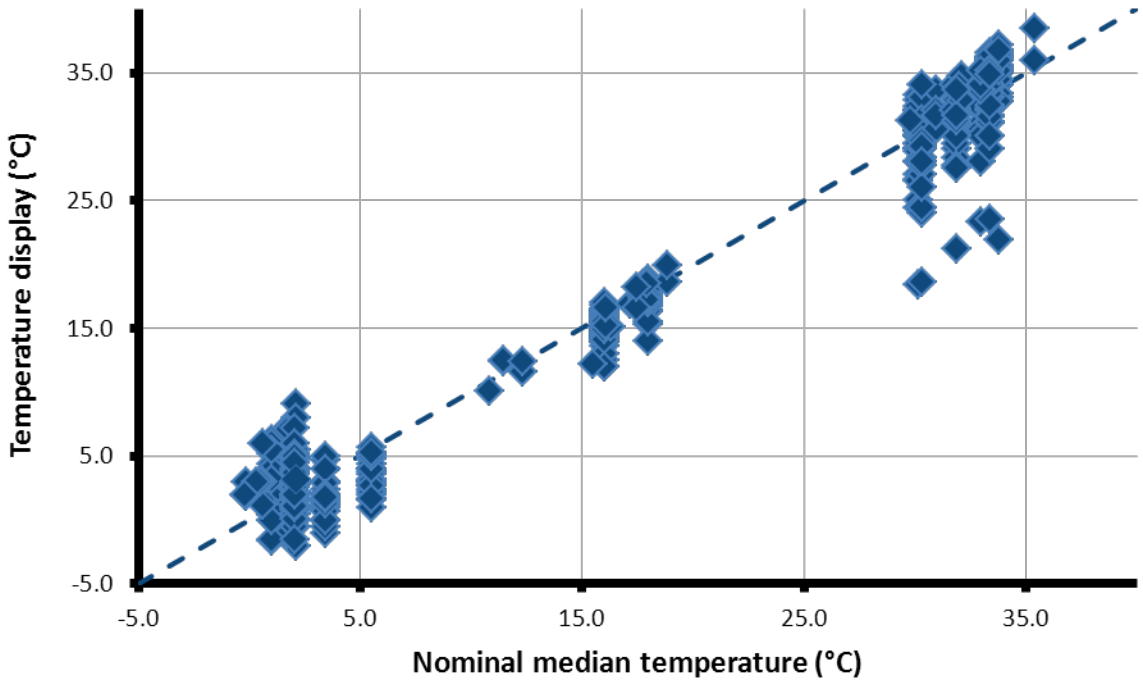

Figure 2. Downloaded temperature records from 47 models of diving computer subjected to temperatures representative of polar (0-5°C), temperate (12-17°C) and tropical (28-33°C) regions (n=800)

Decompression

Any information on decompression obligations displayed by diving computers is explicitly excluded from the scope of EN 13319:2000. Many computers employ established algorithms to manage decompression but the technical literature can state that the algorithms are "modified". The modification is probably a compromise driven by the size and power limitations of the computer (Sieber et al., 2011). In general, for a single square-wave dive, diving computers were more conservative than tables shallower than 30m but less conservative in the 30-50m depth range. Permitted no-stop bottom times ranged between models of diving computer by 23, 15, 8, 5 and 9 minutes at 15, 20, 30, 40 and 50m, respectively (Figure 3). Considerable variation was also recorded at the five depths investigated between the bottom times needed to generate a range of decompression limits.

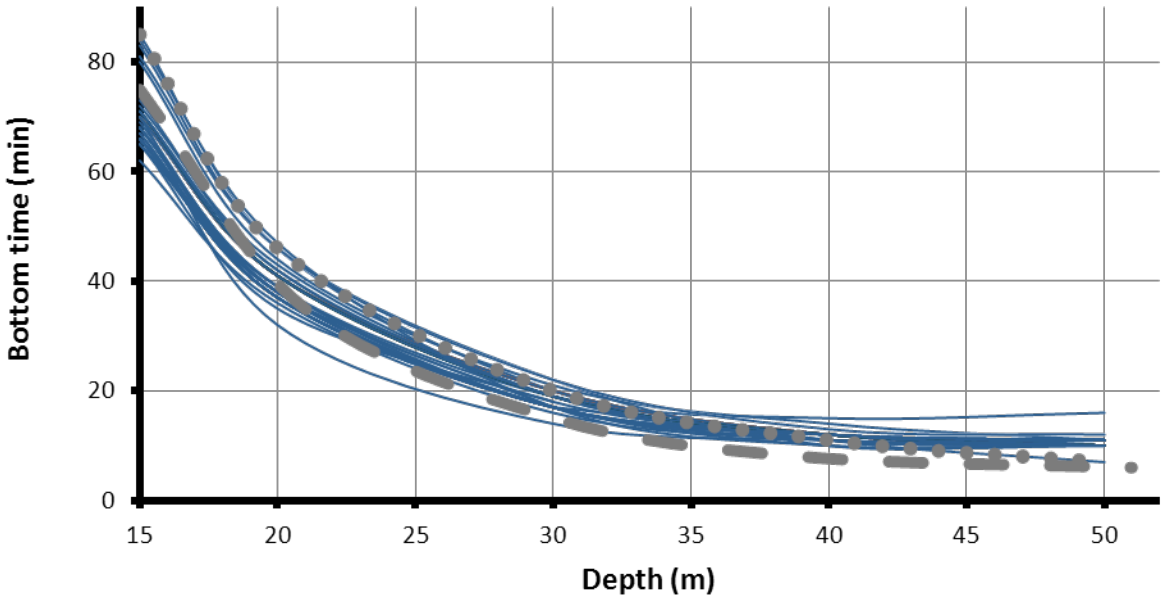

Figure 3. No-stop decompression isopleths for 40 models of diving computer tested over a depth range of 15-50m; compared against DCIEM (- - -) and "RNPL"(· · ·) tables

Discussion

Care should be taken when interpreting downloaded computer data for uses such as scientific measurement or forensic examination; units may not conform fully to EN 13319:2000. Occupational divers need to risk-manage the use of some computers that generate longer bottom times at some depths and for some decompression schedules and be aware of the potential for battery or unit failure. Battery “life” is invariably estimated by diving computer algorithms and not measured directly.

Acknowledgments

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