

**Background/Objective**

With multilevel simulations, including repetitive and multi-day, deco-simulations (also deep stop), emergency ascents, yo-yoing, and extreme temperatures, performance of dive computers (DCs) was compared mutually, and with DCIEM tables, ZH-L16C %M-values and product specifications.

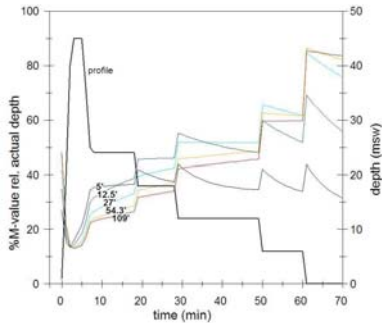


Fig. 1 Calculated %M-values (left axis) of standard simulation (depth on right axis). Numbers are  $t_{1/2}$ 's. %M-values are < 100% with the liberal ZH-L16C (shown). RGBM DCs have 0 msw deco-c ceilings, but ZH-L8ADT DCs at 3 msw.

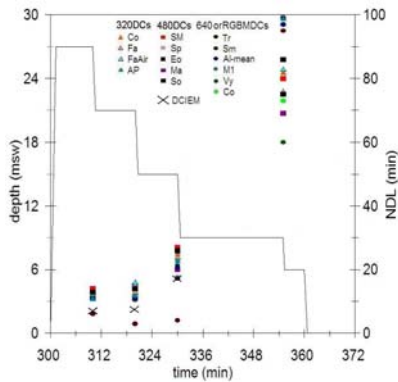
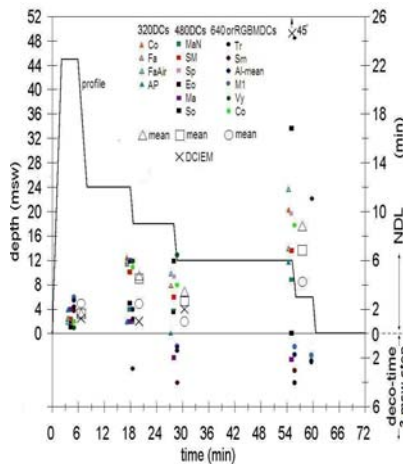


Fig. 2 (a) NDIs (end of each level) and STs at 3 msw (both right axis) of DCs of the 3 classes. STs at 3 msw displayed negatively. On average, 320 DCs are most liberal, 640&RGBM DCs most conservative. The large differences are mainly due to differences in M-values, not to  $t_{1/2}$ . (b) With the 27 msw repetitive dive, 320 DCs were on average also most liberal, followed by 480 DCs.

**Materials and Methods**

In 60 test-chamber sessions, 46 DCs of 29 types (7 fabricates) were examined. No-deco limits (NDLs), depths, stop depths and stop times (STs), and no-fly times (NFTs) were logged (260 simulations). Standard test profiles were realistic and discriminative; maximum diving depth (MDD) 45 msw 6 min, total diving time (TDT) 60 min (Fig. 1), and after 4 h surface interval 27 msw MDD 10 min, TDT 60 min (Fig. 4), decent and ascent speeds 20 and 10 msw/min. 3 classes of DCs were distinguished: 1. 320DCs with the highest  $t_{1/2}$  320 min; 2. 480 DCs with 480 min and no RGBM; 3. 640DCs and RGBM-DCs.)

**Results/Discussion**

**General** DC behaviour was not always in accordance with manuals, decompression theory and physiology.

**Conservatism** NDIs and NFTs of 320- and 480DCs were (far) too liberal, but DCs with RGBM and ZH-L8ADT were more conservative (Fig. 2a&b). With large MDDs, at deep and moderate levels all DCs were more liberal than DCIEM allowed. The shallower the level after a deep 'dive', the larger is the inter-type divergence.

**Reproducibility** of NDIs is generally (very) good (Fig. 3). Two pre-2000 types failed.

**Instable ("noisy") behaviour of NDI** was twice noticed (Fig. 4; pre-2001 types).

**Oscillatory behaviour of NDI** occurred with 7 DCs (pre-2001 types).

**Emergency ascents** were corrected during the final ascent by ZH-L8ADT types; other types hardly or contra-productive.

**Extreme yo-yoing**, repetitive (Fig. 5) or with extreme amplitudes ( $\pm 24$ ,  $\pm 18$  msw) in 45 msw standard profile, was not penalized by RGBM or ZH-L8ADT DCs (once a 2-min increased TDT). Haldanian theory is unsuitable for yo-yoing, but RGBM basically can do.

**Refrigeration** gives longer ascent times with ZH-L8ADT DCs (Uwatec).

**Deep stop dives** were identical to control dives (despite manual) or with longer TDT and NFT. 50% & 100% RGBM settings showed no difference with a 1<sup>st</sup> dive (Fig. 6), also not with a 2<sup>nd</sup> dive (27 msw). RGBM (mathematics) seems not implemented in 1<sup>st</sup> dive (Suunto, Mares); in successive dives only "f factors"?

**Altitude diving** and "personal setting" is handled identically by most fabricates. This is a questionable method.

**NFTs** are mostly shorter than the 12-24-36 (48) hour rule, but generally save.

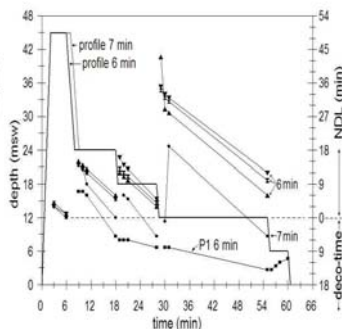


Fig. 3 Reproducibility of the same RGBM-DC, 3x tested with standard 45 msw profile, 1x with P1 setting and 1x with 1 min longer bottom time. Label 'xmin' indicates bottom time. Straight lines between symbols of NDL curves are interpolations.

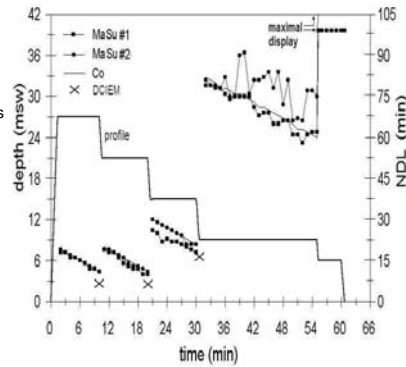


Fig. 4 Instable NDIs (each minute, right axis) during repetitive dive of 2 DCs (MaSu). DC Co behaved regular. DCIEM NDIs presented at the end of each level.

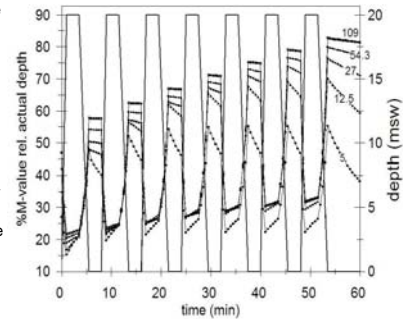


Fig. 5 %M-values calculated for repetitive yo-yo's with ZH-L16C (left axis).

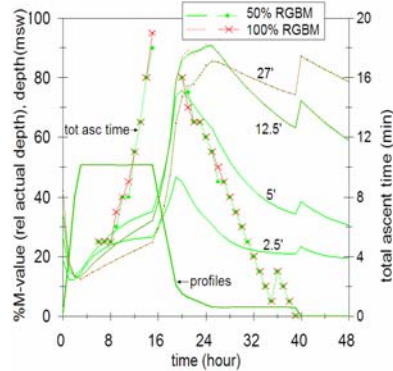


Fig. 6 RGBM-DC with full (100%) and half (50%) "implementation" of RGBM. Left %M-values of ZH-L16C and depth, right total ascent time. After 19 min dive time, 50 and 100% settings yielded identical ascent profiles (as prescribed by DC) and same "total ascent time" displays. NFT 16h22 and 16h15. The smoothed %M-value curves during the "exponential" ascent (<10 msw; compare with Fig. 1) will diminish bubble occurrence.

**Conclusion**

Extreme profiles and large aberrations from the usual rules give large differences in NDIs and STs, even among RGBM and ZH-L8ADT DCs. RGBM is only partly implemented. Present-day DCs are generally not equipped for handling extreme profiles despite manual info, but for normal use they are certainly conservative as compared to DCIEM and ZH-L16C. Manuals need improvement (e.g. effect and meaning of "features", procedures, data-retrieval). (www.duikresearch.org)