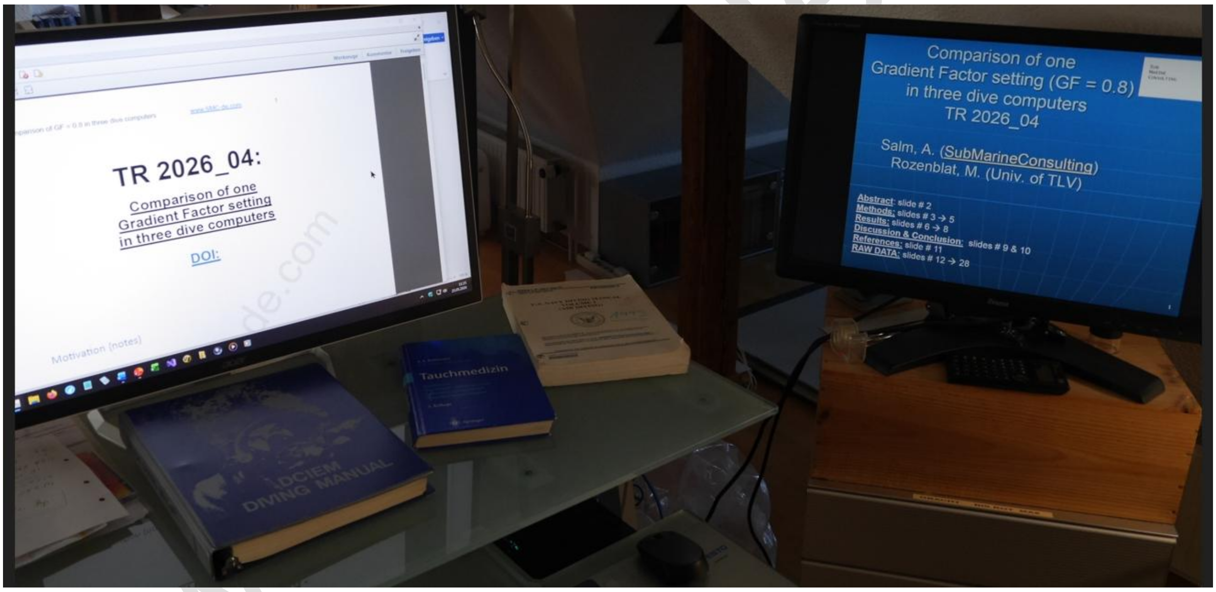
TR 2026_04:

Comparison of one Gradient Factor setting in three dive computers

DOI:

Motivation {notes}

This is our (*) experiment in non-linear documentation: these {notes} could be read in parallel with the presentation from the attachment:



{# slide from the presentation}:

{1} Our technical report (*) is in part a repetition of previous comparisons (pls. cf. ref. [2] in the References section, slide # 11) but motivated through the firmware-updates for two of the assessed dive-computers. Also we wanted to analyze in-depth the devations to a ZH-86 with GF with the advanced tools provided by DIVE Version 3_11. And we wanted to discuss the safety & security implications of these deviations for decompression diving on air, i.e.: a certain measure of the „deco stress“ for the diver during the ascent phase of her dive.

(*) Salm, A. SubMarineConsulting & Rozenblat, M. TAU (06/2026)

Contents of the {notes}:

Further {notes} for the report

{# slide from the presentation}:

{2} Gradient Factor (GF): (multiplicative) factor to modify calculated inertgas partialpressures in the theoretical (tissue) compartments of simple decompression algorithms. The simplicity stems from the solution of simple linear, uncoupled differential equations used to simulate inertgas absorption and -release. The methods used here are basically described in [65], a concise synopsis with the 12.5 min compartment is on slides # 22 → 25.

TTS: time-to-surface = sum of all stop times + bottomdepth/ascent speed

„NDL": „no decompression limit", i.e.: maximum allowed bottom times for „no-stop dives"

We concocted the following set of parameters to indicate a certain „deco stress":

- the TTS
- the inertgas supersaturations
- P(DCS)
- DCIEM deco-stress index I

The details & sources for the P(DCS) and DCIEM deco-stress indexes are referenced here in [2a, 2b, 3a, 4a].

We are quite aware that the advanced tools offered by DIVE 3_11, especially the methods centered around the assessment of P(DCS), bubble prediction and oxygen-toxicity, implemented for tunnel-work and saturation diving, are not in the focus of average (TEC-) divers or hyperbaric practitioners. Our focus is to help the systems-engineer or software-designer to assess their results *before* a new firmware for a computer or a desktop deco-software is transported from the beta test-stage into the „fire zone".

We demonstrated recently for simulated box-profiles [2] and also for real-world diving [3] the deviating displays for the run-times / TTS resp. the „NDL". This is more or less a repetition of parts from [2], but, we thought, was needed as the PERDIX and the iX3M 2 recieved new firmwares in 1st. Q 2026. The topical used hard- & firmware is detailed on slide #3.

{3} We choose GF = 0.8 because the iX3M allows only pre-set GF, whereas the PERDIX and the *G2* TEK allow free user-defined values.

Also we choose „fresh water“ as the *G2* TEK does not allow for the EN 13319 as the others do and probably with the sea-/salt-water setting the deviations would have been even greater: none of the computers specifications give the used salt-water densities!

{5} This somewhat exhaustive list details the parameters: if there is not a 100 % identity in these parameters, variations in the results from the different products will inescapably surface! Fractions of breathing gas components need min. 2 decimals, the respiratory quotient R_q 3, the water density 4!

{7} run #1 & #2: „pure“ ZH-L16 C with the default ascent rates.

{9} P(DCS): statistical probability of contracting a decompression sickness (DCS).

More details, history & background and a link to archived research-papers in [3a]:

- **P(DCS) - on the statistical nature of decompression sickness; a short literature review with limited scope.** (14.04.2024)

{10} If GF Low < GF High, an interpolation is possible. There is no physiologic rationale, but it helps to avoid unnecessary long stops in the shallow part at the end of the dive.

The following screen shots are from a topical DIVE Version 3_11. These display the „un-disturbed“ calculations in the top-rows and the calculations with the GF in the lower rows. Displayed are from left-to-right:

- the stop depth in m
- the stop time in min
- the actual used GF
- the leading compartment #
- the TTS in min:

```
 deco prognosis:
   9m stop  prognosis deco time:      3.0  comp.#:  3
   6m stop  prognosis deco time:      6.0  comp.#:  4
   3m stop  prognosis deco time:     18.0  comp.#:  6
TTS =      31.0 min      0:31.0(hrs:min)
 deco prognosis with gradient factors:   GF HI=  0.8000 GF LO=  0.8000
12m stop  prognosis deco time:      2.0  GF =  0.8000  comp.#:  3
 9m stop  prognosis deco time:      5.0  GF =  0.8000  comp.#:  4
 6m stop  prognosis deco time:     11.0  GF =  0.8000  comp.#:  5
 3m stop  prognosis deco time:     27.0  GF =  0.8000  comp.#:  7
TTS =      49.00 min      0:49.0(hrs:min)
 what next?
```

Example from DIVE 3_11 for 42 m / 27 min with GF High = 0.8, GF Low = 0.8

With the un-symmetrical setting below (0.9 / 0.8) the last stops are cut by ca. 7-8 min:

```
 deco prognosis:
   9m stop  prognosis deco time:      3.0  comp.#:  3
   6m stop  prognosis deco time:      6.0  comp.#:  4
   3m stop  prognosis deco time:     18.0  comp.#:  6
TTS =     31.0 min     0:31.0(hrs:min)
 deco prognosis with gradient factors:  GF HI=  0.9000 GF LO=  0.8000
12m stop  prognosis deco time:     2.0  GF =  0.8000  comp.#:  3
 9m stop  prognosis deco time:     4.0  GF =  0.8250  comp.#:  4
 6m stop  prognosis deco time:     9.0  GF =  0.8500  comp.#:  5
 3m stop  prognosis deco time:    22.0  GF =  0.8750  comp.#:  7
TTS =     41.00 min     0:41.0(hrs:min)
```

Example from DIVE 3_11 for 42 m / 27 min with GF High = 0.9, GF Low = 0.8

GF Low increases linearly so that by reaching surface the GF High is exactly met.

But this method is also not standardized, so with GF Hi = GF Lo we choose a symmetrical GF setting and avoided another possible source of deviations.

{12} As a further benchmark partner and, especially to validate the DIVE 3_11 results, we choose (since long, since 2011) OSTC planner. We used the v3.00 BETA 14 from 2016. But presently (06/2026) the website https://ostc-planner.net/ displays only:

Error establishing a database connection

{28} From the NEDU Report TR 04-41 from 12/2004 [2a] we implemented:

➔ the standard formula (formula (4) on p. 8 and the parameters from p. 11, table 2, the STANDAIR model); and the so-called:

➔ „Combined Model“ (the LOGIT formula (3) p. 4 in the follow-up report from 2005 [2b], the parameters on p. 6 (Table 2))

to assess the P(DCS) for simple box-profiles on air / EAN. These two methods fit the dive scenarios here: they use only one additional free parameter: the TTS!

DIVE 3_11 provides simultaneously 7 P(DCS) calculations for various other diving-scenarios, also with other breathing-gases, including the upper & lower error margins introduced with the standard deviations of the fitted parameters, also in [3a]:

D3_11 - [Graphic1]

```
          deco stage too close to surface:
          go below ceiling!
 deco prognosis:
   9m stop  prognosis deco time:      3.0  comp.#:  3
   6m stop  prognosis deco time:      6.0  comp.#:  4
   3m stop  prognosis deco time:     18.0  comp.#:  6
 TTS =      31.0 min     0:31.0(hrs:min)
 what next?pdcs
 Input of the prognosed TTS (for methods IVa  and IVb) in min:
30.
 Method I:   Southerland 1992,              P(DCS) =  0.23454
 Method II:  PME enhanced 6 Compartments,   P(DCS) =  0.14562
 ************************************************************
 Method III: Stat. Tables Part VI,  Model 4 P(DCS) =  0.16588
 Method III: lower error margin,            P(DCS) =  0.00809
 Method III: upper eror margin,             P(DCS) =  0.35321
 ************************************************************
 Method IVa: NEDU Report 12/2004,           P(DCS) =  0.08199
 Method IVa: lower error margin,            P(DCS) =  0.01698
 Method IVa: upper error margin,            P(DCS) =  0.78556
 Method IVb: Combined Model,                P(DCS) =  0.07705
 Method IVb: lower error margin,            P(DCS) =  0.01834
 Method IVb: upper error margin,            P(DCS) =  0.40031
 ************************************************************
 Method Va:  NEDU Report 03/2009,           P(DCS) =  0.22088
 Method Va:  lower error margin,            P(DCS) =  0.00000
 Method Va:  upper error margin,            P(DCS) =  1.00000
 ************************************************************
 Method Vb:  NEDU Report 03/2009,           P(DCS) =  0.15889
 Method Vb:  lower error margin,            P(DCS) =  0.00000
 Method Vb:  upper error margin,            P(DCS) =  1.00000

 SDEV =  0.05644                            MEAN   =  0.15498
 ************************************************************
 what next?
```

```
 what next?bpa
 Stat. Tables I M4   NMRI BOX PROFILE AIR:   P(DCS) =  0.20562
 lower error margin  NMRI BOX PROFILE AIR:   P(DCS) =  0.15329
 upper error margin  NMRI BOX PROFILE AIR:   P(DCS) =  0.23011
 ************************************************************

 P-NO-STOP Model: NEDU TR 04-42,             P(DCS) =  0.31969
 P-NO-STOP Model: lower error margin,        P(DCS) =  0.04495
 P-NO-STOP Model: upper error margin,        P(DCS) =  0.85205
 ************************************************************
 what next?
```

The other references for all these algorithms are documented in the QA-part of the DIVE Version 3 Manuals [1c].

The ca. TTS for DCIEM & USN stems from a numerical simulation of these frameworks: there is no tabulated entry in DCIEM Air table nor in the USN air table for **27** min at 42 m / 140 fsw.

The P(DCS) tabulated on slide #28 would decrease substantially for this diving-scenario with an extended and deeper stop (+ 5 min @ 6 m) to 0.04964 resp. 0.05654.

{29} DIVE Version 3_11 has implemented the full DCIEM deco-stress index I [4a] dependent on TAT (total ascent time; DCIEM nomenclature) and used gases: we focus here on a TTS of 30 & 55 min with air only and with the TAT of 100 %, the tendency as well as the %-values as such similar to the P(DCS) calculations from above, even if the methods are completely different!

D3_11 - [Graphic1]

```
what next?ds
deco stress indices: PrT & I (DCIEM):
planned total-stop-time (TST)?
in minutes (min.)!  30.
 max. depth / ascent rate + sum of all stop times:  34.23
 PrT value, all segments:   26.63
 PrT value topical segment only: 26.63

                          DCIEM I values for air, EAN/O2 deco, trimix:

 50 % TAT [min]:  17.12    I AIR:  6.24    I EAN/O2:   4.99    I TMX:  1.87
      TAT [min]:  34.23    I AIR:  5.07    I EAN/O2:   4.06    I TMX:  1.52
150 % TAT [min]:  51.35    I AIR:  4.49    I EAN/O2:   3.59    I TMX:  1.35
200 % TAT [min]:  68.46    I AIR:  4.12    I EAN/O2:   3.29    I TMX:  1.24
what next?ds
deco stress indices: PrT & I (DCIEM):
planned total-stop-time (TST)?
in minutes (min.)!  55.
 max. depth / ascent rate + sum of all stop times:  59.23
 PrT value, all segments:   26.63
 PrT value topical segment only: 26.63

                          DCIEM I values for air, EAN/O2 deco, trimix:

 50 % TAT [min]:  29.62    I AIR:  5.29    I EAN/O2:   4.24    I TMX:  1.59
      TAT [min]:  59.23    I AIR:  4.30    I EAN/O2:   3.44    I TMX:  1.29
150 % TAT [min]:  88.85    I AIR:  3.81    I EAN/O2:   3.05    I TMX:  1.14
200 % TAT [min]: 118.46    I AIR:  3.49    I EAN/O2:   2.79    I TMX:  1.05
what next?
```

The pressure-square root index from Hempleman (PrT) = ca. 27 being the same for all of the eight runs; but it is needed to calibrate the I index. The history, idea and useage of the PrT index is described in details with examples in [5a].

Literature: further references & further reading for the {notes}

[1a] DIVE Version 3_11 (EN), all downloads for free:

https://www.divetable.info/DIVE_V3/V3e/index.htm

[1b] the manual:

https://www.divetable.info/DIVE_V3/V3e/DOXV3_0.pdf

[1c] the Quality Assurance part:

https://doi.org/10.13140/RG.2.2.27980.88969

[2a] H. D. Van Liew, E. T. Flynn, NEDU Report TA 01-07 NEDU TR 04-41 12/2004: A SIMPLE PROBABILISTIC MODEL FOR ESTIMATING THE RISK OF STANDARD AIR DIVES

[2b] H. D. VAN LIEW, E. T. FLYNN, *UHM 2005, Vol. 32, No. 4:* A simple probabilistic model for standard air dives that is focused on total decompression time

[3a] Salm, Albi & Rosenblat, Miri. (2024). P(DCS). 10.13140/RG.2.2.33711.75685.

P(DCS) - on the statistical nature of decompression sickness; a short literature review with limited scope. (14.04.2024)

https://dx.doi.org/10.13140/RG.2.2.33711.75685

[4a] Julien HUGON, Ron NISHI, Fethi BOUAK, Jean-Eric BLATTEAU, Emmanuel GEMPP (2015) A stress index to enhance DCS risk assessment for both air and mixed gas exposures. UHMS Annual Scientific Meeting 2015 – Montreal - June 17th-20th, Session A4

[5a] Salm, Albi & Eisenstein, Yael (2024) Technical Report 2024_07:
On the Calculation of an Inert Gas Dose
https://dx.doi.org/10.13140/RG.2.2.32062.29769

Attachment: Presentation for the TR 2026_04

Keywords: Gradient Factor, GF, ZH-86, TTS, P(DCS), deco stress

(*): SubMarineConsulting: www.SMC-de.com, Version from: 2026-05-31, Filesize: 1846 kB

Source: C:\DIVE\Papers\2026\Technical Reports\80_80\TR_2026_04.docx

Status: Technical Report @ Researchgate, # pages: 8 , # words: 1382

Comparison of one Gradient Factor setting (GF = 0.8) in three dive computers TR 2026_04

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Abstract:

In this technical report we compared simulations of one simple box profile on air (42 m / 27 min) from 3 popular mix-gas diver-carried computers (*G2* TEK, Perdix, iX3M 2 Deep) along one gradient factor setting (GF).

Conclusions (synopsis):

1) a certain gradient factor setting, say a GF of 0.8, in one product does not imply the same thing as the identical GF of 0.8 in another product ([2] & [3])!

2) The idea of GF is to implement a certain measure of safety for the diver during her decompression phase [1]: in comparison with a standard ZH-86 method, two of the assessed three computers fail in this aspect.

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Methods (1):

We simulated only one of our notorious test-profiles on air,
a simple box-profile, i.e.:
only one pressure step to BD, constant for the complete BT.
→ 42 m bottom depth (BD) / 27 min bottom time (BT)
→ along only one symmetrical GF setting (GF High = GF Low = 0.8)
→ and compared to GF = 1.00, i.e. the original ZH-86 table [65] and:
→ a simulated ZH-86 with the GF

with the following 3 diver-carried computers (pls. cf. nx. slide):

→ LHS: SCUBAPRO / UWATEC ***G2 TEK,*** HW-Ver. & SW-Ver.: 1.0
ID: 7500005522

→ MI: SHEARWATER **PERDIX AI**, firmware: 102/BT13, hardware: SA-02A
S/N: 201370DF

→ RHS: RATIO / DIVE Industries srl **iX3M 2 Deep,** firmware: 5.2.9.2 / 016,
S/N: 73083

Methods (2):

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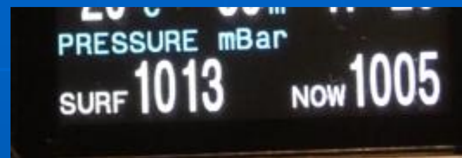
With these starting conditions in our lab:



we configured all 3 boxes to:

- ➔ fresh water
- ➔ breathing mix: Air (21/79)
- ➔ ZH-L 16 C where possible
- ➔ the Gradient Factors: GF High = 0.8, GF Low = 0.8
- ➔ and then BD 42 m, BT 27 min into the computers inter-active dive planning tools (# 19 – 21).

The results have been tabulated and compared against each other and against a simulated ZH-86 table, derived from a fully compliant ZH-L16 C **(Δ)** desktop software product .

The ZH-86 „table“ has to be simulated, the original printed tables have, in TEC-lingo, „a GF of 1.00, i.e. 100 %“.

Methods (3):

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(Δ):
„fully compliant“ implies, here in this context:

that a desktop decompression software should use:
➔ the ZH-L 16 ***C*** coefficient set, and
➔ the respective compartment half-times *as published [65], p. 158*, and:
the possibility of parametrizing:
➔ GF High & GF Low separately
➔ fractions of the used gases to the 2nd. decimal
➔ instantaneous descent ([65], p. 165)
➔ the Bühlmann safety-factor (pls. cf. [65], p. 165!)
➔ the water density and temperature ([65], p. 165)
➔ the respiratory coefficient ([65], p. 90)
➔ the ascent speed ([65], pp. 225 - 228)
➔ the surface air pressure @ start or end of dive

to be configured according to [65] to obtain a *transparent comparability and a well-defined base-line to the ZH-86 table entries*, i.e.: GF High = GF Low = 1.00 or 100% of the original a-/b-coefficients.

Results:

The tables with the simulations from the 3 dive computers & the GF scenario, contrasted with DIVE 3_11 and the simulated ZH-86 (with GF):

➔ synopsis table with the detailed stop times
➔ synopsis table with the TTS and ΔTTS evaluations to the software-derived base-line

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Synopsis: stop times for 42 m / 27 min @ air with GF High = GF Low = 0.8

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Run #:	AR	12 m [min]	9 m [min]	6 m [min]	3 m [min]	TTS [min]
1) DIVE	9	2	5	11	27	**49**
2) OSTC (°)	9	-	6	11	29	**51**
3) DIVE / ZH-86 Simulation (*)	13	3	6	12	29	**53**
4) DIVE (**)	7	3	6	13	31	**59**
5) OSTC (*, °)	9	2	6	13	33	**60**
6) RATIO	10.5	3	6	8	19	**40**
7) PERDIX	14	1	5	10	24	**43**
8) G2 TEK	7	2	9	16	26	**59**

Rem.: (*) Bühlmann Safety-Factor, AR = ascent rate in [m/min]
(**) to match the reduced ascent speed from G2 TEK and the Bühlmann Safety-Factor
(°) OSTC planner software v3.00 BETA 14 from 2016

Synopsis 42 m / 27 min;
GF High = GF Low = 0.80

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GF = 0.80 / 0.80	*G2* TEK	PERDIX	iX3M 2	DIVE 3_11	ZH-86 (*)
TTS [min]	59	43	40	49	53
deepest stop [m]	12	12	12	12	12
stop time [min]	2	1	3	2	3
ΔTTS [min]	**+ 6**	**- 10**	**- 13**	**- 4**	**0**

(*) the ZH-86 table entries simulated with DIVE, parametrized that with GF = 1.00 the original values incl. the TTS are matched to 100 %!
ΔTTS: Δ time-to-surface = TTS $_{\text{computer}}$ - TTS $_{\text{ZH-86 table simulation}}$

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Discussion / Conclusion (1):

Basically, a GF < 1.0 should reduce the allowed / tolerated inertgas partial pressures in the theoretical 16 compartments and thus the „NDL“ or **increase the TTS** ([1] and slide #22 – 24).

But as the *PERDIX & the iX3M constantly fall short of the pure ZH-L 16 C in the 80 %-scenario (Perdix - 6 min, iX3M - 9 min), users should not be lulled into a putative increased safety from these GF!*

This even more so when compared to the documented & proven safety- & security record of a ZH-86 system: there the Perdix is missing 10 min & the iX3M 13 min (pls. cf. [2] and all the references therein)! The iX3M displays also increased super-saturations in the compartments #2 to #7 in comparison to the ZH-86 simulation!

Or, in other words: the insinuated added safety-margin of the GF is missing in these two GF-implementations (pls. cf. also the heat-maps comparison of the simulated ZH-86 vs. iX3m in the DATA section or the detailed calculated compartmental N_2 partial-pressures)! This is also reflected, almost 1:1, in the **increased P(DCS)** values and the **DCIEM deco-stress index** (#28 & 29)!

Discussion / Conclusion (2):

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And also, generally speaking: a certain GF, say of 0.80, in one product does not imply the identical thing as the same GF of 0.80 in another product [3]! That is:
a „1:1“ comparison of the GF from one box (dive computer, desktop deco-software) to another is just open to conjecture.

As the calculations of the GF as such are not standardized and, especially, the interpolation method from a GF Low to a GF High (if GF Lo < GF Hi) has no specific physiologic rationale, except to avoid excessively long stops in the shallow, GF should be considered as an *individual safety factor with an experimental, subjective, character.*

Final Remark:

The *G2* TEK calls for ca. 6 min of ascent time in this simulation (slide #19), whereas ZH-86 table allowed for only 3 min (slides #13 & 14). If we take this Δ = + 3 min also into account, the *G2* TEK would then match the original ZH-86 and the derived GF-scenario by almost 100 %!

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References:

[1] Salm, Albi & Vered, Nurit & Rosenblat, Miri. (2023). Gradient Factors: on the rise?. 10.13140/RG.2.2.20301.20963.
https://dx.doi.org/10.13140/RG.2.2.20301.20963

[2] Salm, Albi & Rosenblat, Miri (01.01.2025)
Comparison of various Gradient Factor (GF) implementations in three dive computers
(On the reliability of dive computer generated run-times; part XVI):
DOI: 10.13140/RG.2.2.14441.81760

[3] Salm, Albi & Rosenblat, Miri (11.11.2025)
On the reliability of dive computer generated run-times; Part XVII:
GF = 0.93 is not equal GF = 0.93!
https://doi.org/10.13140/RG.2.2.17175.84643

[65] Albert A. Bühlmann, Ernst B. Völlm (Mitarbeiter), P. Nussberger (2002) Tauchmedizin, Springer, ISBN 3-540-42979-4
https://www.divetable.eu/BOOKS/65.pdf

RAW DATA:

- → 42 m BD excerpt from ZH-86 table
- → DIVE Version 3_11 screen shots
- → OSTC (°)
- → photos from the 3 dive computers planning tools
- → Compartment #3 with half-time 12.5 min:
  - → original AAB values
  - → modified with GF = 0.8
- → Comparison of heatmaps for run #3 & run #6
  - → calculated compartmental pN_2
- → P(DCS) results
- → DCIEM deco-stress index I

(°) presently (06/2026) there is no reference possible for the OSTC planner as the website produces only a data-base error

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42	9	3				1	4
	12	3	—			4	7
	15	3			1	5	9
	18	3			4	6	13
	21	3		2	4	10	19
	24	3		3	6	16	28
	27	3		4	7	19	33
	30	3	2	4	9	24	42

Comparison with ZH-86 Table:
Source: [65], p. 227; i.e.:
https://www.divetable.info/books/65.pdf
"Tauchmedizin", Albert A. Bühlmann, Ernst B. Völlm (Mitarbeiter), P. Nussberger; 5. Auflage in 2002, Springer, ISBN 3-540-42979-4

42	9	3				1	4
	12	3	—			4	7
	15	3			1	5	9
	18	3			4	6	13
	21	3		2	4	10	19
	24	3		3	6	16	28
	27	3		4	7	19	33
	30	3	2	4	9	24	42

Comparison with ZH-86 Table; Source: [65], p. 227.

On pages 175 resp. 165: „ … with 10m/min calculated …, very conservative … for altitude … “

But above, from the 1st. line we take:

(bottom depth – first stop depth) / (TTS – stop time) =

(42 – 3) m / (4 – 1) min = 39 m / 3 min = 13 m/min

#3) DIVE V 3_11:
dive 42 m / 27 min on air without (top part) and with gradient factors (GF 0.8), lower part.
To match the ZH-86 tabulated entries (4/7/19 from the top part resp. the prev. slides) the Bühlmann safety correction factor has to be used and the increased ascent rate from the table
➔ 13 m / min:

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```
 deco prognosis:
   9m stop  prognosis deco time:      4.0  comp.#:  3
   6m stop  prognosis deco time:      7.0  comp.#:  5
   3m stop  prognosis deco time:     19.0  comp.#:  6
TTS =      33.0 min     0:33.0(hrs:min)
 deco prognosis with gradient factors:   GF HI=  0.8000 GF LO=  0.8000
12m stop  prognosis deco time:      3.0  GF =  0.8000  comp.#:  3
 9m stop  prognosis deco time:      6.0  GF =  0.8000  comp.#:  4
 6m stop  prognosis deco time:     12.0  GF =  0.8000  comp.#:  5
 3m stop  prognosis deco time:     29.0  GF =  0.8000  comp.#:  7
TTS =      53.00 min     0:53.0(hrs:min)
 what next?
```

#1) DIVE V 3_11:
dive 42 m / 27 min on air without (top part) and with gradient factors (GF), lower part (no safety, 9 m/min):

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```
 deco prognosis:
   9m stop  prognosis deco time:      3.0  comp.#:  3
   6m stop  prognosis deco time:      6.0  comp.#:  4
   3m stop  prognosis deco time:     18.0  comp.#:  6
TTS =      31.0 min     0:31.0(hrs:min)
 deco prognosis with gradient factors:   GF HI=  0.8000 GF LO=  0.8000
12m stop  prognosis deco time:      2.0  GF =  0.8000  comp.#:  3
 9m stop  prognosis deco time:      5.0  GF =  0.8000  comp.#:  4
 6m stop  prognosis deco time:     11.0  GF =  0.8000  comp.#:  5
 3m stop  prognosis deco time:     27.0  GF =  0.8000  comp.#:  7
TTS =      49.00 min     0:49.0(hrs:min)
```

#4) DIVE V 3_11:
dive 42 m / 27 min on air without (top part) and with gradient factors (GF), lower part: (Bühlmann safety & ascent speed = 7m/min to match the G2 TEK)

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```
 deco prognosis:
   9m stop  prognosis deco time:      4.0  comp.#:  3
   6m stop  prognosis deco time:      8.0  comp.#:  5
   3m stop  prognosis deco time:     20.0  comp.#:  6
TTS =      38.0 min     0:38.0(hrs:min)
 deco prognosis with gradient factors:   GF HI=  0.8000 GF LO=  0.8000
12m stop  prognosis deco time:     3.0  GF =  0.8000  comp.#:  3
 9m stop  prognosis deco time:     6.0  GF =  0.8000  comp.#:  4
 6m stop  prognosis deco time:    13.0  GF =  0.8000  comp.#:  6
 3m stop  prognosis deco time:    31.0  GF =  0.8000  comp.#:  7
TTS =      59.00 min     0:59.0(hrs:min)
```

#5) OSTC planner v3.00 BETA 14:
dive 42 m / 27 min on air with gradient factors (GF), and Bühlmann safety & ascent speed = 9 m/min; water density not specified, assumed „fresh water“; Bühlmann safety factor has to be added manually: calculated BD = planned BD * 1.03 + 1 m = 42 * 1.03 + 1 = 44.26

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Bühlmann ZH-L16C-1a 2002 with GRADIENT FACTOR decompression:
* computer = OSTC2 (fw 2.10)
* GF_low (CF32) = 80 %.
* GF_high (CF33) = 80 %.
* deko abweichung (CF16) = 1.0 m
* Letzter Stopp (CF29) = 3 m
*Tauchgang Start mit Pamb = 1013 mbar
* Gas Wechsel Verzögerung (CF55) = 0 min

OC Gas Liste:
* erstes Gas#1 = Luft

...
==== OC Runtime ====
27:00 44.0m Deko:
44 m 27 ' 27.0 ' Gas#1
12 m 2 ' 32.2 '
9 m 6 ' 38.5 '
6 m 13 ' 51.8 '
3 m 33 ' 85.1 '
0 m ---- 86.1 '
TTS = 60 '
CNS = 13%

#8) Scubapro *G2* TEK

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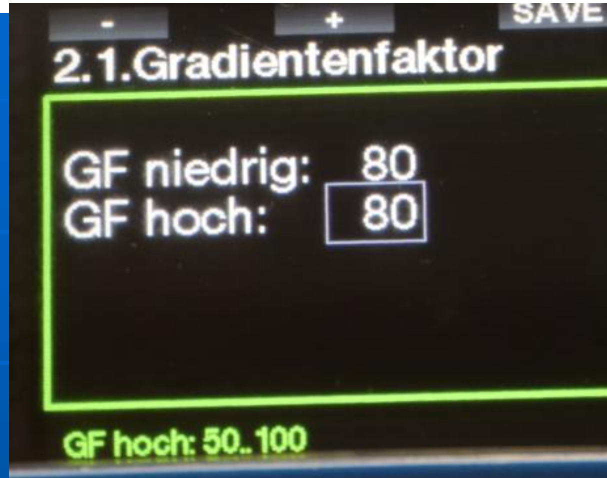

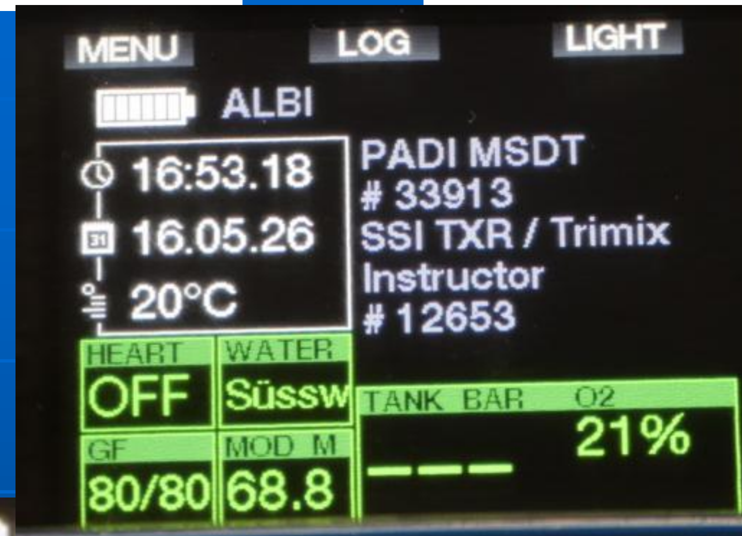

#7) Shearwater PERDIX AI

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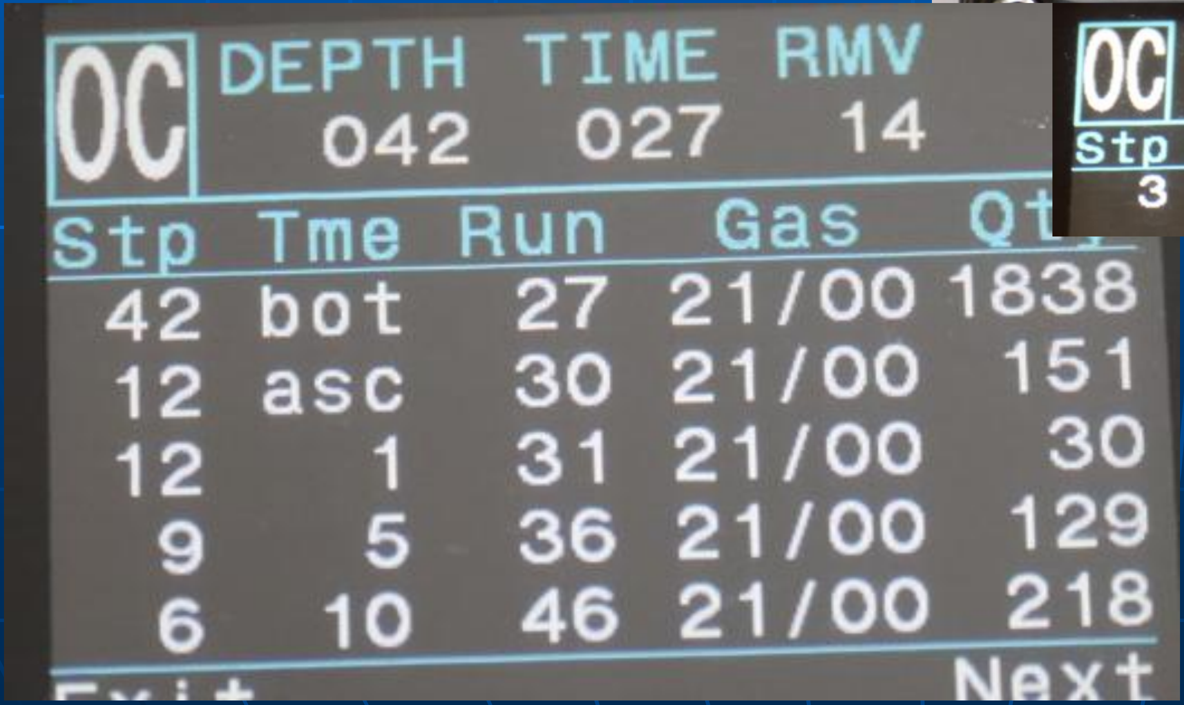

#6) Dive Systems RATIO iX3M 2 Deep

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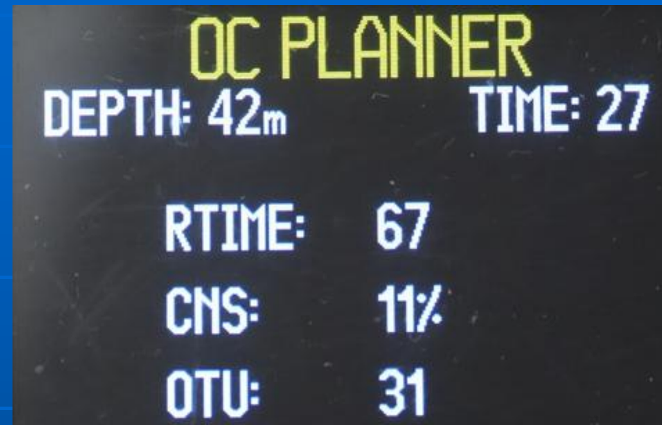

Bühlmann (Gradients)
GFL/GFH
- 0 = 93/93 (minimum conservativism)
- 1 = 90/90
- 2 = 80/80
- 3 = 75/75 (max linear conservatism)
- 4 = 50/85
- 5 = 45/80

$p_{ambient,tolerated}$ vs. p_{tissue} from [65], p. 140:

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140

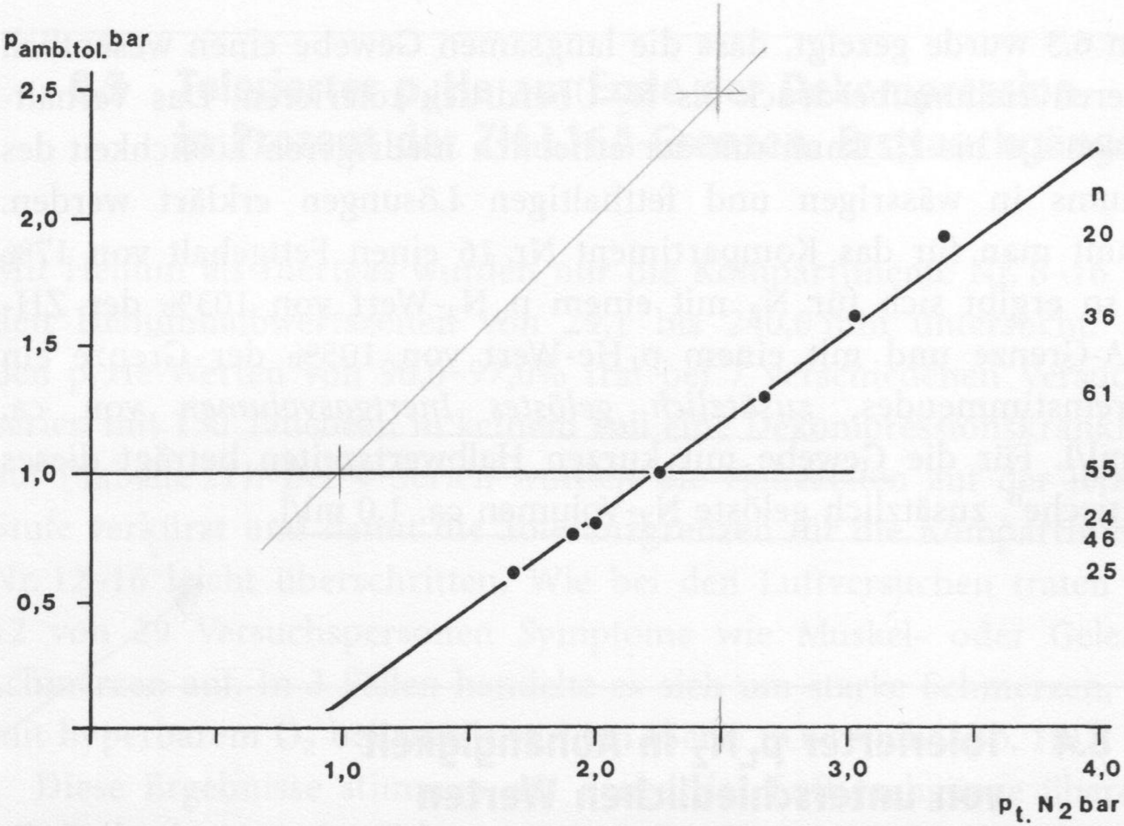

Abb. 25. N_2-Halbwertszeit 12,5 min. Beziehung zwischen Umgebungsdruck und toleriertem $p_t.N_2$. • Mittelwerte des $p_t.N_2$ bei der angegebenen Zahl von Versuchspersonen. $p_t.N_2$-Werte in der Höhe und bei 1,0 bar am Ende der Dekompression, im Überdruckbereich während der Dekompression. $p_{amb.\,tol.} = (p_t.N_2 - 0{,}8618) \cdot 0{,}7222$

Pressure Graph / „M-Value“ lines,
created with Microsoft® Mathematics© 2011 4.0.0325:

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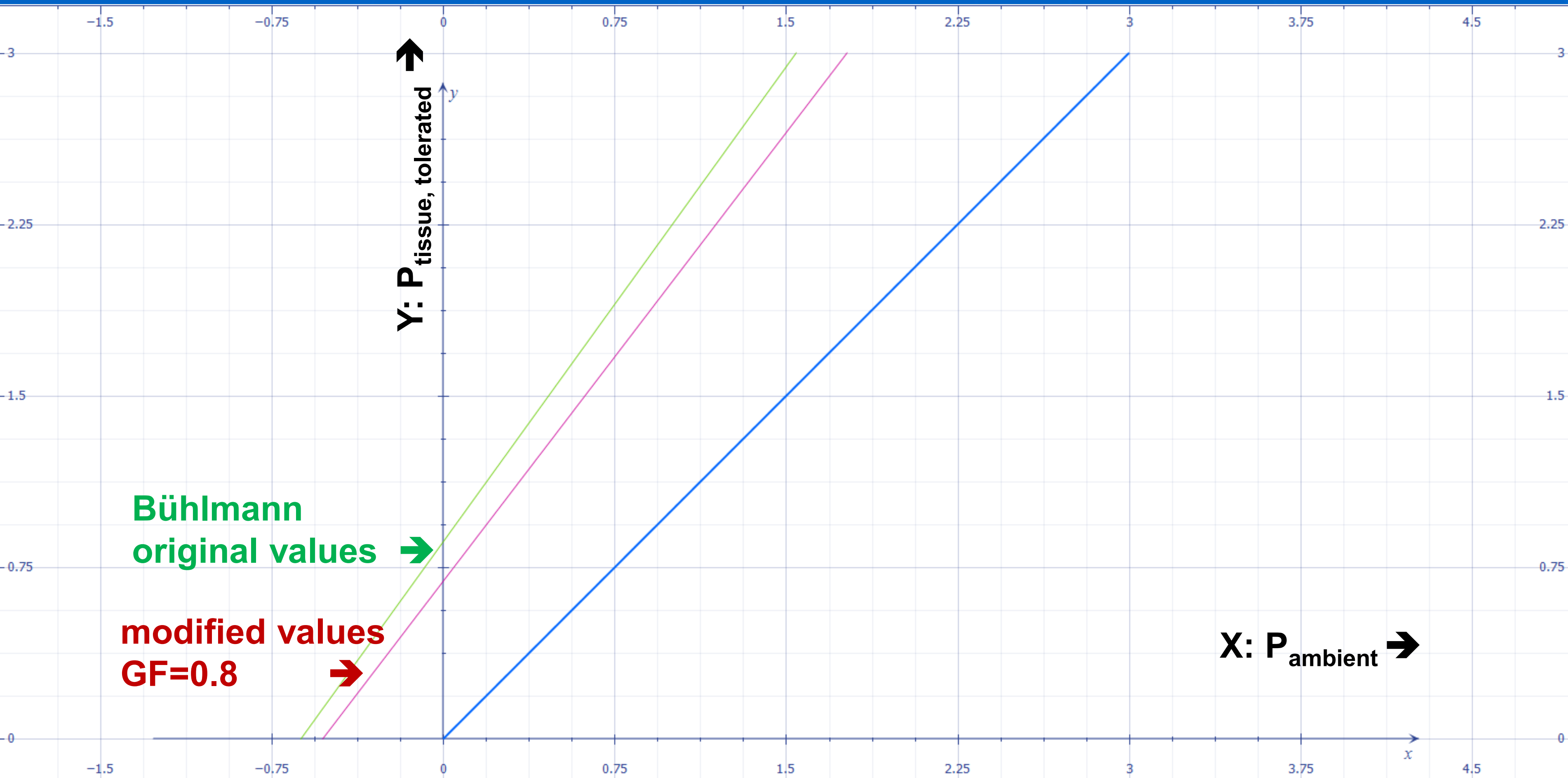

The Pressure Graphs / „M-Value“ lines, usually from Diving Manuals etc., are inverted to the AAB-original graphs; resp. mirrored at the bi-sectrix line

Pressure Graph / „M-Value“ lines, legend:

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Arbeitsblatt | Graphen

Gleichungen und Funktionen

2D | Kartesisch

1 $y = x$

2 $y = \frac{x}{0.7222} + 0.8618$

3 $y = \frac{x}{0.7646} + 0.6894$

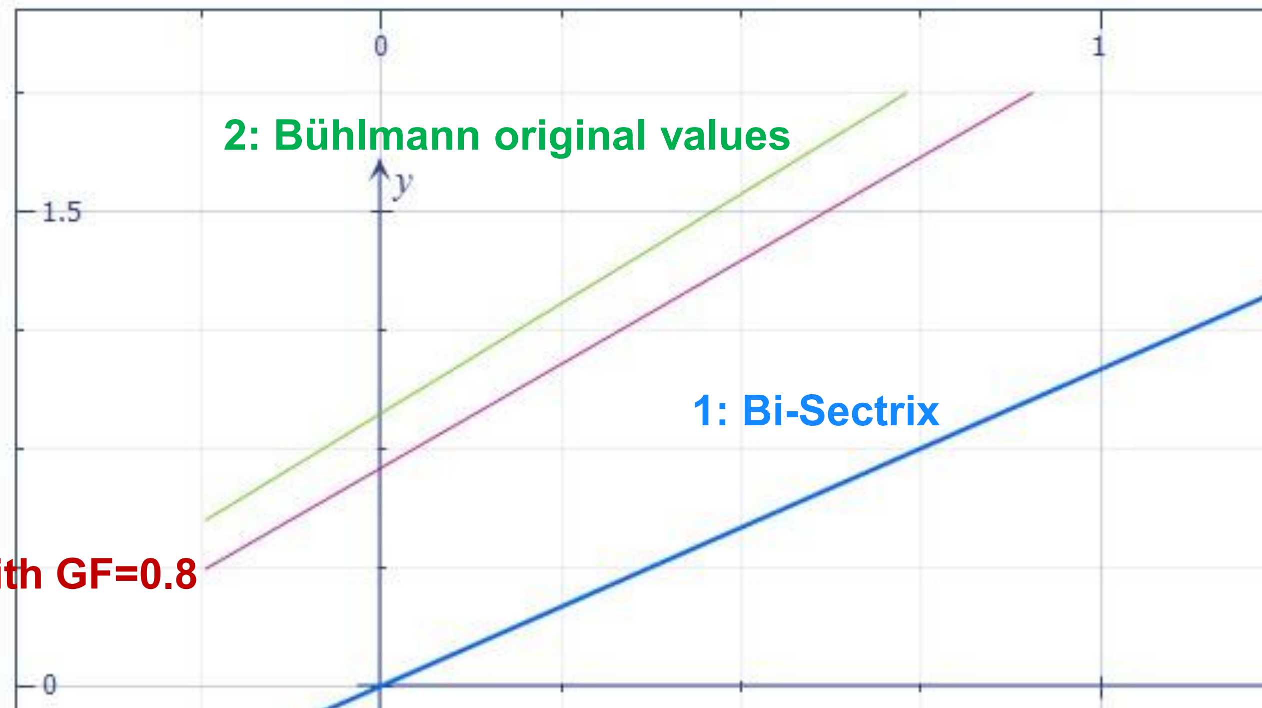
$y = x$ — 1: Bi-Sectrix, ambient pressure line

$y = \frac{x}{0.7222} + 0.8618$ — 2: P_{amb} / b + a = P_{amb} / 0.7222 + 0.8618

$y = \frac{x}{0.7646} + 0.6894$ — 3: P_{amb} / b + a = P_{amb} / 0.7646 + 0.6894

Y: $P_{tissue,\ tolerated}$
= „M-Value“ lines

X: $P_{ambient}$



3: modified values with GF=0.8
pls. cf. nx. slide:

Calculation of $P_{tissue,tolerated}$ with Gradient Factors:

From [65], p. 117 we have:

$$P_{ambient,\ tolerated} = (P_{tissue} - a) * b \qquad ;resp.:$$

$$P_{tissue,\ tolerated} = (P_{amb} / b) + a$$

with the a- & b-coefficients on p. 158. The method of using GF is not standardized, one idea, among many others is scaling the a- & b-coefficients separately, for e.g.:

$$a \rightarrow a * GF$$
$$b \rightarrow 1 / (GF / b - GF + 1)$$

For the theoretical compartment #3 with the half-time of 12.5 min we have:

$a = 0.8618 \rightarrow \quad a * GF = 0.8618 * 0.8 = 0.6894$
$b = 0.7222 \rightarrow \quad 1/(GF / b - GF + 1) = 1/(0.8/0.7222 - 0.8 + 1.0) = 0.7646$

(We choose compartment #3 as this also the benchmark in a lot of DAN studies on the DSL / DSG databanks)

Comparison of Heat Maps for run #3 & #6:

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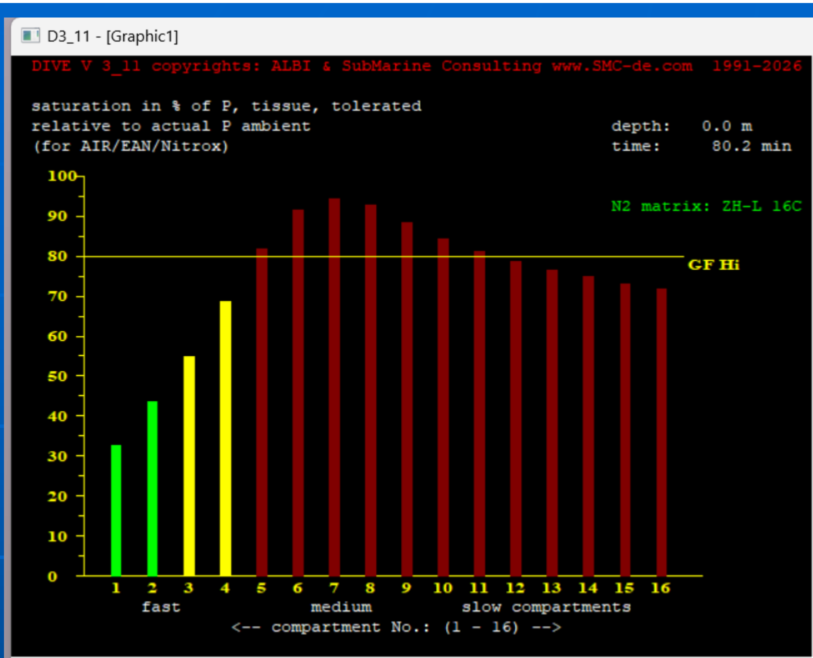

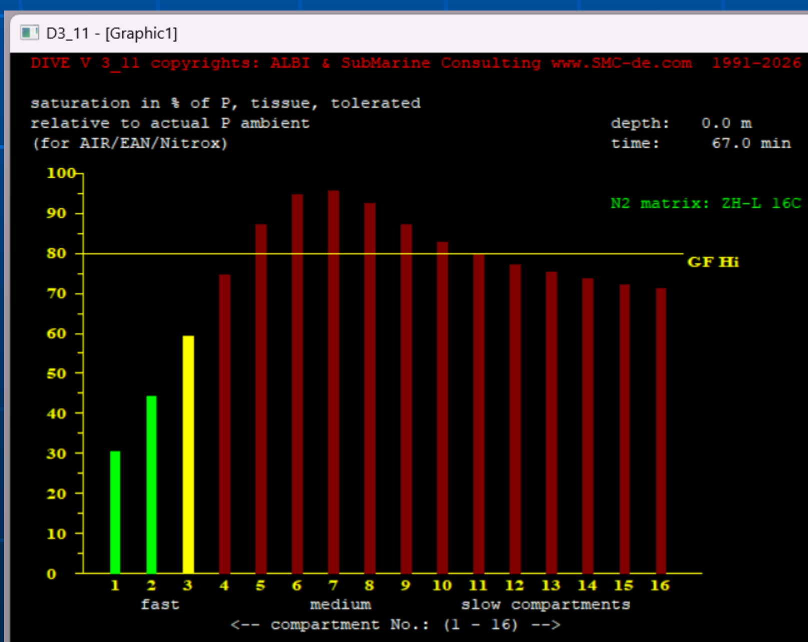

Heat maps:
generated @ end of run-time,
values at reaching surface:
run #3: 80 min,
run #6: 67 min

run #3 ZH-86:

run #6 iX3M:
higher super-saturations in the compartments #2 ➔ #7;
beginning with compartments #2 & # 3,
#4 is already „red“, #5: 85 %

Details: compartmental N_2 partial-pressures @ end of run-time for run #3 & #6:

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run #3 ZH-86:

```
Nr.:  1 1.0612 P N2
Nr.:  2 1.1148 P N2
Nr.:  3 1.2446 P N2
Nr.:  4 1.4058 P N2
Nr.:  5 1.5258 P N2
Nr.:  6 1.5589 P N2
Nr.:  7 1.5168 P N2
Nr.:  8 1.4250 P N2
Nr.:  9 1.3141 P N2
Nr.: 10 1.2216 P N2
Nr.: 11 1.1499 P N2
Nr.: 12 1.0872 P N2
Nr.: 13 1.0336 P N2
Nr.: 14 0.9882 P N2
Nr.: 15 0.9509 P N2
Nr.: 16 0.9206 P N2
```

run #6 iX3M:

```
Nr.:  1 0.9906 P N2
Nr.:  2 1.1290 P N2
Nr.:  3 1.3409 P N2
Nr.:  4 1.5281 P N2
Nr.:  5 1.6233 P N2
Nr.:  6 1.6148 P N2
Nr.:  7 1.5351 P N2
Nr.:  8 1.4188 P N2
Nr.:  9 1.2959 P N2
Nr.: 10 1.2001 P N2
Nr.: 11 1.1285 P N2
Nr.: 12 1.0674 P N2
Nr.: 13 1.0161 P N2
Nr.: 14 0.9732 P N2
Nr.: 15 0.9383 P N2
Nr.: 16 0.9102 P N2
```

Details: P(DCS) results from USN NEDU Report TR 04-41:

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TTS [min]	P(DCS) from: NEDU TR 04-41 „STANDAIR“	P(DCS): Combined Model	rem.
30	**0.08199**	**0.07705**	
33	**0.07807**	**0.07485**	original ZH-86, w.o. GF
40	**0.06997**	**0.07010**	iX3m 2
43	**0.06689**	**0.06821**	Perdix
ca. 47	**0.06322**	**0.06582**	USN, DCIEM
53	**0.05724**	**0.06193**	ZH-86 with GF 0.8
59	**0.05357**	**0.05938**	*G2* TEK
65	**0.04964**	**0.05654**	Add. deeper stop for: 5 min @ 6 m

Details: DCIEM deco-stress index I for air

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```
what next?ds
deco stress indices: PrT & I (DCIEM):
planned total-stop-time (TST)?
in minutes (min.)!  30.
 max. depth / ascent rate + sum of all stop times:  34.23
 PrT value, all segments:   26.63
 PrT value topical segment only: 26.63

                          DCIEM I values for air, EAN/O2 de

 50 % TAT [min]:  17.12    I AIR:  6.24    I EAN/O2:   4.9
      TAT [min]:  34.23    I AIR:  5.07    I EAN/O2:   4.0
150 % TAT [min]:  51.35    I AIR:  4.49    I EAN/O2:   3.5
200 % TAT [min]:  68.46    I AIR:  4.12    I EAN/O2:   3.2
what next?ds
deco stress indices: PrT & I (DCIEM):
planned total-stop-time (TST)?
in minutes (min.)!  55.
 max. depth / ascent rate + sum of all stop times:  59.23
 PrT value, all segments:   26.63
 PrT value topical segment only: 26.63

                          DCIEM I values for air, EAN/O2 de

 50 % TAT [min]:  29.62    I AIR:  5.29    I EAN/O2:   4.2
      TAT [min]:  59.23    I AIR:  4.30    I EAN/O2:   3.4
150 % TAT [min]:  88.85    I AIR:  3.81    I EAN/O2:   3.0
200 % TAT [min]: 118.46    I AIR:  3.49    I EAN/O2:   2.7
what next?
```