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II. DWSD
Do., 07.10.2021:
deco workshop digital # II

Über die ZNS-Uhr:
CNS-OT & P-OT,
Ran Arielis K-Werte
und das DMAC

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Inhalt:

- Kurze Wiederholung ☺

die 2 Arten der Sauerstoff-Vergiftung
(OT = oxygen toxicity)

- ZNS (CNS) Zentralnervensystem
- P (pulmonal), die Lunge betreffend

- Paul Bert & James Lorrain Smith
- Bob Hamilton: „There is no experimental basis on this!“
- K-Wert Rechnung (Ran Arieli, israelische Navy)
- Aktuelle Implementierung in DIVE Version 3
- DMAC (Diving Medicine Advisory Committee)

Paul Bert und James Lorrain Smith:
ja genau der, ohne "e" und ohne Bindestrich!

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Allgemeine Bezeichnung	**Ganzkörper-Sauerstoff Vergiftung oder Pulmonale Sauerstoffvergiftung**	**ZNS-Sauerstoffvergiftung (Zentrales Nerven System)**
Name des Forschers	J. Lorrain Smith	Paul Bert
Zeitraster	long term	short term
Dosishöhe	low dose	high dose
Wirkungsweise	Pulmonale (=die Lunge betreffend) Sauerstoffvergiftung, chronisch	ZNS Sauerstoffvergiftung, akut, spontan
Ab welchem Sauerstoff-partialdruck?	Ab 0,55 Bar pO_2, ab ca. 15 h	Ab ca. 1,4 Bar pO_2 ;ab 3,0 Bar pO_2 innerhalb von Sekunden (*)

NOAA Oxygen Exposure Limits (ZNS Belastung)

NOAA Grenzen für Sauerstoff-Exposition, NOAA Diving Manual 5th ed., 2013 Table 4.5, p. 4-28:

pO_2 [atm]	Maximum: **Single** Exposure [min.]	Maximum **per 24 h** [min.]
1,60	45	150
1,55	83	165
1,50	120	180
1,45	135	180
1,40	150	180
1,35	165	195
1,30	180	210
1,25	195	225
1,20	210	240
1,10	240	270
1,00	300	300
0,90	360	360
0,80	450	450
0,70	570	570
0,60	720	720

Oxygen Exposure Limits

(Quelle [63] "Bennett and Elliott's Physiology and Medicine of Diving“
Alf Brubakk, Neuman et al., 5 th Ed. Saunders,
ISBN 0-7020-2571-2,, S. 399)

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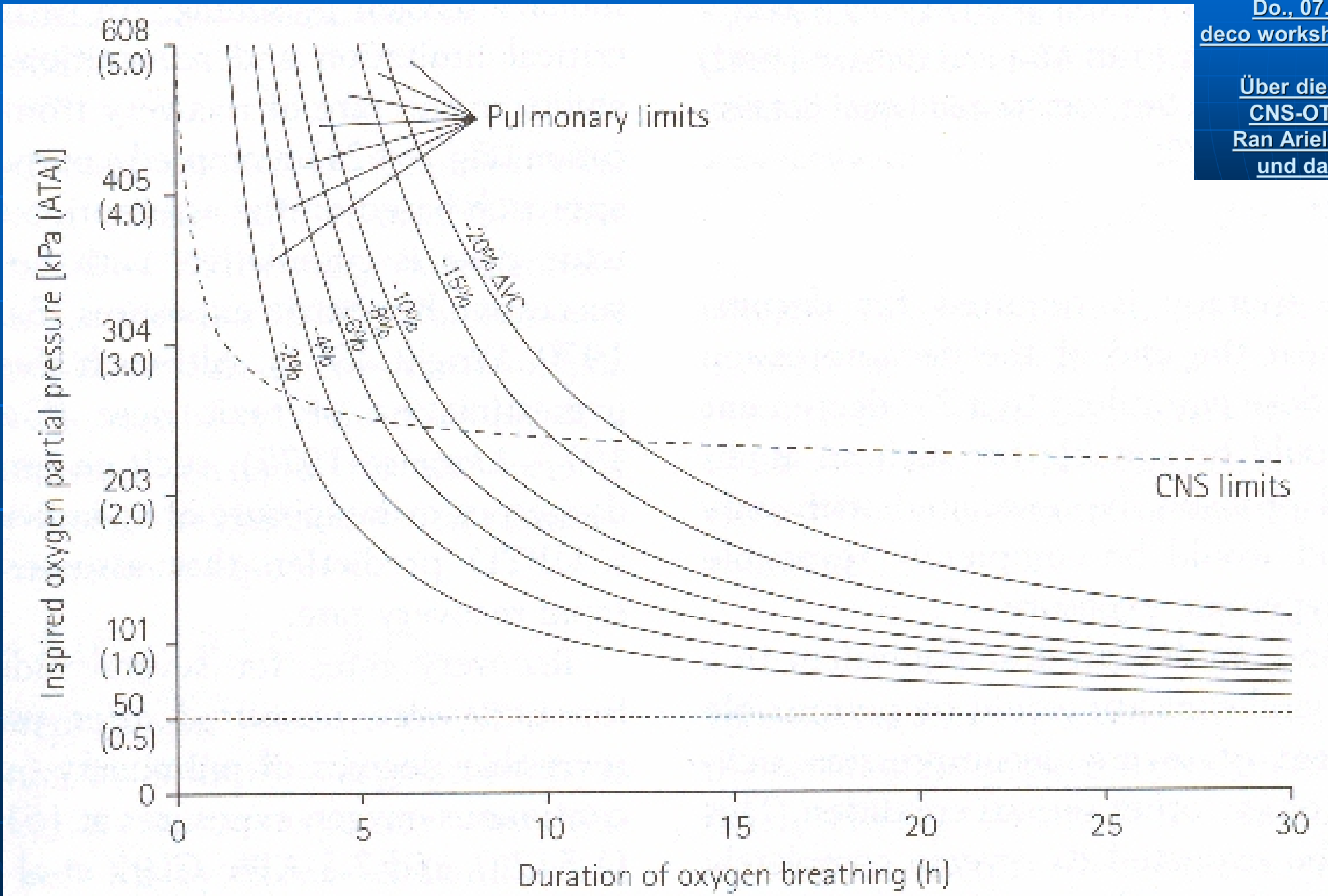

OTU Tabelle (Oxygen Tolerance Units; Quelle: [149], p. 4-26, Table 4.4:)

pO_2 [atm]	OTU / min.		pO_2 [atm]	OTU / min.
0,50	0,00		1,25	1,40
0,55	0,15		1,30	1,48
0,60	0,27		1,35	1,56
0,65	0,37		1,40	1,63
0,70	0,47		1,45	1,70
0,75	0,56		1,50	1,78
0,80	0,65		1,55	1,85
0,85	0,74		1,60	1,92
0,90	0,83		1,65	2,00
0.95	0,92		1,70	2,07
1,00	1,00		1,75	2,14
1,05	1,08		1,80	2,22
1,10	1,16		1,85	2,28
1,15	1,24		1,90	2,35
1,20	1,32		2,00	2,49

OTU Tabelle (Oxygen Tolerance Units; Quelle: [149], Table 4.6, p. 4-29:)

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Tauch Tage	Durchschnittliche Dosis	Maximale Total-Dosis (für alle Tage)
1	850	850
2	700	1400
3	620	1860
4	525	2100
5	460	2300
6	420	2520
7	380	2660
8	350	2800
9	330	2970
10	310	3100
11	300	3300
12	300	3600
13	300	3900
14	300	4200
15 – 30	300	Nach Anforderung

REPEX

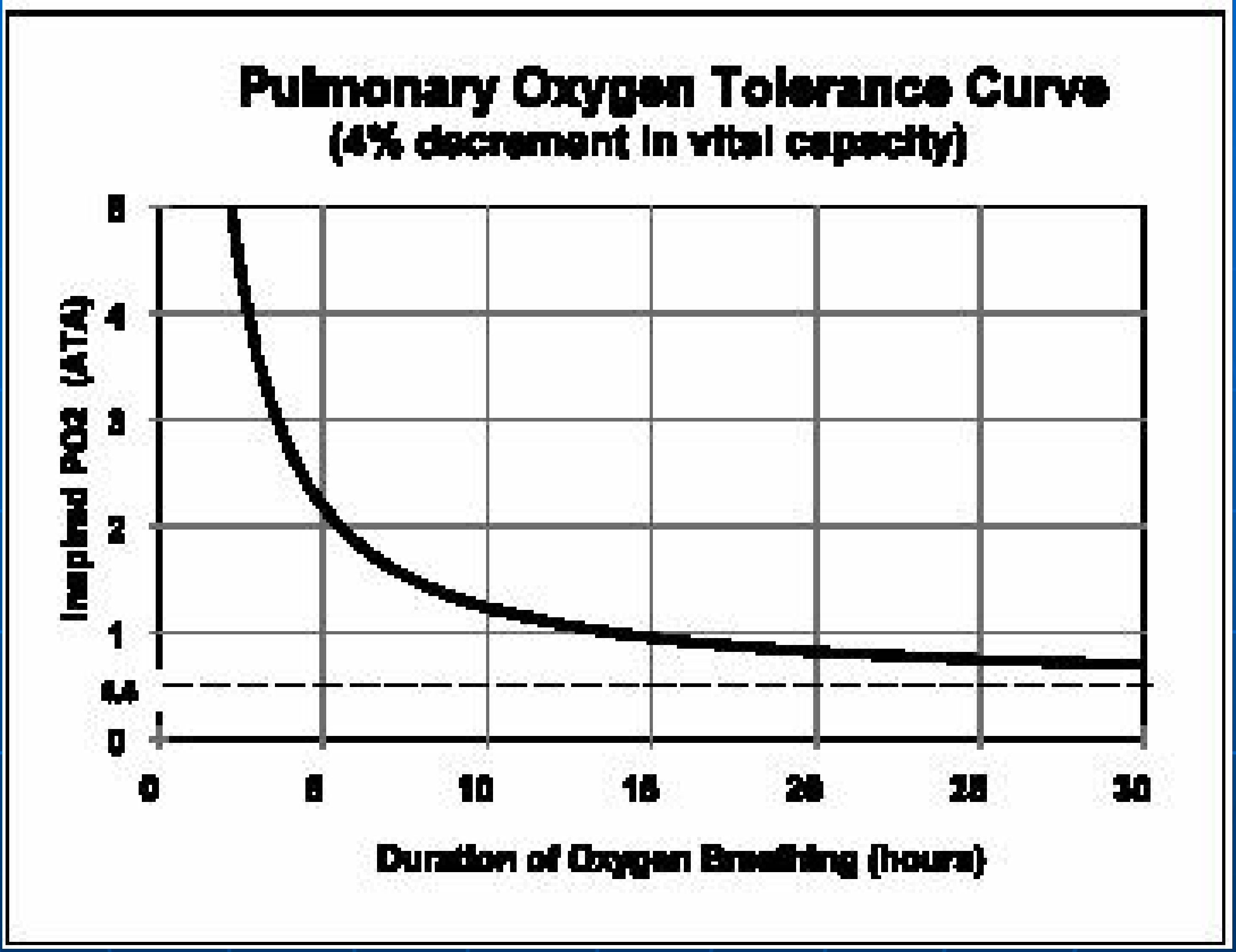
OTU (Oxygen Tolerance Units) und REPEX Verfahren

Quelle:

Hamilton, R.W., Kenyon, D.J., Peterson, R. E., Butler, G.J., Beers, D.M., 1988 May,

Repex: Development of repetitive excursions, surfacing techniques, and oxygen procedures for habitat diving,

NURP Technical Report 88-1A, Rockwell M.D., U.S. DoD):



$$OTU = t * ((pO_2 - 0{,}5) / 0{,}5) \exp 0{,}83$$

Paul Bert und James Lorrain Smith:
ja genau der, ohne "e" und ohne Bindestrich!

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BAROMETRIC PRESSURE

Researches In Experimental Physiology

BY

PAUL BERT

Translated from the French by

MARY ALICE HITCHCOCK, M.A.

Formerly Professor of Romance Languages at the University of Akron

—Dog during the tonic convulsions of oxygen poisoning.

Original:
La Pression Barometrique, 1878

Paul Bert und James Lorrain Smith:
ja genau der, ohne "e" und ohne Bindestrich!

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THE PATHOLOGICAL EFFECTS DUE TO INCREASE OF OXYGEN TENSION IN THE AIR BREATHED.

BY J. LORRAIN SMITH, M.A., M.D.

(From the Pathological Laboratory, Queen's College, Belfast.)

THE investigation which forms the subject of the present paper arose out of a series of experiments on the attenuation of microbes by oxygen at high pressure. Part of this series was carried out with the view of ascertaining the effect of the oxygen on animals which had been infected. It soon became apparent, however, that the oxygen at a tension of over 100 % of an atmosphere produced pneumonia in the normal animal. It was therefore necessary to carry out a preliminary research in regard to this.

Oxygen and the Diver:
was in den Hafenkneipen am Kanal über Donald erzählt wird ...

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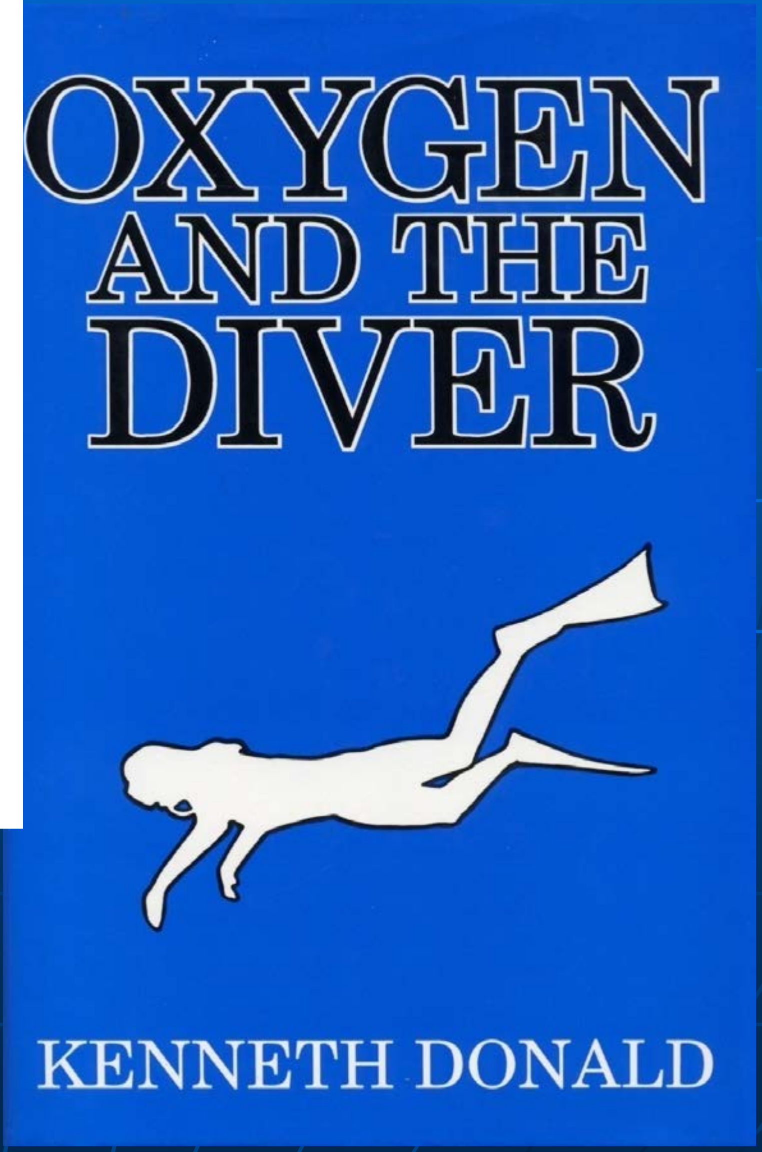
Author (centre) with two members of the first charioteer group after a day's oxygen diving in Horsea Lake, Portsmouth, April 1942.



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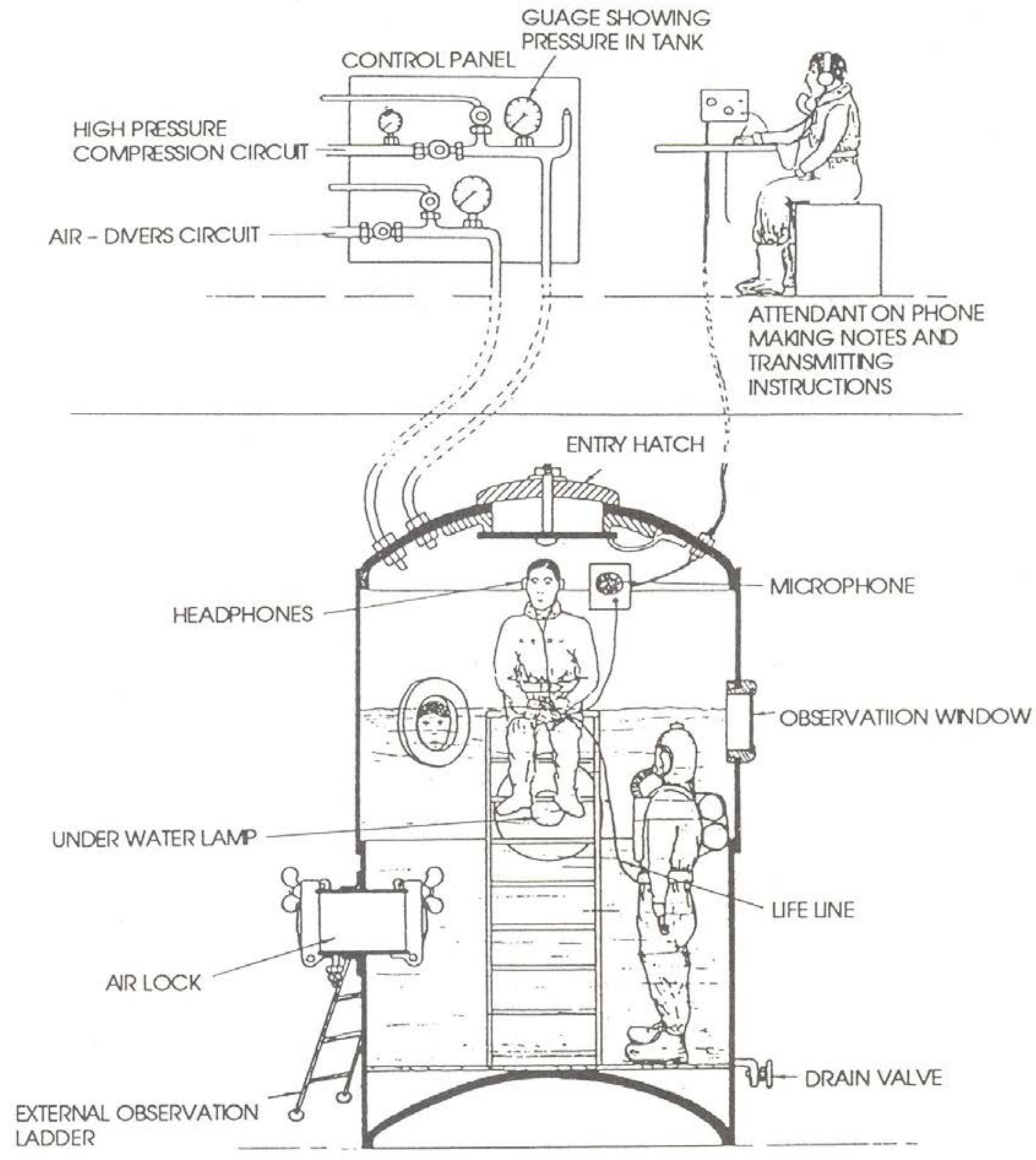

FIG. 2 Showing wet pressure chamber with diver under water breathing oxygen in self-contained set. Internal and external attendants.

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"There is no experimental basis on this!" (*)

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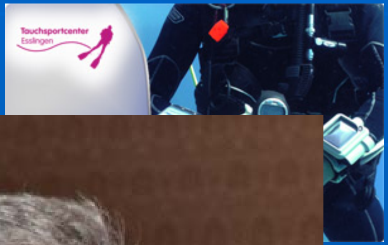

Übliche Vorgehensweise bei Nitrox-/TEC-Kursen:

(*) "There is no experimental basis on this!”

R.W. Bill Hamilton,
49th UHMS workshop, 2001, p. 70

"There is no experimental basis on this!" (*)

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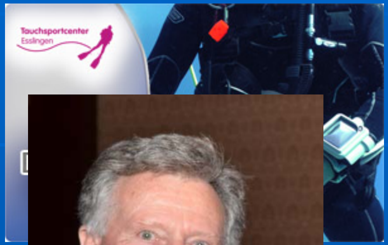

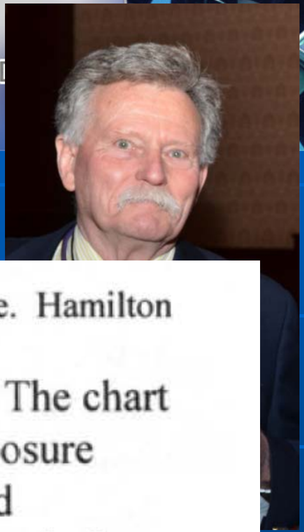

R.W. Bill Hamilton,
49th UHMS workshop, 2001, p. 70:

Lambertsen and his colleagues; that it was derived from the USN chart is apparent. The chart takes into account both CNS and whole-body or pulmonary toxicity, and covers exposure over a full 24-hr day. It allows a little more time for the critical level of 1.6 atm, and considerably more for the lower levels where the Navy chart is unrealistic. This chart is for diving under ideal conditions, without heavy work, dense gas, breathing resistance, or the like.

The recreational divers do an interesting thing with this by interpolating the limits chart. For example, if one is allowed 120 min at 1.5 atm PO_2 and has spent 60 minutes, this is an accumulation of 50% of the limit. Both depth and exposure time can be interpolated (Kenyon and Hamilton, 1989). The divers call this the "oxygen clock." There is no experimental bases for this, but it makes sense physiologically because this seems to be a linear function. And it does seem to work in practice.

"There is no experimental basis on this!" (*)

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Und weitere gleichlautende Quellen von R.W. Bill Hamilton:

→ „NAUI NITROX“ Manual [30], 1st. edition 1997)
auf den S. 4-4 bis 4-8

→ DAN TEC Conference 2008, S. 38 – 66;
(bei „Manuals_4_free“)

→ [75] "Bove and Davis' DIVING MEDICINE", Alfred A. Bove,
4 th. edition, Saunders 2004, ISBN 0-7216-9424-1
auf der Seite 105

→ auf den 3 folgenden Seiten:

"There is no experimental basis on this!" (*)

„NAUI NITROX“ Manual [30], 1st. edition 1997, 4-7:

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Oxygen Physiology, Toxicity, and Tolerance

For multilevel dives or more than one dive of less than maximum allowed duration, it is possible to **interpolate** the limit values (Fig 4-5). That is to say, at any level the full limit on the oxygen clock is 100% of the limit, or an O_2 limit fraction of 1.0. Exposures at all levels are totaled. For example, at 1.4 atm the allowable exposure time is 150 min. If a diver has an exposure to that level for 75 min, half the allowable time, this would run the oxygen clock to 50% of the limit or the limit fraction to 0.5. If there is additional exposure on the same dive, say 60 min at 1.3 PO_2, an additional one-third, 33% or 0.33 is added, giving an oxygen clock now of 83% or a limit fraction of 0.83. When the total reaches 100% or 1.0, the diver is considered to have reached the allowable limit, and further exposure to elevated oxygen is at increased risk. Diving beyond the limit is not recommended.

Although there has been no laboratory validation of this technique of interpolating the exposure times, it makes sense and has been shown to work in practice with many thousands of actual dives. The NOAA oxygen exposure limits themselves are also generalizations, but have been proven to be reasonable limits through extensive practice.

with 32% oxygen, and to 95 fsw (29 msw) with 36%. The allowed times are sufficiently generous that the oxygen exposure time limits are not at all likely to be encountered in normal no-stop scuba diving.

One may ask why NAUI imposes more conservative oxygen exposure limits than NOAA. There are several reasons. First, the NAUI procedures are intended to be appropriate for divers with limited training and experience. There may be discrepancies not only in the conduct of the dive but also in gas mixing and analysis, making the actual oxygen exposure greater than expected. The range of activities of a NAUI diver may exceed those used for the planning of the NOAA limits. And there have been convulsions in divers with a calculated oxygen exposure well below the limit. Also, the rescue system for most recreational divers may not be as effective if a convulsion does occur.

If a convulsion does occur

A convulsion in itself rarely causes injury, but the secondary consequences for a diver can be disastrous. First, the intense muscle contraction of the neck and jaw cause the diver to spit out the mouthpiece. It is usually impossible to put it back in. Consequently, the diver is

"There is no experimental basis on this!" (*)

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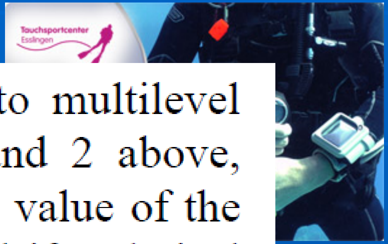
DAN TEC Conference 2008, S. 38 – 66;
(bei „Manuals_4_free“)



The O_2 clock is a logical tool for applying square dive exposure limits to multilevel exposures, but its foundation is uncertain, and as indicated by cases 1 and 2 above, obeying its principles it does not guarantee freedom from CNS toxicity. The value of the O_2 clock as a predictor of CNS toxicity probability might be better assessed if technical divers recorded their depth, time, and O_2 partial pressure profiles and sent them to DAN (with medical outcomes) for analysis.

But like the limits themselves . .

- There is no scientific basis for this interpolation
- Is it working? **We don't know!**
- This points out a serious need for data from recorded dive logs

"There is no experimental basis on this!" (*)

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Quelle: [75] "Bove and Davis' DIVING MEDICINE", Alfred A. Bove,
4 th. edition, Saunders 2004, ISBN 0-7216-9424-1
auf der Seite 105 :

time, and Po_2, keeping records of their "CNS %" or "oxygen limit fraction," the portion of the published limit that has been reached.[37] There is no research basis for the method of interpolating between limits, but it has apparently worked in extensive field experience. Despite these misgivings, a workshop representing a broad sector of the relevant diving community has endorsed the 1.6 atm limit.[38]

Another approach is that of Harabin and colleagues,[39] who used maximum likelihood statistics to predict CNS toxicity. Using data mostly from exposures to pure oxygen in the water, their analysis shows that risk increases nonlinearly as a function of oxygen level and time of exposure, with the risk increasing sharply with oxygen levels above threshold values and being significantly attenuated by intermittent exposure. In a report based on work with animals and some data from humans, Arieli and colleagues derived a simple relationship based on the square of time and a power function of Po_2, of the following form:

$$K = t^2(Po_2)^c$$

where K is a cumulative oxygen toxicity index such that symptoms appear when the index reaches a certain threshold level, and c is a variable determined from the data.[40] This equation can be applied to both pulmonary and CNS toxicity.

"There is no experimental basis on this!" (*)

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This is the most stupid thing I ever saw in diving physiology!

1 – The selected limit values are only a decision of NOAA

This is totally arbitrary: French regulation limits <u>1.6 bar to 3 hours</u> !!!!

2 – CNS intoxication is NOT linear neither proportional to the duration of exposure

3 – The effects of a given PO_2 level on the brain are extremely different for 1.4 or 1.6 Bar, and <u>those % cannot be added</u>.

This CNS clock is of <u>NO value</u> and <u>cannot predict the risk of convulsion</u>

When it is incorporated in a dive computer you should question the manufacturer's understanding in diving physiology …

http://jclp-hyperbarie.fr

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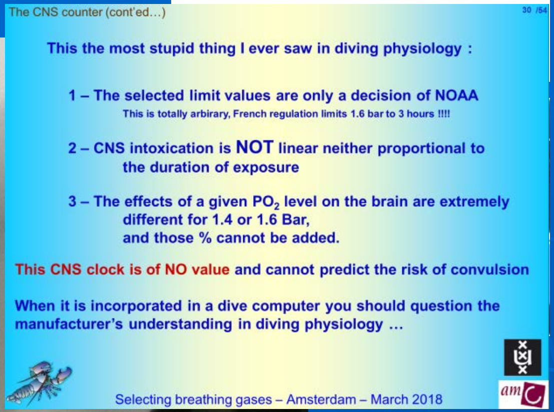

Jean-Claude Le Pechon (rechts) mit Sigrid Theunissen (Schoko Siggi, mitte) und mir auf dem Weg zum AMC Amsterdam 03/2018

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Fig. 1 Oxygen partial pressure limits for nitrogen/oxygen scuba and surface-supplied helium/oxygen mixed gas diving.

Exposure times *(mins)*	Normal exposure *(bar)*	Exceptional exposure *(bar)*
30	1.6	2.0
40	1.5	1.9
50	1.4	–
60	1.3	1.8
80	1.2	1.7
100	–	1.6
120	1.1	1.5
180	–	1.4
240	1.0	1.3

Maximum oxygen partial pressure = 6 bar

Certain types of closed circuit breathing equipment

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Quelle:
[167]S. 317

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pO_2 [Bar]	KP		UPTD =
2,0	2,50		T * KP
2,5	3,17	UPTD, max:	1,425
3,0	3,82	UPTD, tol.:	615

Quelle:
[167] Bevan, John (ed.) (2011)
The Professional Diver's Handbook,
Submex Ltd., ISBN 978-0-09508242-6-0S. 318

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Calculated risk of pulmonary and central nervous system oxygen toxicity: a toxicity index derived from the power equation

Ran Arieli[1,2]

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[2] *Eliachar Research Laboratory, Western Galilee Medical Centre, Nahariya, Israel*

Corresponding author: *Dr Ran Arieli, 12 Klil-Hakhoresh, Rakefet, D N Misgav 0020175, Israel*
arieli1940@gmail.com

"There is no experimental basis on this!" (*)

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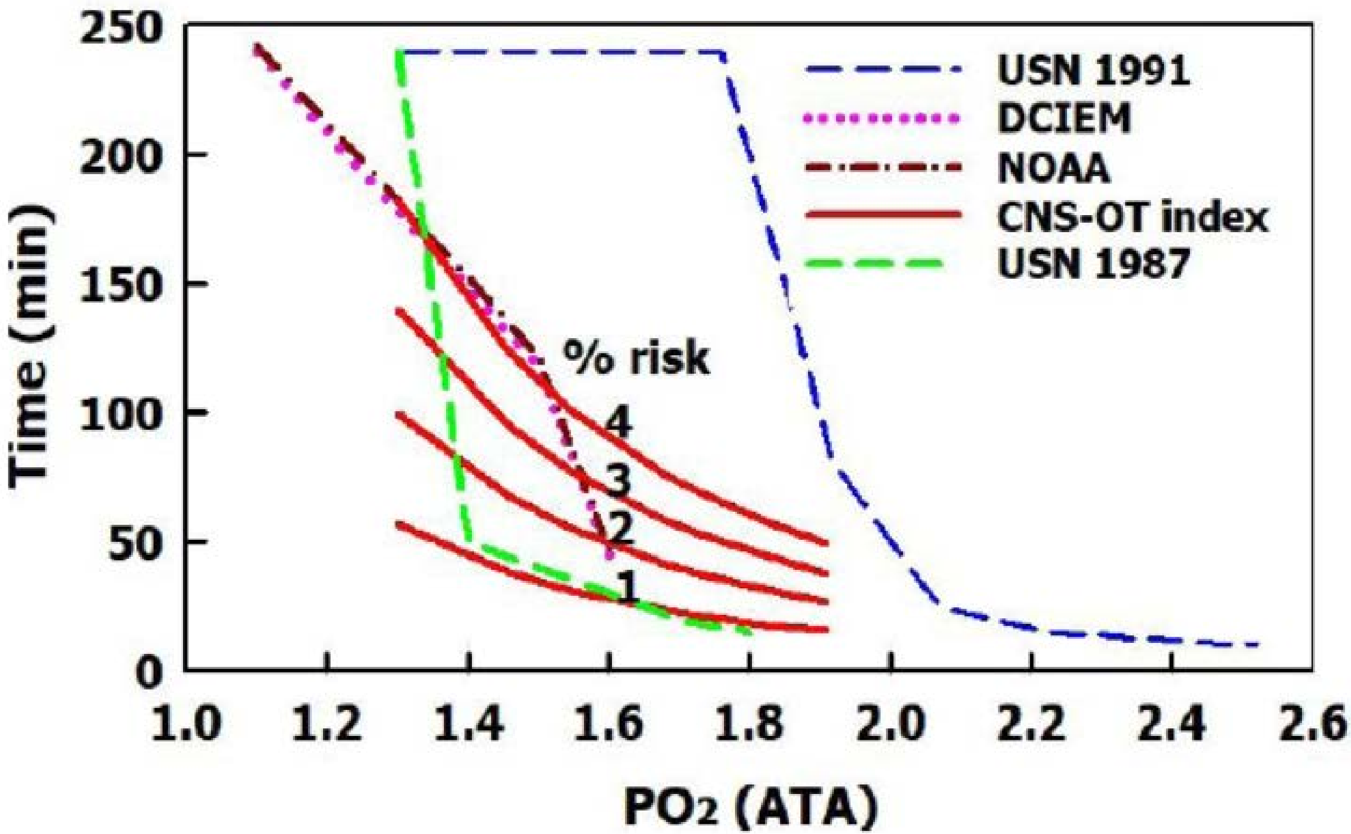
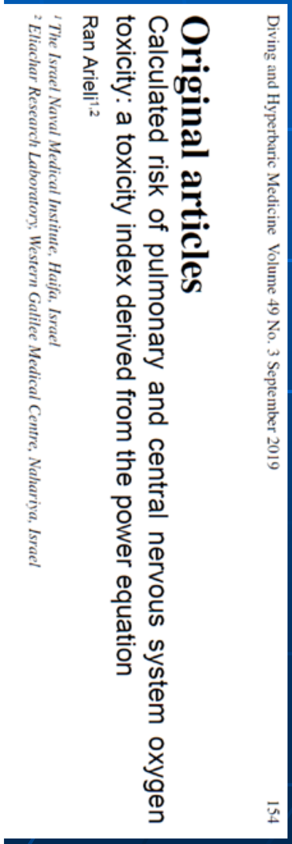
Figure 4

Permissible exposure to hyperoxia (PO_2/time) to avoid CNS oxygen toxicity in diving; data from different institutes. Both 1987 and 1991 US Navy recommendations are shown. The calculated percentage risk using the *CNS-OT index* is also shown





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The power equation for CNS-OT was similar in form to that derived for P-OT:

$$K = t^2 \times (PO_2)^{6.8} \qquad (8)$$

where K is the *CNS-OT index*, t is the duration of the hyperoxic exposure in minutes, and PO_2 is expressed in atm abs. Risk is related to the magnitude of K.


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		Empfehlung:	**26108**		**25**		
			58571	2 % Risk	57		
			196811	4 % Risk	195		
			432700	6 % Risk	431		
			K =		k_{ALBI} =	Integer(K/1000) + 1	
	min	atm					
NOAA exp.	30	2	100287,425		101		
Exposures	45	1,9	159202,365		160		
	60	1,8	195954,633		196		
	75	1,7	207575,07		208		
	120	1,6	351866,867		352		
	150	1,5	354489,258		355		
	180	1,4	319312,304		320		
	240	1,3	342955,111		343		
NOAA	45	1,6	49481,2782		50		
Limits	120	1,5	226873,125		227		
	150	1,4	221744,655		222		
	180	1,3	192912,25		193		
	210	1,2	152360,035		153		
	240	1,1	110126,73		111		
	300	1	90000		91		

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Depth (fsw/msw)	Limit US Navy (United States Department of the Navy NSSC, 2008) (min)	Risk of CNS toxicity (Arieli et al., 2002)(%)	Limit Arieli et al. <5% (min)
25/7.7	240	13.1	83
30/9.2	80	6.3	63
35/10.7	25	2.4	48
40/12.3	15	1.7	38
50/15.3	10	1.8	24

Depth in feet of sea water (fsw) and meters of sea water (msw). The limits are printed as in the US Navy Diving Manual with (in the third column) their associated risk for CNS toxicity based on the model of Arieli et al. (2002). The last column shows the bottom time when accepting a maximum risk of CNS toxicity of 5%.

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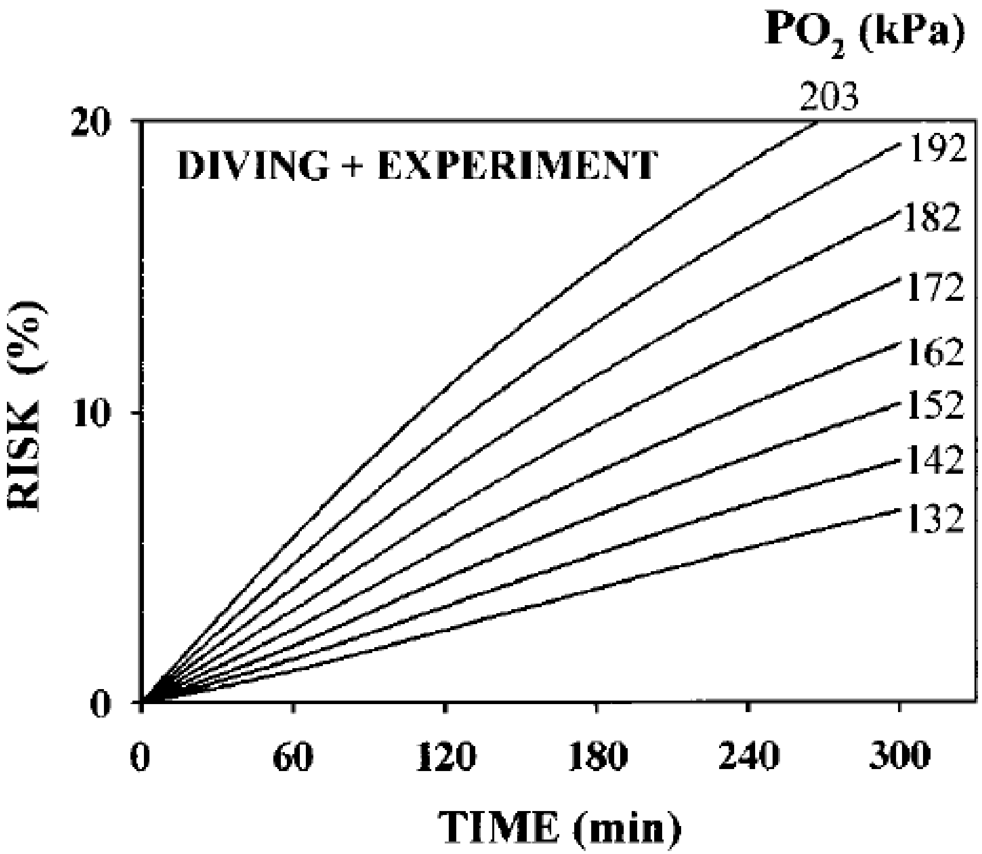

Fig. 8. Percent risk of CNS oxygen toxicity as a function of time and Po_2. The parameters for the calculation were derived from both hyperbaric experiments and diving.

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recovery expression is:

$$Ktr = K_e \times e^{-0.079 \times tr} \qquad (9)$$

where the subscript e represents the end of the hyperoxic exposure and tr is the recovery period in min.

In a complex hyperbaric exposure comprising a number of periods of hyperoxia (in excess of 1.3 atm abs), the following two expressions (similar to those derived for P-OT) may be used for a sequence of distinct pressures and for a continuous function of PO_2 with time, respectively:

$$K = [\sum_{i=1}^{n} ti \times (PO_2 i)^{3.4}]^2 \qquad (10)$$

$$K = [\int_0^{tox} (PO_2 i)^{3.4} dt]^2 \qquad (11)$$

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Do., 07.10.2021:
deco workshop digital # II

Über die ZNS-Uhr:
CNS-OT & P-OT,
Ran Arielis K-Werte
und das DMAC

	Start	49000	
	10 min	22456,821	
	30 min	4625,5458	
	45 min	1414,243	
	60 min	432,39938	
	Start	49	
	10 min	22	
	30 min	4	
	45 min	1	
	60 min	0	

recovery expression is:

$$Ktr = K_e \times e^{-0.079 \times tr} \quad (9)$$

where the subscript e represents the end of the hyperoxic exposure and tr is the recovery period in min.

In a complex hyperbaric exposure comprising a number of periods of hyperoxia (in excess of 1.3 atm abs), the following two expressions (similar to those derived for P-OT) may be used for a sequence of distinct pressures and for a continuous function of PO_2 with time, respectively:

$$K = [\sum_{i=1}^{n} ti \times (PO_2 i)^{3.4}]^2 \quad (10)$$

$$K = [\int_0^{tox} (PO_2 i)^{3.4} dt]^2 \quad (11)$$

Mother Nature is a Bitch: jenseits von 1,6 … Details von der israel. Navy [Ran Arieli]:

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RESEARCH ARTICLE

CNS Oxygen Toxicity in Closed-Circuit Diving: Signs and Symptoms Before Loss of Consciousness

RAN ARIELI, YEHUDA ARIELI, YOCHANAN DASKALOVIC, MIRIT EYNAN, AND AMIR ABRAMOVICH

ARIELI R, ARIELI Y, DASKALOVIC Y, EYNAN M, ABRAMOVICH A. *CNS oxygen toxicity in closed circuit diving: signs and symptoms before loss of consciousness.* Aviat Space Environ Med 2006; 77:1153–7.

to provide the diver the opportunity to return to the surface."

There is a dearth of information regarding CNS oxy-

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t_{max} sind zur leichteren Merkbarkeit nach unten korrigiert!

	K_{max} @ 1% risc		<------------------------						bottom time [min]						------------------------>		
100% = t_{max} [min]	26108	pO_2 [atm]	10	15	20	25	30	35	40	45	50	55	60	90	120	180	240
15		2	42	~~100%~~	-	-	-	-	-	-	-	-	-	-	-	-	-
18		1,9	30	67	-	-	-	-	-	-	-	-	-	-	-	-	-
20		1,8	20	46	~~100%~~	-	-	-	-	-	-	-	-	-	-	-	-
25		1,7	14	31	56	~~100%~~	-	-	-	-	-	-	-	-	-	-	-
30		1,6	9	21	37	58	~~100%~~	-	-	-	-	-	-	-	-	-	-
40		1,5	6	13	24	37	54	73	~~100%~~	-	-	-	-	-	-	-	-
50		1,4	3	8	15	23	33	46	60	76	~~100%~~	-	-	-	-	-	-
65		1,3	2	5	9	14	20	27	36	46	57	68	82	-	-	-	-
85		1,2	1	2	5	8	11	16	21	26	33	40	47	-	-	-	-
110		1,1	0	1	2	4	6	8	11	14	18	22	26	59	-	-	-
150		1	0	0	1	2	3	4	6	7	9	11	13	31	55	-	-
200		0,9	0	0	0	1	1	2	2	3	4	5	6	15	26	60	-
300		0,8	0	0	0	0	0	1	1	1	2	2	3	6	12	27	48
500		0,7	0	0	0	0	0	0	0	0	0	1	1	2	4	10	19
700		0,6															
							% of K_{max}										

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t_{max} sind zur leichteren Merkbarkeit nach unten korrigiert!

	K_{max} @ 2% risc		<------ bottom time [min] ------>														
100% = t_{max} [min]	58571	pO_2 [atm]	10	15	20	25	30	35	40	45	50	55	60	90	120	180	240
5		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10		2,5	~~100%~~	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20		2	19	42	~~100%~~	-	-	-	-	-	-	-	-	-	-	-	-
25		1,9	13	30	53	~~100%~~	-	-	-	-	-	-	-	-	-	-	-
30		1,8	9	20	37	58	~~100%~~	-	-	-	-	-	-	-	-	-	-
35		1,7	6	14	25	39	56	~~100%~~	-	-	-	-	-	-	-	-	-
40		1,6	4	9	16	26	37	51	~~100%~~	-	-	-	-	-	-	-	-
50		1,5	2	6	10	16	24	32	43	54	~~100%~~	-	-	-	-	-	
60		1,4	1	3	6	10	15	20	26	34	42	50	~~100%~~	-	-	-	-
80		1,3	1	2	4	6	9	12	16	20	25	30	36	-	-	-	-
120		1,2	0	1	2	3	5	7	9	11	14	17	21	47	~~100%~~	-	-
150		1,1	0	0	1	2	2	3	5	6	8	9	11	26	47	-	-
200		1	0	0	0	1	1	2	2	3	4	5	6	13	24	55	-
320		0,9	0	0	0	0	0	1	1	1	2	2	3	6	12	27	48
500		0,8															
800		0,7															
1200		0,6															
2000		0,5															
							% of K_{max}										

Mother Nature is a Bitch: jenseits von 1,6 …
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P-OT:

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		<------------------------------				bottom time [min]				------------------------------>		
pO$_2$ [atm]		60	90	120	180	240	300	360	420	480	540	600
3		152	341	606	1364	2424	3788	5454	7424	9697	12272	15151
2,5		66	148	263	593	1054	1646	2371	3227	4215	5334	6585
2		24	53	95	214	380	594	855	1164	1520	1924	2375
1,9		19	42	75	169	301	470	676	921	1202	1522	1879
1,8		15	33	59	132	235	367	528	719	939	1189	1468
1,7		11	25	45	102	181	283	407	554	723	915	1130
1,6		9	19	34	77	137	214	308	420	548	694	857
1,5		6	14	26	57	102	159	230	313	408	517	638
1,4		5	10	19	42	74	116	168	228	298	377	465
1,3		3	7	13	30	53	83	119	163	212	269	332
1,2		2	5	9	21	37	58	83	113	147	186	230
1,1		2	3	6	14	25	39	56	76	99	125	155
1		1	2	4	9	16	25	36	49	64	81	100
0,9		1	1	2	6	10	15	22	30	40	50	62
0,8		0	1	1	3	6	9	13	18	23	29	36
0,7		0	0	1	2	3	5	7	10	13	16	20
0,6		0	0	0	1	2	2	3	5	6	8	10
0,5		0	0	0	0	1	1	2	2	3	3	4

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<u>Übersicht K-Werte Berechnungen für CNS-OT bei risc ca. 1 % & P-OT < 2 % ΔVC:</u>

power function:

$$\mathbf{K = t^2 * pO_2^{\,c}}$$

CNS-OT:	**K < 26.108**	*t in min.*	*pO_2 in atm*	*<u>c = 6,8</u>*
P-OT:	**K < 250**	*t in hours*	*pO_2 in atm*	*<u>c = 4,57</u>*

recovery function:

$$\mathbf{K_{recovery} = K_{end} * e^{-(\tau * t_{recovery})}}$$

τ = time constant: 0,079; $t_{recovery}$ in min.

K-Wert Berechnung, Bsp.: CNS-OT:

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$$K = [\sum_{i=1}^{n} ti \ x \ (PO_2 i)^{3.4}]^2 \quad (10)$$

$$K = [\int_0^{tox} (PO_2 i)^{3.4} dt]^2 \quad (11)$$

Dekompressions Phase:

z.B.: 6,25 m @ 100 % O_2, 15 min

$K_{deko} = [15 * 1,6^{3,4}]^2 = [74,1]^2 = 5,498$

K-Wert für den kompletten TG:

$K = [60 * 1,1^{3,4} + 15 * 1,6^{3,4}]^2 = 24,684$

Grund Phase:

z.B.: 1,1 atm pO_2, 60 min

$K_{bottom} = [60 * 1,1^{3,4}]^2 = [82,9]^2 = 6.883$

Tiefe **Zeit**

***Mother Nature is a Bitch*: jenseits von 1,6 … Details von der israel. Navy [Ran Arieli]:**

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Aktuelle Implementierung in:
DIVE Version 3_10

Software & Handbuch zum kostenlosen herunterladen:

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

Übersichtsartikel:
An agile implementation of the "K-Value" severity index for cns- and pulmonary oxygen toxicity (CNS-OT & P-OT)

mit Beispielen etc., auf RESEARCHGATE:
https://dx.doi.org/10.13140/RG.2.2.17583.87205

- **DMAC:**
- Diving Medicine Advisory Committee
- https://www.dmac-diving.org/
- Guidance bzgl. CNS-OT & P-OT Berechnungen:
-

Zum guten Schluß, aus dem neuen „deco manual“, Version 2021 / 2022, nun mit ca. 850 Seiten:

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“Als junger Mensch suchte ich oft Gelehrte und Geistliche auf,
um ihren Streitgesprächen zu lauschen.
Aber ich ging nie klüger weg, als ich gekommen war.“
Omar Chayyam, undatiert

(**Quelle:** *Umar-i Ḫayyām*; arabisch عمـر الخيـام, war persischer Mathematiker, Astronom, Astrologe, Kalenderreformer, Philosoph und durch seine Vierzeiler (die Rubāʿīyāt) berühmter Dichter. Er lebte von ca. 1048 – 1131. Sein obiger „grüner Spruch“ könnte gut auf unseren DWSD oder den analogen deco workshop gelten … ☺)