

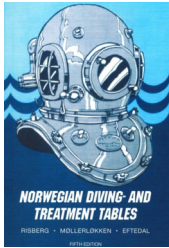
Draft TUP Decompression procedures

Jan Risberg



Position and conflict of interest

- Employed by NUI, Norwegian Armed Forces Joint Medical Services and Haukeland University Hospital
- Tasked by NUI:
 - Consultant services/RCDD/Advisory diving physician for a number of offshore E&P and off/onshore diving contractors
 - RCDD for SubseaPartner
- Independent/personal responsibility
 - First author of NDTT
 - Commitment of co-authors for this presentation
 - The main concepts/principles have been orally discussed, presentation has been reviewed and main conclusions accepted
 - The final, formal and written decisions have not been taken
 - What is good in this presentation should be considered a mutual achievement
 - What is bad should be considered my personal responsibility

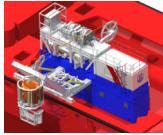


Task

- E-mail from Øyvind Loennechen to the authors of NDTT on Aug 16th 2019 (unofficial translation):
 - Related to the fact that Norwegian Oil and Gas Association, Forum for diving and underwater intervention has established a workgroup for TUP diving we would like to inquire the authors whether they could establish a set of (decompression) tables for diving to 50 meters on air/Nitrox. The Norwegian Diving and Treatment Tables are referred to as the only accepted set of air (decompression) tables.

Initially a caveat TUP-dives <> Bounce dives


- Bounce dive
 - No universal definition
 - Most commonly associated with 1970-1980 diving
 - > Air diving range
 - Rapid compression
 - Heliox bottom gas
 - Air > Nitrox > O₂ decompression gas
 - Company specific decompression routines
- TUP dive
 - No universal definition
 - In this presentation
 - Surface oriented diving
 - Closed bell
 - Air or Nitrox as bottom gas
 - Air or O₂ as decompression gases



SMP Commercial Diving Equipment Blog



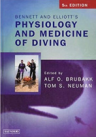

Method

- NDDT Editorial board
 - Olav Eftedal, Andreas Møllerløyken, Jan Risberg
- Three meetings (video/telephone)
- Searched for and harvested relevant literature
- Agreed on the principles of table development



Sources

- Non-systematic search
 - Bennett and Elliott's Physiology and Medicine of Diving (2003)
 - Pubmed
 - Rubicon Research Repository
 - Google
- Search phrases
 - Transfer under pressure
 - TUP
- Personal communication
 - N-Sea
 - USN
 - Neil Pollock

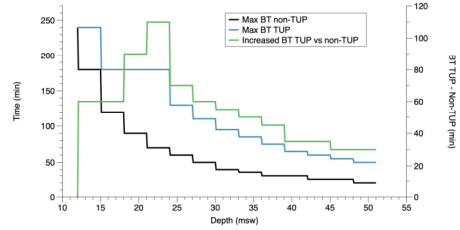
Identified IW air/O₂ decompression procedures

- Canadian
- Dutch
- Frenchx2
- USN



Table	O ₂ from (msw)	New single dive after (h)
CAN	9	18
FRA 12m	12	12
FRA 6m	6	12
NLD	9	12
USN	9	18

TUP – extension of bottom time



Comparing CAN, FRA, NLD and USN

Depth (msw)	Table	BT (min)	BT (min)	BT (min)	BT (min)
15	CAN	15	15	15	15
18	CAN	18	18	18	18
24	CAN	24	24	24	24
30	CAN	30	30	30	30
36	CAN	36	36	36	36
42	CAN	42	42	42	42

Depth (msw)	Table	BT (min)	BT (min)	BT (min)	BT (min)
15	FRA	15	15	15	15
18	FRA	18	18	18	18
24	FRA	24	24	24	24
30	FRA	30	30	30	30
36	FRA	36	36	36	36
42	FRA	42	42	42	42

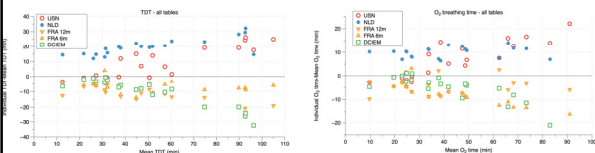
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Code: box19

dive time (min)	BT for stop (min)	BT for stop (min)						BT stop time (min)	BT OTU
		15	18	24	30	36	42		
15	15	15	15	15	15	15	15	15	
18	18	18	18	18	18	18	18	18	
24	24	24	24	24	24	24	24	24	
30	30	30	30	30	30	30	30	30	
36	36	36	36	36	36	36	36	36	
42	42	42	42	42	42	42	42	42	

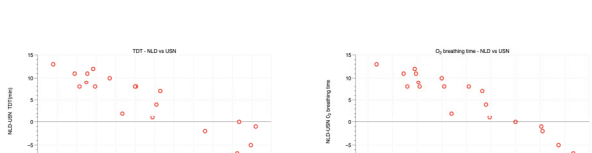
Table comparison criteria


- Table depths (6)
 - 15, 18, 24, 30, 36 and 42 msw
- Bottom times (3)
 - Longest allowed non-TUP, longest allowed TUP, intermediate
- Variables
 - Total decompression time (TDT)
 - O₂ breathing time

TDT and O₂ breathing time – all tables



TDT and O₂ breathing time – NLD vs USN






Summary

- CAN, FRA, NLD and USN procedures have similar decompression obligation (total decompression time - TDT) except for
 - Short bottom times (NLD)
 - The very longest bottom times (FRA)

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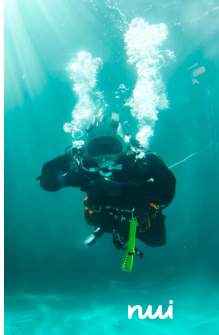
The question of repetitive diving



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Minimum surface interval before next dive


Depth	Time	CAN and USN	FRA and NLD
15	240	18	12
24	180	18	12
36	85	18	12
42	65	18	12




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Bottom time penalty, 30m 70 min, 12:30 surface interval

Depth 2nd dive (msw)	CAN	FRA and NLD (min)	USN (min)
18	NA	0	14
24	NA	0	9
30	NA	0	8
42	NA	0	6



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Summary - repeated dives

- Repeated dives
 - In descending order of conservatism:
 - CAN > USN > NLD > FRA
 - For some profiles, FRA procedures are significantly more liberal than CAN, NLD and USN

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Grand summary

- CAN, FRA, NLD and USN TUP decompression procedures can be expected to provide similar and acceptable DCS risk for the majority of single dives
 - Caution might be appropriate for the decompression obligation stipulated for the longest NLD and FRA profile
- NLD and FRA procedures for repetitive diving tend to be more liberal than CAN and USN
- O₂ toxicity to be considered and handled irrespective of decompression table used



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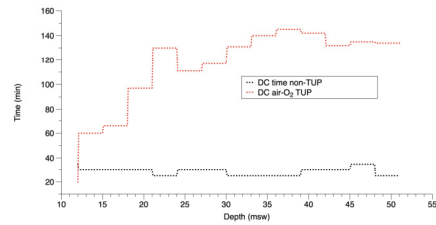


NDTT – editors opinion

- In favour of preferring USN TUP decompression procedures
 - Better documented algorithm and verification
 - DCS risk reduction for the longest bottom times and repetitive dives
 - Repetitive diving, flying after diving and air iw/SurDO2/TUP integrated in one framework



There's nothing such as a free lunch



Hyperoxic burden – USN procedures

Gas	Depth	EAD	BT	O ₂ index	Bottom phase	Deco	Total	Threshold value
Nitrox 40	27	21	180	OTU	315	164	479	300-850
				PO	54	17	71	250
Nitrox 40	22	14	240	OTU	348	102	450	300-850
				PO	49	7	56	200
Air	39	39	75	OTU	75	185	260	300-850
				PO	1	16	17	200

