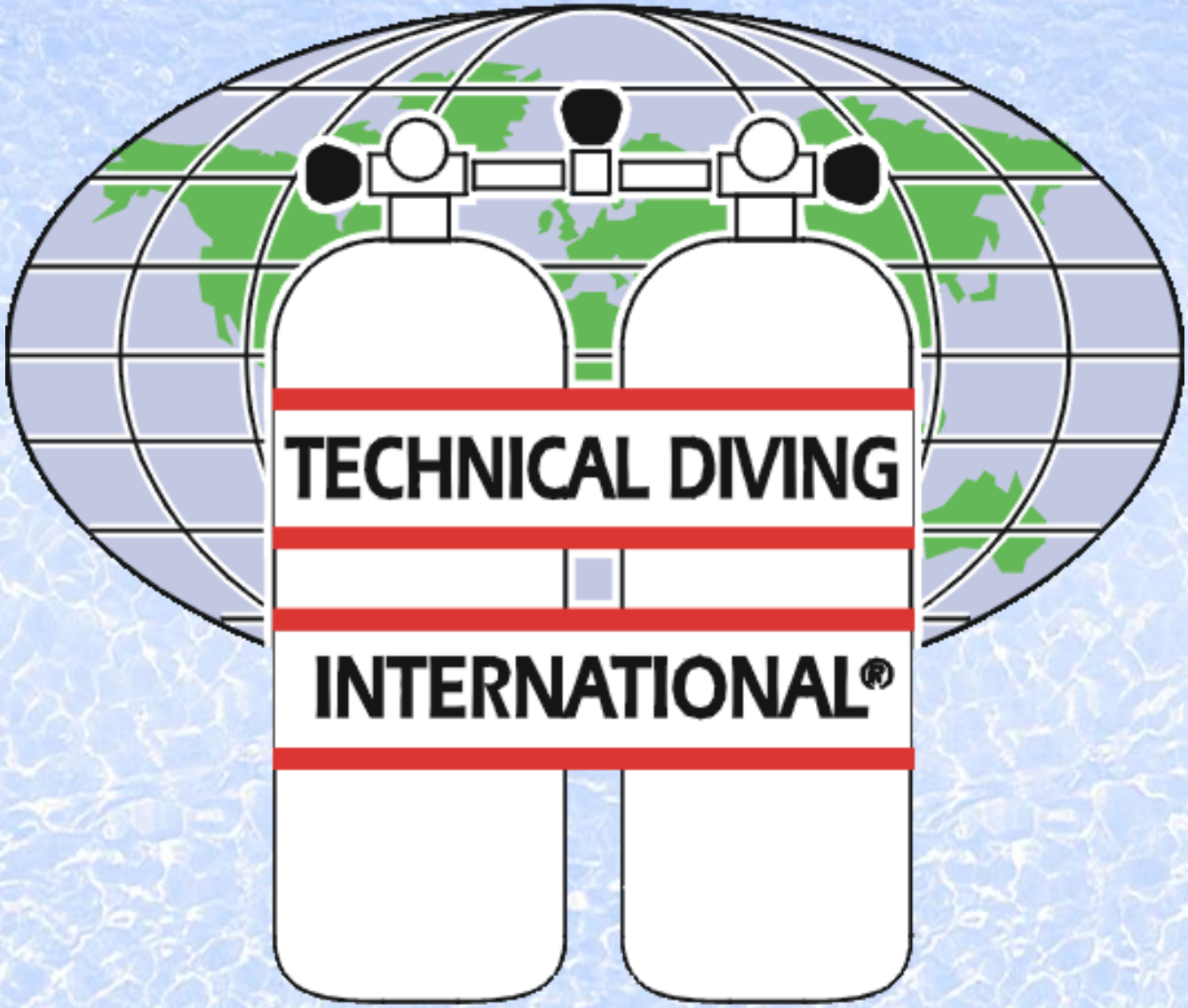

TECHNICAL DIVING
INTERNATIONAL®

Welcome to Decompression Procedures

Course Overview:

Equipment Requirements

Equipment Setup

Decompression Techniques

Decompression Gases

What is Decompression Diving?

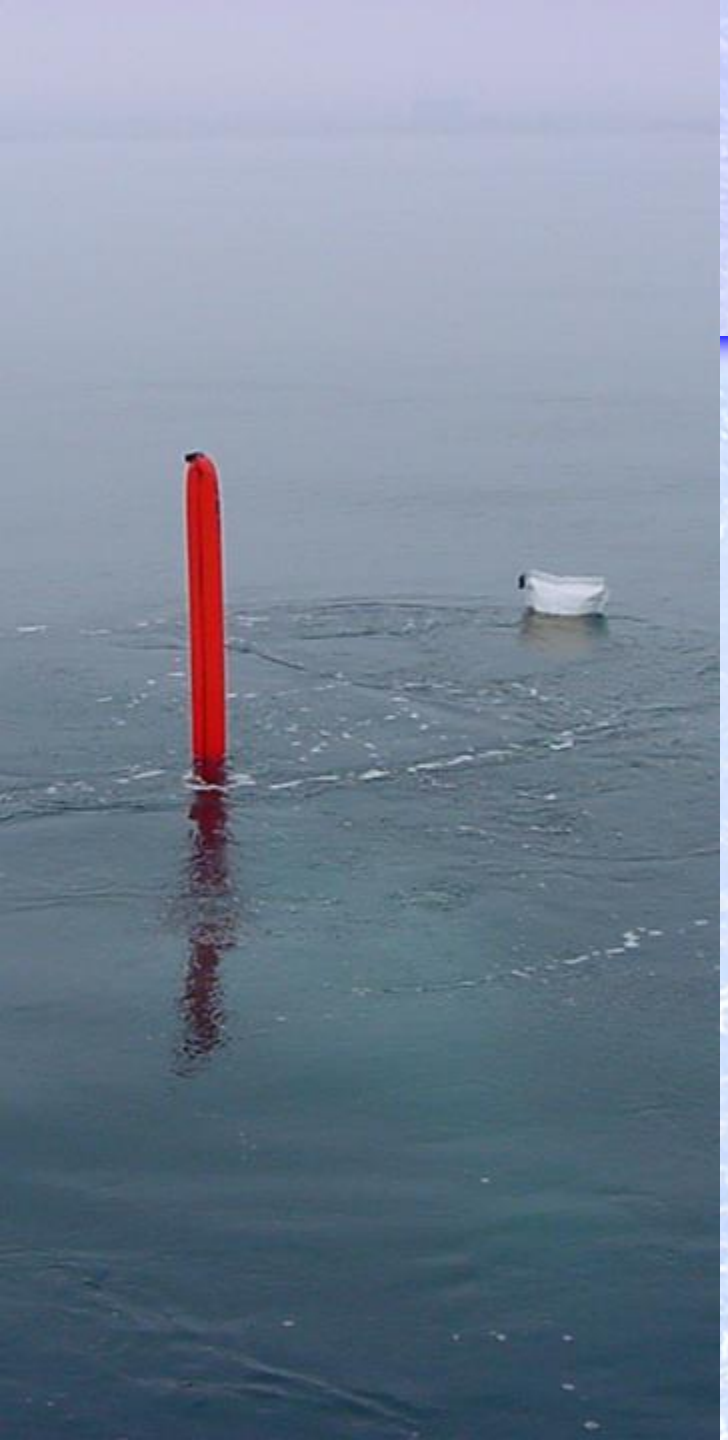
Did you know..?

ALL dives are decompression dives!

What is a Decompression Stop?

Things to consider:

- Where to stop?
- Deeper stops?
- Swimming during deco?
- Gas requirements?
- Rough seas?
- Currents?



Why Decompression Dive?

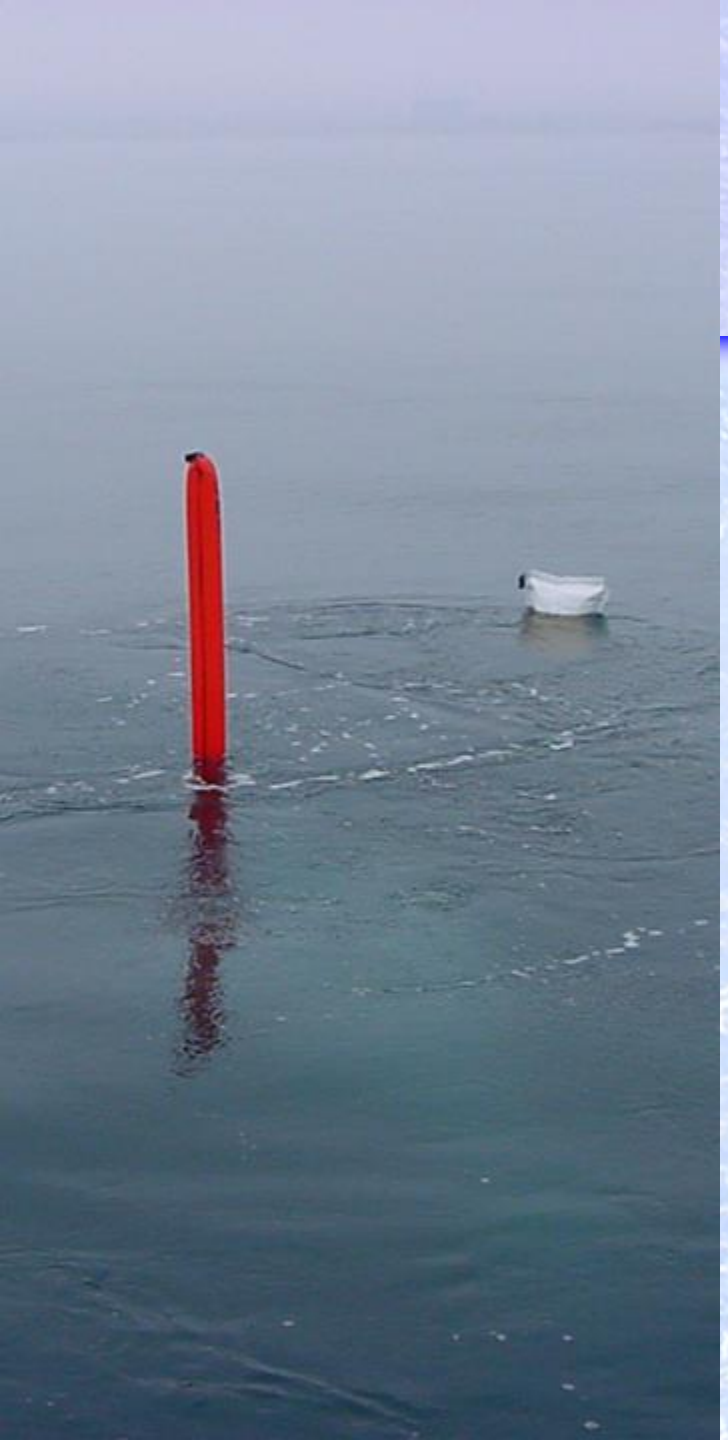
Reasons for Decompression Diving:

- Extended Bottom Times
- Planned Safety Stops
- Accidental Extended Bottom Time

Remember… ALL dives are decompression dives!

Factors Governing Decompression:

- Descent Rate
- Gas Mixes
- Depth
- Bottom Time
- Ascent Rate



Why Decompression Dive?

No-Deco Dive = No mandatory stop time dive.

Deco Dive when too much N_2 in body tissues.

“Virtual Overhead”

Decompression Divers = Self Sufficient Divers

RUNNING OUT OF GAS IS
NOT TO BE TOLERATED

What is Decompression Diving? ~ Review

1. List 2 reasons a diver may be forced into a decompression dive.

   Entanglement, time to get back to an anchor/ascent line, disoriented, misread depth, etc.

2. True/False All dives are decompression dives.

   a. True b. False

3. List at least 4 factors that determine decompression status.

   - Descent rate
   - Depth
   - Ascent rate
   - The breathing mix
   - Bottom time

What is Decompression Diving? ~ Review

4. List 4 types of “overhead diving”.
   - Ice diving
   - Wreck penetration diving
   - Cavern or cave diving
   - “Decompression diving” (The virtual overhead)

5. A decompression diver should be prepared to operate alone.

   a. True b. False

Diving Principals

Review: Air = 21% O_2 + 78% N_2 & “other stuff”

More and more divers starting to use Nitrox!

Pressure

- Increase in depth = Increase in pressure

Units of Pressure

- Barometric, PSI, BAR, TORR, ATA …
- Gauge Pressure Vs. Absolute Pressure

O_2 & N_2 Pressures

Depth		Total	Air	
fsw	metres	Pressure (BAR)	Nitrogen	Oxygen
Surface		1	0.79	0.21
33	10	2	1.58	0.42
66	20	3	2.37	0.63
99	30	4	3.15	0.84
132	40	5	3.95	1.05
165	50	6	4.74	1.26

Nitrogen

Inert Gas ~ “Noble Gas”

Nitrogen is “inert” …
ONLY AT THE SURFACE!

Nitrogen Narcosis
Decompression Sickness

Oxygen

Respiration Cycle:
Inhale O_2 ⇨ Respiration ⇨ Exhale CO_2

Hypoxia – Hyperoxia

Maximum Operating Depth

Pulmonary Toxicity – CNS Toxicity

ConVENTID

NOAA Tables

NOAA Oxygen Pressure Time Limits (Minutes)			
PO_2 (BAR)	Single Dive	%CNS / Minute	Daily
1.6	45	2.22	150
1.5	120	0.83	180
1.4	150	0.67	180
1.3	180	0.56	210
1.2	210	0.48	240
1.1	240	0.42	270
1.0	300	0.33	300
0.9	360	0.28	360
0.8	450	0.22	450
0.7	570	0.18	570
0.6	720	0.14	720

Diving Principals Review

1. What is the difference between “absolute pressure” and “gauge pressure”?

   Absolute pressure includes the pressure of the atmosphere added to a gauge pressure.

2. What is the normal pressure at the surface of the earth at sea level?

   1 Atmosphere Absolute (1 ATA) =

   - Barometric pressure (760 mmHg, 29.92 inHg)
   - Pounds per square inch (14.7 psi)
   - Bar (1.0132 bar)
   - Torr (760 torr) …

Diving Principals Review

3. What is the total pressure at 30 metres?

   4 BAR or 4 Atmospheres Absolute (4 ATA)

4. What gas makes up the largest part of normal air?

   Nitrogen

5. List 2 problems associated with nitrogen.

   - Nitrogen Narcosis
   - Decompression Sickness

6. Does the human body require oxygen “percentage” or oxygen “pressure” to maintain life?

   Oxygen PRESSURE (in fact many routine Trimix dives are done using only about 10 percent oxygen)

Diving Principals Review

7. What are the two types of oxygen toxicity? Which one is of major concern to a diver?

   Pulmonary Oxygen Toxicity And CNS Oxygen Toxicity, CNS Oxygen Toxicity is the MAJOR concern of a diver.

8. Does a diver always get a warning before an oxygen convulsion?

   NO

9. What is the maximum time exposure if the diver is at an oxygen pressure of 1.4 BAR?

   The single dive exposure for 1.4 BAR is 150 minutes.

10. What is the oxygen pressure of AIR at 40 metres?

    1.05 BAR

Decompression Planning

Need for decompression: Compressed N_2

Pressure Gradient:
N_2 Enters different tissues at different rates

DCS or: “The Bends”

J. S. Haldane:
1:1.58 Differential Gas Pressure is
when bubbling occurs

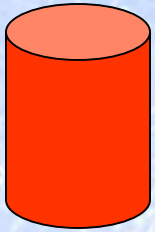
Half Times

Model For a Tissue With 120 Minute Halftime			
Halftime	**Time**	**% Full**	
1	120	50%	1/2
2	240	75%	3/4
3	360	87.5%	7/8
4	480	93.75%	15/16
5	600	96.875%	31/32
6	720	98.4375%	63/64

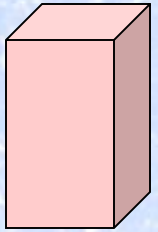
Tissue

Symmetrical:

On-Gassing Rate (saturation) = Off-Gassing Rate (de-saturation)



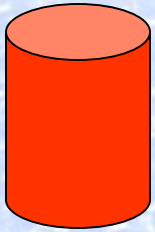
Blood Flow



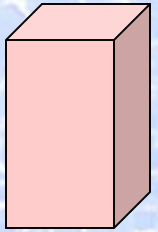
Tissues

Non-Symmetrical:

On-Gassing Rate (saturation) > Off-Gassing Rate (de-saturation)



Blood Flow

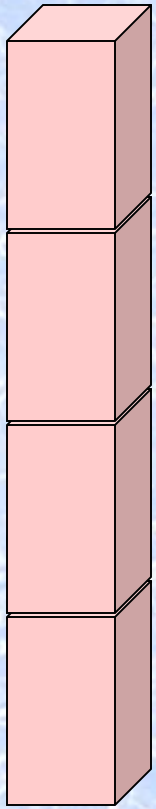


Tissues

Saturation Rates

Blood Flow

"Slow"



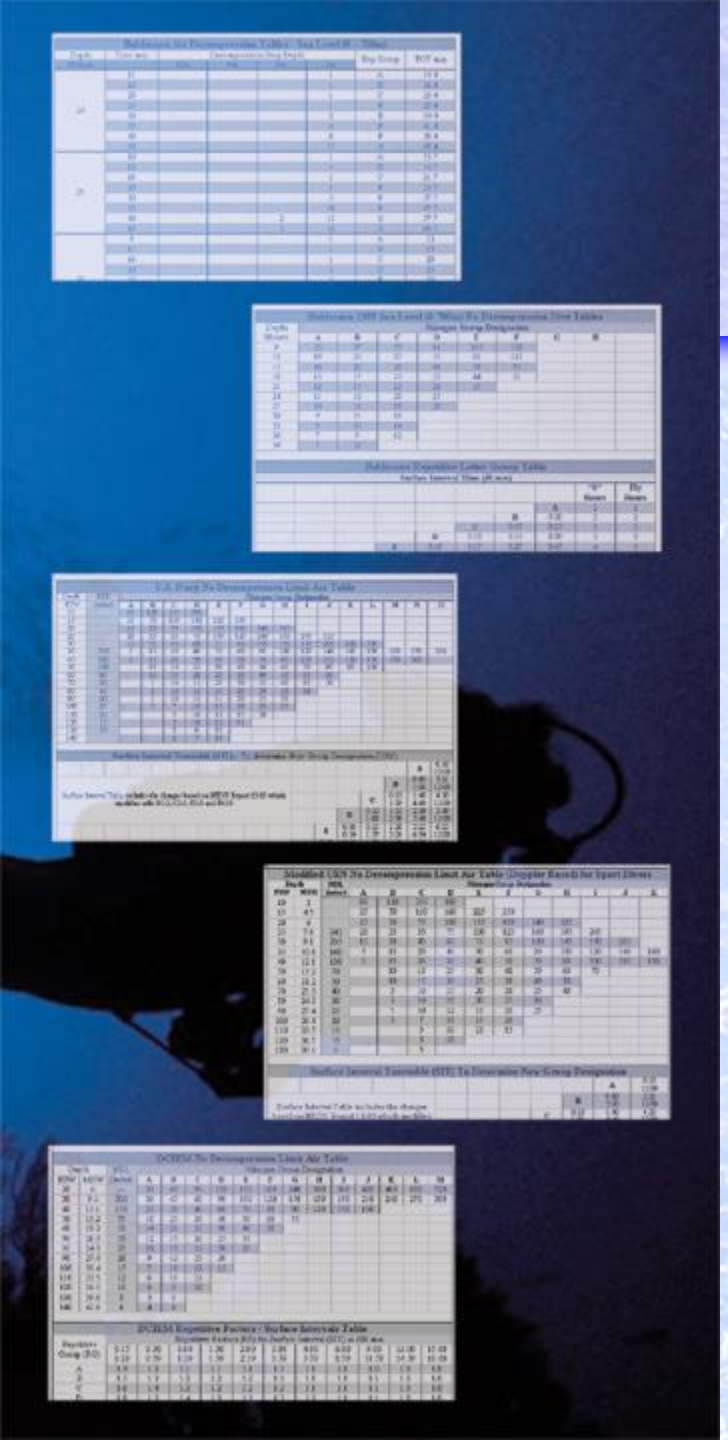
Bone

Muscle

Fat

Blood

"Fast"



Advent Of Dive Tables

Haldane's early dive tables used arbitrarily chosen half time compartments of:
5, 10, 20, 40 and 75 minutes.

Further dive table advancement based on empirical observations.

Early Computers used "Table" calculations.

Modern Computers use algorithmic methods.

Tables Vs. Computers

Multi-Level Capability

Account for missed stops, depths, etc …

Ease of use

Less Stressful than having to “work the tables”

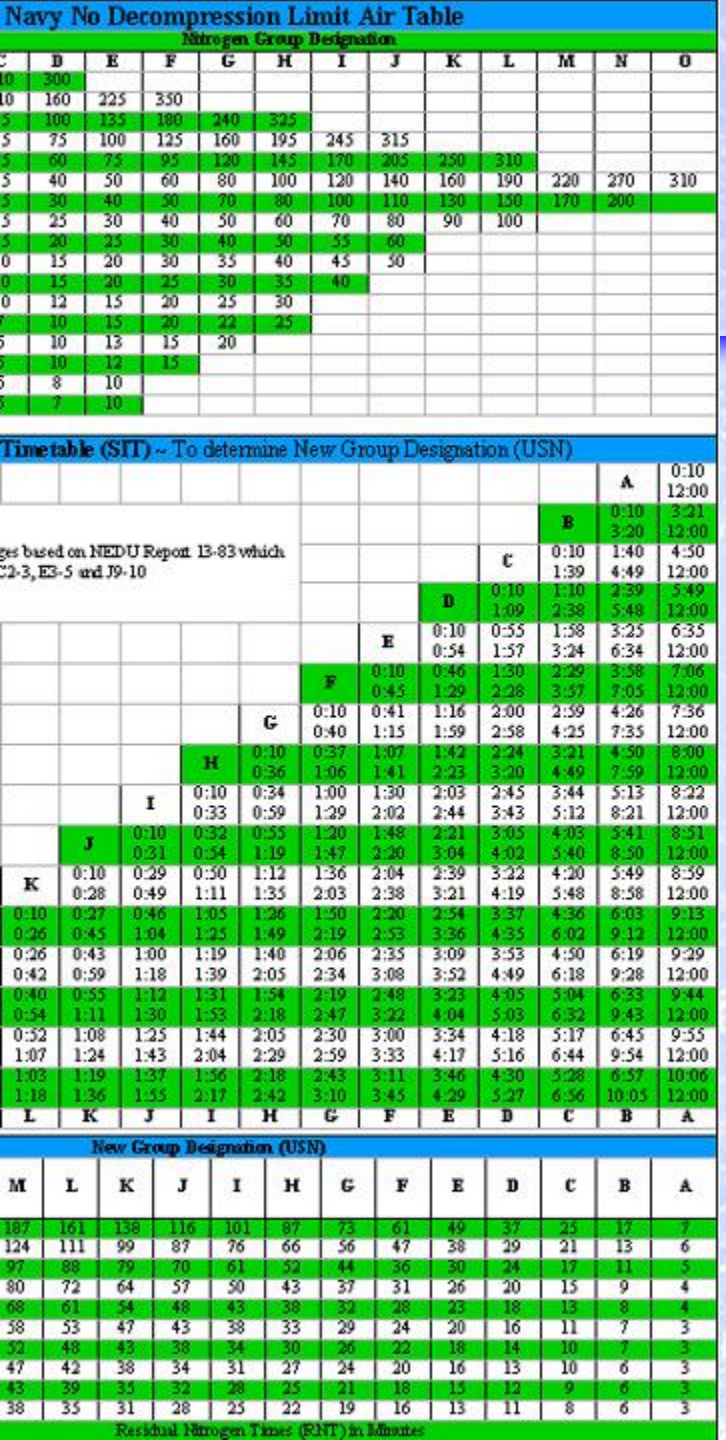
Table Types

U.S.N.
U.S.N. Doppler Modified
DCIEM
Buhlmann
Etc …

DO NOT MIX TABLE TYPES!!!

Some tables are “worked” differently than others

U.S.N. Tables



Navy No Decompression Limit Air Table

Nitrogen Group Designation

C	D	E	F	G	H	I	J	K	L	M	N	O
10	300											
10	160	225	350									
5	100	135	180	240	325							
5	75	100	125	160	195	245	315					
5	60	75	95	120	145	170	205	250	310			
5	40	50	60	80	100	120	140	160	190	220	270	310
5	30	40	50	70	80	100	110	130	150	170	200	
5	25	30	40	50	60	70	80	90	100			
5	20	25	30	40	50	55	60					
0	15	20	30	35	40	45	50					
0	15	20	25	30	35	40						
0	12	15	20	25	30							
7	10	15	20	22	25							
5	10	13	15	20								
5	10	12	15									
5	8	10										
3	7	10										

Timetable (SIT) – To determine New Group Designation (USN)

ges based on NEDU Report 13-83 which
C2-3, E3-5 and J9-10

										A	0:10 12:00
									B	0:10 3:20	3:21 12:00
								C	0:10 1:39	1:40 4:49	4:50 12:00
							D	0:10 1:09	1:10 2:38	2:39 5:48	5:49 12:00
						E	0:10 0:54	0:55 1:57	1:58 3:24	3:25 6:34	6:35 12:00
					F	0:10 0:45	0:46 1:29	1:30 2:28	2:29 3:37	3:38 7:05	7:06 12:00
				G	0:10 0:40	0:41 1:15	1:16 1:59	2:00 2:58	2:59 4:25	4:26 7:35	7:36 12:00
			H	0:10 0:36	0:37 1:06	1:07 1:41	1:42 2:23	2:24 3:20	3:21 4:49	4:50 7:59	8:00 12:00
		I	0:10 0:33	0:34 0:59	1:00 1:29	1:30 2:02	2:03 2:44	2:45 3:43	3:44 5:12	5:13 8:21	8:22 12:00
	J	0:10 0:31	0:32 0:54	0:55 1:19	1:20 1:47	1:48 2:20	2:21 3:04	3:05 4:02	4:03 5:40	5:41 8:50	8:51 12:00
K	0:10 0:28	0:29 0:49	0:30 1:11	1:12 1:35	1:36 2:03	2:04 2:38	2:39 3:21	3:22 4:19	4:20 5:48	5:49 8:58	8:59 12:00
0:10 0:26	0:27 0:45	0:46 1:04	1:05 1:25	1:26 1:49	1:50 2:19	2:20 2:53	2:54 3:36	3:37 4:35	4:36 6:02	6:03 9:12	9:13 12:00
0:26 0:42	0:43 0:59	1:00 1:18	1:19 1:39	1:40 2:05	2:06 2:34	2:35 3:08	3:09 3:52	3:53 4:49	4:50 6:18	6:19 9:28	9:29 12:00
0:40 0:54	0:55 1:11	1:12 1:30	1:31 1:53	1:54 2:18	2:19 2:47	2:48 3:22	3:23 4:04	4:05 5:03	5:04 6:32	6:33 9:43	9:44 12:00
0:52 1:07	1:08 1:24	1:25 1:43	1:44 2:04	2:05 2:29	2:30 2:59	3:00 3:33	3:34 4:17	4:18 5:16	5:17 6:44	6:45 9:54	9:55 12:00
1:03 1:18	1:19 1:36	1:37 1:55	1:56 2:17	2:18 2:42	2:43 3:10	3:11 3:45	3:46 4:29	4:30 5:27	5:28 6:56	6:57 10:05	10:06 12:00
L	K	J	I	H	G	F	E	D	C	B	A

New Group Designation (USN)

M	L	K	J	I	H	G	F	E	D	C	B	A
187	161	138	116	101	87	73	61	49	37	25	17	7
124	111	99	87	76	66	56	47	38	29	21	13	6
97	88	79	70	61	52	44	36	30	24	17	11	5
80	72	64	57	50	43	37	31	26	20	15	9	4
68	61	54	48	43	38	32	28	23	18	13	8	4
58	53	47	43	38	33	29	24	20	16	11	7	3
52	48	43	38	34	30	26	22	18	14	10	7	3
47	42	38	34	31	27	24	20	16	13	10	6	3
43	39	35	32	28	25	21	18	15	12	9	6	3
38	35	31	28	25	22	19	16	13	11	8	6	3

Residual Nitrogen Times (RNT) in Minutes

Multi-Level Capability

Decompression and No-Decompression available

60 feet – *18 meters* per minute ascent rate

The example we will be following:
Follow the tables for a 75 fsw – *22.9 metres* dive for 25 minutes, determine ending dive letter and RNT in preparation for a second dive to 62 fsw – *20.4 metres* for Maximum Possible No-Deco Time;
SIT = 1:15

Note: although metres are presented on the following tables, the original USN tables did not include metric measurements.

U.S.N.
No-Deco

U.S. Navy No Decompression Limit Air Table								
Depth		NDL	Nitrogen Group Designation					
fsw	metres	(mins)	D	E	F	G	H	I
35	10.6	310	40	50	60	80	100	120
40	12.1	200	30	40	50	70	80	100
50	15.2	100	25	30	40	50	60	70
60	18.2	60	20	25	30	40	50	55
70	21.3	50	15	20	30	35	40	45
80	24.3	40	15	20	25	30	35	40
90	27.4	30	12	15	20	25	30	

U.S.N.
Surface Interval

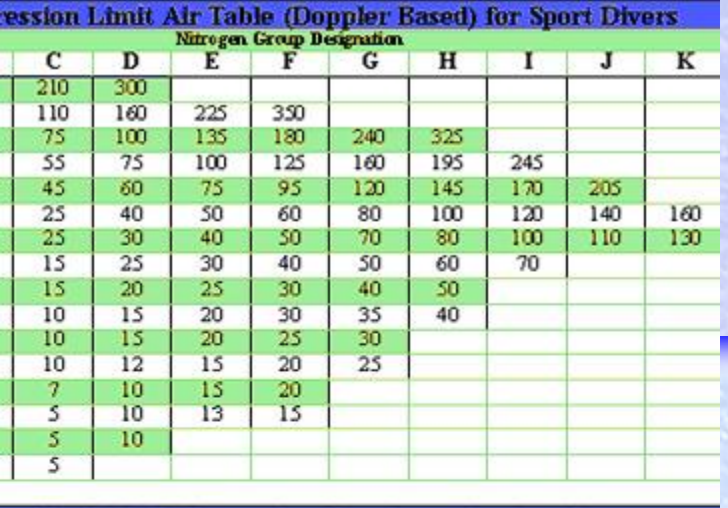
Surface Interval Time (SIT) To Determine New Group Designation (USN)						
				F	0:10 0:45	0:46 1:29
			G	0:10 0:40	0:41 1:15	1:16 1:59
		H	0:10 0:36	0:37 1:06	1:07 1:41	1:42 2:23
	I	0:10 0:33	0:34 0:59	1:00 1:29	1:30 2:02	2:03 2:44
J	0:10 0:31	0:32 0:54	0:55 1:19	1:20 1:47	1:48 2:20	2:21 3:04
0:10 0:28	0:29 0:49	0:50 1:11	1:12 1:35	1:36 2:03	2:04 2:38	2:39 3:21
K	J	I	H	G	F	E

U.S.N.
New Group Designation

New Group Designation (USN)								
Repetitive Dive Depth								
fsw	metres	J	I	H	G	F	E	D
50	15.2			66	56	47	38	29
60	18.3				44	36	30	24
70	21.3				37	31	26	20
80	24.4					28	23	18

Maximum Possible No-Deco Dive Time =
50 NDL Limit (at 70 fsw – *21.3 metres*) – 26 RNT = 24 minutes TBT Max

U.S.N. Doppler



ression Limit Air Table (Doppler Based) for Sport Divers

	Nitrogen Group Designation							
C	D	E	F	G	H	I	J	K
210	300							
110	160	225	350					
75	100	135	180	240	325			
55	75	100	125	160	195	245		
45	60	75	95	120	145	170	205	
25	40	50	60	80	100	120	140	160
25	30	40	50	70	80	100	110	130
15	25	30	40	50	60	70		
15	20	25	30	40	50			
10	15	20	30	35	40			
10	15	20	25	30				
10	12	15	20	25				
7	10	15	20					
5	10	13	15					
5	10							
5								

etable (SIT) To Determine New Group Designation

						A	0:10 12:00
hanges modifies 0					B	0:10 3:20	3:21 12:00
				C	0:10 1:39	1:40 4:49	4:50 12:00
			D	0:10 1:09	1:10 2:38	2:39 5:48	5:49 12:00
		E	0:10 0:54	0:55 1:57	1:58 3:24	3:25 6:34	6:35 12:00
	F	0:10 0:45	0:46 1:29	1:30 2:28	2:29 3:57	3:58 7:05	7:06 12:00
G	0:10 0:40	0:41 1:15	1:16 1:59	2:00 2:58	2:59 4:25	4:26 7:35	7:36 12:00
0:10 0:36	0:37 1:06	1:07 1:41	1:42 2:23	2:24 3:20	3:21 4:49	4:50 7:59	8:00 12:00
0:34 0:59	1:00 1:29	1:30 2:02	2:03 2:44	2:45 3:43	3:44 5:12	5:13 8:21	8:22 12:00
0:55 1:19	1:20 1:47	1:48 2:20	2:21 3:04	3:05 4:02	4:03 5:40	5:41 8:40	8:41 12:00
1:12 1:35	1:36 2:03	2:04 2:38	2:39 3:21	3:22 4:19	4:20 5:48	5:49 8:58	8:59 12:00
H	G	F	E	D	C	B	A

up Designation (Doppler Modified USN)

I	H	G	F	E	D	C	B	A
399	279	208	159	120	88	62	39	18
159	132	109	88	70	54	39	25	12
101	87	73	61	49	37	25	17	7
	66	56	47	38	29	21	13	6
		44	36	30	24	17	11	5
		37	31	26	20	15	9	4
			28	23	18	13	8	4
			24	20	16	11	7	3
				18	14	10	7	3
					13	10	6	3
						9	6	3
								3

Residual Nitrogen Times in Minutes

Multi-Level Capability

Decompression and No-Decompression available

30 feet – *9 metres* per minute ascent rate

Using the same Example:
Follow the tables for a 75 fsw – *22.9 metres* dive for 25 minutes, determine ending dive letter and RNT in preparation for a second dive to 62 fsw – *20.4 metres* for Maximum Possible No-Deco Time;
SIT = 1:15

U.S.N. Doppler No-Deco

Modified U.S. Navy No Decompression Limit Air Table (Doppler)								
Depth		NDL	Nitrogen Group Designation					
fsw	metres	(mins)	D	E	F	G	H	I
35	10.6	160	40	50	60	80	100	120
40	12.1	130	30	40	50	70	80	100
50	15.2	70	25	30	40	50	60	70
60	18.2	50	20	25	30	40	50	
70	21.3	40	15	20	30	35	40	
80	24.3	30	15	20	25	30		
90	27.4	25	12	15	20	25		

U.S.N. (Doppler)
Surface Interval

Surface Interval Time (SIT) To Determine New Group Designation (USN)						
				F	0:10 0:45	0:46 1:29
			G	0:10 0:40	0:41 1:15	1:16 1:59
		H	0:10 0:36	0:37 1:06	1:07 1:41	1:42 2:23
	I	0:10 0:33	0:34 0:59	1:00 1:29	1:30 2:02	2:03 2:44
J	0:10 0:31	0:32 0:54	0:55 1:19	1:20 1:47	1:48 2:20	2:21 3:04
0:10 0:28	0:29 0:49	0:50 1:11	1:12 1:35	1:36 2:03	2:04 2:38	2:39 3:21
K	J	I	H	G	F	E

USN
New Group Designation

New Group Designation (USN)								
Repetitive Dive Depth								
fsw	metres	J	I	H	G	F	E	D
50	15.2			66	56	47	33	29
60	18.3				44	36	30	24
70	21.3				37	31	26	20
80	24.4					28	23	18

Maximum Possible No-Deco Dive Time =
40 NDL Limit (at 70 fsw – *21.3 metres*) – 26 RNT = 14 minutes TBT Max

U.S.N. Decompression

r Decompression Table (2000)					
compression Stops FSW & MSW				Total Ascent Time	Repetitive Group Letter
0	30	20	10		
2.1	9.1	6.0	3.0		
			0	1:40	L
			3	4:40	L
			5	6:40	M
			10	11:40	M
			21	22:40	N
			29	30:40	O
			0	2:00	J
			2	4:00	K
			7	9:00	L
			14	16:00	M
			26	28:00	N
			39	41:00	O
			48	50:00	Z
			56	58:00	Z
			0	2:20	J
			8	10:20	K
			14	16:20	L
			18	20:20	M
			23	25:20	N
			33	35:20	N
		2	41	45:20	O
			0	2:40	I
			10	12:40	K
			17	19:40	L
			23	25:40	M
		2	31	35:40	N
		7	39	48:40	N
		11	46	59:40	O
		13	53	68:40	O
		17	56	75:40	Z
			0	3:00	H
			7	10:00	J
			18	21:00	L
			25	28:00	M
		7	30	40:00	N
		13	40	56:00	N
		18	48	69:00	O

30 feet – *9 metres* per minute ascent rate

Example:

Determine the Deco Schedule for a dive to 139 fsw – *42.4 metres* for 30 minutes.

U.S.N. Decompression

U.S. Navy Standard Air Decompression Table (2000)									
Depth	Bottom Time	Time to first stop	Decompression Stops fsw & metres					Total Ascent Time	Repet. Group Letter
fsw			50	40	30	20	10		
metres			15.2	12.1	9.1	6.0	3.0		
140 fsw 42.6 metres	25	4:00				2	14	20:40	J
	30	4:00				5	21	30:40	K
	40	3:40			2	16	26	48:40	N

Decompression Limit Air Table

Nitrogen Group Designation

D	E	F	G	H	I	J	K	L	M
120	150	180	240	300	360	420	480	600	720
90	100	120	150	180	190	210	240	270	300
60	70	80	90	120	130	150			
40	50	60	75						
30	40	50							
25	35								
20	25								
20									
15									

ive Factors / Surface Intervals Table

Factors (RF) for Surface Interval (SIT) in HH:mm

1:30 1:59	2:00 2:59	3:00 3:59	4:00 5:59	6:00 8:59	9:00 11:59	12:00 14:59	15:00 18:00
1.1	1.1	1.1	1.1	1.1	1.0	1.0	1.0
1.2	1.2	1.1	1.1	1.1	1.1	1.0	1.0
1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0
1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0
1.4	1.3	1.3	1.2	1.2	1.1	1.1	1.0
1.5	1.4	1.3	1.3	1.2	1.1	1.1	1.0
1.6	1.5	1.4	1.3	1.2	1.1	1.1	1.0
1.7	1.6	1.5	1.4	1.3	1.1	1.1	1.1
1.8	1.7	1.5	1.4	1.3	1.1	1.1	1.1
1.9	1.8	1.6	1.5	1.3	1.2	1.1	1.1
2.0	1.9	1.7	1.5	1.3	1.2	1.1	1.1
	2.0	1.7	1.6	1.4	1.2	1.1	1.1
		1.8	1.6	1.4	1.2	1.1	1.1

on Repetitive Diving Table (DCIEM)

llowable No Decompression Limits for RF

1.4	1.5	1.6	1.7	1.8	1.9	2.0
214	200	187	176	166	157	150
107	100	93	88	83	78	75
45	41	38	36	34	32	31
29	27	26	24	23	22	21
19	18	17	16	15	14	13
15	14	13	12	12	11	11
11	11	10	9	9	8	8
9	9	8	8	7	7	7
8	7	7	6	6	6	6
6	6	6	5	5	5	5
5	5	5	4	4	4	4

D.C.I.E.M. Tables

Multi-Level Capability

Decompression and No-Decompression available

60 fsw (± 10 fsw) – *18 metres (± 3 metres)* per minute ascent rate.

Using the same Example:
Follow the tables for a 75 fsw – *22.9 metres* dive for 25 minutes, determine ending dive letter and RNT in preparation for a second dive to 62 fsw – *20.4 metres* for Maximum Possible No-Deco Time;
SIT = 1:15

D.C.I.E.M.
No-Deco

DCIEM No Decompression Limit Air Table							
Depth		NDL	Nitrogen Group Designation				
fsw	metres	(mins)	A	B	C	D	E
20	6	---	30	60	90	120	150
30	9.1	300	30	45	60	90	100
40	12.1	150	22	30	40	60	70
50	15.2	75	18	25	30	40	50
60	18.2	50	14	20	25	30	40
70	21.3	35	12	15	20	25	35
80	24.3	25	10	13	15	20	25

D.C.I.E.M.
Repetitive Factors

DCIEM Repetitive Factors / Surface Intervals Table						
Repetitive Group (RG)	Repetitive Factors (RF) for Surface Interval (SIT) in HH:mm					
	0:15 0:29	0:30 0:59	1:00 1:29	1:30 1:59	2:00 2:59	3:00 3:59
A	1.4	1.2	1.1	1.1	1.1	1.1
B	1.5	1.3	1.2	1.2	1.2	1.1
C	1.6	1.4	1.3	1.2	1.2	1.2
D	1.8	1.5	1.4	1.3	1.3	1.2
E	1.9	1.6	1.5	1.4	1.3	1.3
F	2.0	1.7	1.7	1.5	1.4	1.3
G		1.9	1.9	1.6	1.5	1.4

D.C.I.E.M.
No-Deco Limits

No Decompression Repetitive Diving Table (DCIEM)								
Depth		Allowable No Decompression Limits for RF						
fsw	metres	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**
50	15.2	60	55	50	45	41	38	36
60	18.2	40	35	31	29	27	26	24
70	21.3	30	25	21	19	18	17	16
80	24.3	20	18	16	15	14	13	12

Maximum Possible No-Deco Dive Time = 18 minutes TBT Max

D.C.I.E.M. Decompression

EM AIR DECOMPRESSION TABLES								
EXCEPTIONAL EXPOSURE								
TABLE 1: STANDARD AIR DECOMPRESSION								
top Times (mins) at Different Depths							Decom. Time (min)	Repet. Group
	60	50	40	30	20	10		
	18.3	15.3	12.2	9.2	6.1	3.1		
							2	A
							2	B
							2	D
						8	8	E
					3	10	13	F
					6	10	16	G
					8	11	19	H
					9	18	27	I
				3	8	25	36	J
				4	9	30	43	K
				5	9	37	51	L
				6	9	43	58	
				7	10	48	65	
				8	10	55	73	
				8	15	59	82	
				9	18	65	92	
			2	8	22	71	103	
			2	8	25	79	114	
			3	8	29	87	127	
			3	9	32	95	139	
			4	8	36	104	152	
			4	9	39	112	164	
							2	A
							2	B
							2	C
						5	5	D
					3	9	12	F
					6	10	16	G
					9	11	20	H
				4	7	19	30	I
				5	8	26	39	J
				6	9	33	48	K
				8	9	39	56	M
				9	9	46	64	N
			3	7	11	53	74	
			3	8	16	58	85	
			4	8	20	64	96	
			5	8	23	73	109	
			5	8	28	81	122	
			6	8	32	91	137	
			6	9	35	101	151	
			7	9	40	111	167	
			7	10	44	120	181	
			8	13	46	129	196	
			8	16	50	136	210	

60 fsw (± 10 fsw) – *18 metres (± 3 metres* per minute ascent rate

Example:

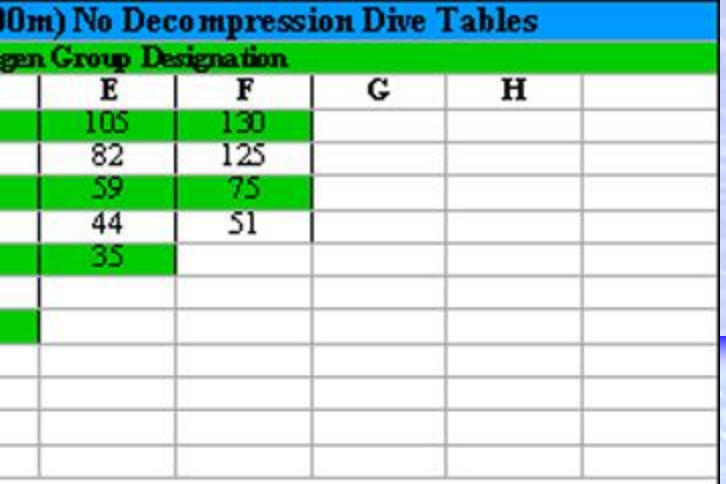
Determine the Deco Schedule for a dive to 139 fsw – *42.4 metres* for 30 minutes.

D.C.I.E.M. Decompression

DCIEM Air Decompression Tables								
Depth	Bottom Time (min)	Stop Times (min) at Different Depths (fsw)					Decom Time (min)	Repet. Group
fsw		50	40	30	20	10		
metres*		15.3	12.2	9.2	6.1	3.0		
140 fsw	20			4	7	11	22	G
	25			7	8	19	34	I
42.7* metres	30		4	6	9	29	48	K

* Metric is ONLY listed here for reference. There are separate metric tables.

Buhlmann Tables



0m) No Decompression Dive Tables

gen Group Designation

	E	F	G	H	
	105	130			
	82	125			
	59	75			
	44	51			
	35				

ive Letter Group Table

rval Time (Hmm)

				"0" Hours	Fly Hours
			A	2	2
		B	0:20	2	2
	C	0:10	0:25	3	3
	0:10	0:15	0:30	3	3
	0:15	0:25	0:45	4	3
	0:45	1:15	1:20	8	4
	1:15	1:40	2:10	12	5
	3:00	4:00	5:40	24	7
	C	B	A		

itrogen Time Table (RNT)

	D	C	B	A
	81	55	37	25
	57	37	25	19
	41	29	20	16
	33	25	17	14
	28	22	15	12
	24	20	13	11
		18	12	10
			11	9
			10	8
			9	7
			8	7

Multi-Level Capability

Decompression and No-Decompression available

33 feet – *10 metres* per minute ascent rate

Using the same Example:
Follow the tables for a 75 fsw – *22.9 metres* dive for 25 minutes, determine ending dive letter and RNT in preparation for a second dive to 62 fsw – *20.4 metres* for Maximum Possible No-Deco Time;
SIT = 1:15

Note: although feet is presented on the following tables, the original Buhlmann tables does not show imperial measurement.

Buhlmann No-Deco

Buhlmann 1989 Sea Level (0-700m) No Decompression Dive Tables						
Depth		Nitrogen Group Designation				
Feet	Meters	A	B	C	D	E
29.5	9	25	37	55	81	105
39.4	12	19	25	37	57	82
49.2	15	16	20	29	41	59
59.0	18	15	17	25	33	44
68.9	21	12	15	22	28	35
78.7	24	11	13	20	25	
88.6	27	10	12	18	20	

Buhlmann
Repetitive Letter Group

Buhlmann Repetitive Letter Group Table						
Surface Interval Time (H:mm)						
					“0” Hours	Fly Hours
			B	0:20	2:00	2:00
		C	0:10	0:25	3:00	3:00
	D	0:10	0:15	0:30	3:00	3:00
E	0:10	0:15	0:25	0:45	4:00	3:00
E	D	C	B	A		

Buhlmann
Residual Nitrogen Times

Buhlmann Residual Nitrogen Time Table (RNT)								
Depth								
Feet	Meters	G	F	E	D	C	B	A
39.4	12	137	111	82	57	37	25	19
49.2	15			59	41	29	20	16
59.0	18			44	33	25	17	14
68.9	21				28	22	15	12

Maximum Possible No-Deco Dive Time =
35 NDL Limit (at 68.9 fsw – *21 metres*) – 12 RNT = 23 minutes TBT Max

Buhlmann Decompression

ession Tables - Sea Level (0 – 700m)				
mpression Stop Depth			Rep Group	TOT min
9m	6m	3m		
		1	A	11.9
		1	D	14.9
		4	E	22.9
	3	7	F	33.9
2	4	12	G	46.9
3	7	18	G	61.9
5	9	28	G	80.9
		1	A	11.2
		1	B	12.2
		1	D	14.2
		4	D	20.2
	1	5	E	25.2
	4	6	F	32.2
2	4	10	F	41.2
3	6	16	G	53.2
4	7	19	G	61.2
4	9	25	G	74.2
		1	A	11.5
		2	E	15.5
		5	E	21.5
	3	5	E	27.5
2	4	9	F	37.5
3	5	13	G	46.5
4	6	18	G	56.5
4	9	22	G	68.5
6	10	27	G	80.5
		1	B	11.8
		1	C	13.8
		3	E	16.8
	2	5	E	23.8
	4	6	F	29.8
3	4	10	F	39.8
4	6	16	G	51.8
4	7	22	G	63.8
		1	B	11.1
		1	C	13.1
		4	E	18.1
	3	6	E	25.1
2	4	8	F	34.1
4	5	13	F	45.1
4	7	18	G	58.1

33 feet – *10 metres* per minute ascent rate

Example:

Determine the Deco Schedule for a dive to 139 fsw – *42.4 metres* for 30 minutes.

Buhlmann Decompression

Buhlmann Air Decompression Tables - Sea Level (0 – 700m)							
Depth	Time min	Decompression Stop Depth				Rep Group	TOT min
Meters		12	9	6	3		
Feet		39.4	29.5	19.7	9.8		
45 metres / 147.6 fsw	21		3	5	13	G	46.5
	24		4	6	18	G	56.5
	27	2	4	9	22	G	68.5
	30	3	6	10	27	G	80.5

Diver Considerations

Buoyancy Control

Anchor Line
Lift Bags
Ledges, etc …

Exercises during decompression …

Hydration

Fitness

Omitted Decompression

From 6 metres or shallower, and feels they can return to water in less than 1 minute:

Repeat all missed stops adding 1 minute to each stop time.

From 6 metres or shallower, free of symptoms and can't return to water in 1 minute:

Return to first missed stop and multiply deco times by 1.5.

Omitted Decompression

From deeper than 6 metres, free of symptoms and a stand-by diver is available:

1. Return the diver to the depth of the 1st stop.
2. Follow deco schedule for any stops 12 metres or greater.
3. Use 1 minute between stops not 20 seconds.
4. Multiply the 9 metres stops and shallower by 1.5.

Decompression Planning Review

1. What is the common term for decompression sickness?

   Bends

2. What is the gas responsible for decompression sickness?

   Nitrogen (in the case of Air and Nitrox diving)

3. What is the benefit of a dive computer over dive tables?

   Ensures proper time and depth monitoring

4. What is the maximum no-decompression time for a dive to 60 fsw – *18.3 metres* using the standard US Navy tables?

   60 minutes for the first dive (see tables)

Decompression Planning Review

5. What nitrogen group would a diver be after a dive to 72 fsw – *22 metres* for 33 minutes?

   Using the USN tables, the dive would be at 80 fsw – *24.4 metres* for 35 minutes = “H” group

6. Can a diver use Buhlmann tables for the first dive then US Navy tables for the second dive?

   NO, the nitrogen status would not be known correctly

7. After a surface interval of 3:44, what would be the residual nitrogen category of a “G” diver (USN Tables)?

   “C” group (USN tables)

8. Besides standard printed tables, what other sources of tables are available to the diver?

   Commercially available software for computers such as Abyss, Pro-Planner or Voyager, among others

Decompression Planning Review

9. What would be the stops required for a dive to 124 fsw - *37.8 metres* that had 28 minutes of bottom time (USN Standard Tables)?

   Use the 130 fsw - *39.6 metres* schedule at 30 minutes:
   3 minutes at 20 fsw - *6.1 metres*
   18 minutes at 10 fsw - *3 metres*

10. What is the recommended ascent rate for the US Navy and most other sport diving tables?

    30 feet per minute - *9 mpm*

11. What is the leading preventative measure for decompression sickness?

    Besides proper planning, hydration (drinking water) is the leading preventative technique.

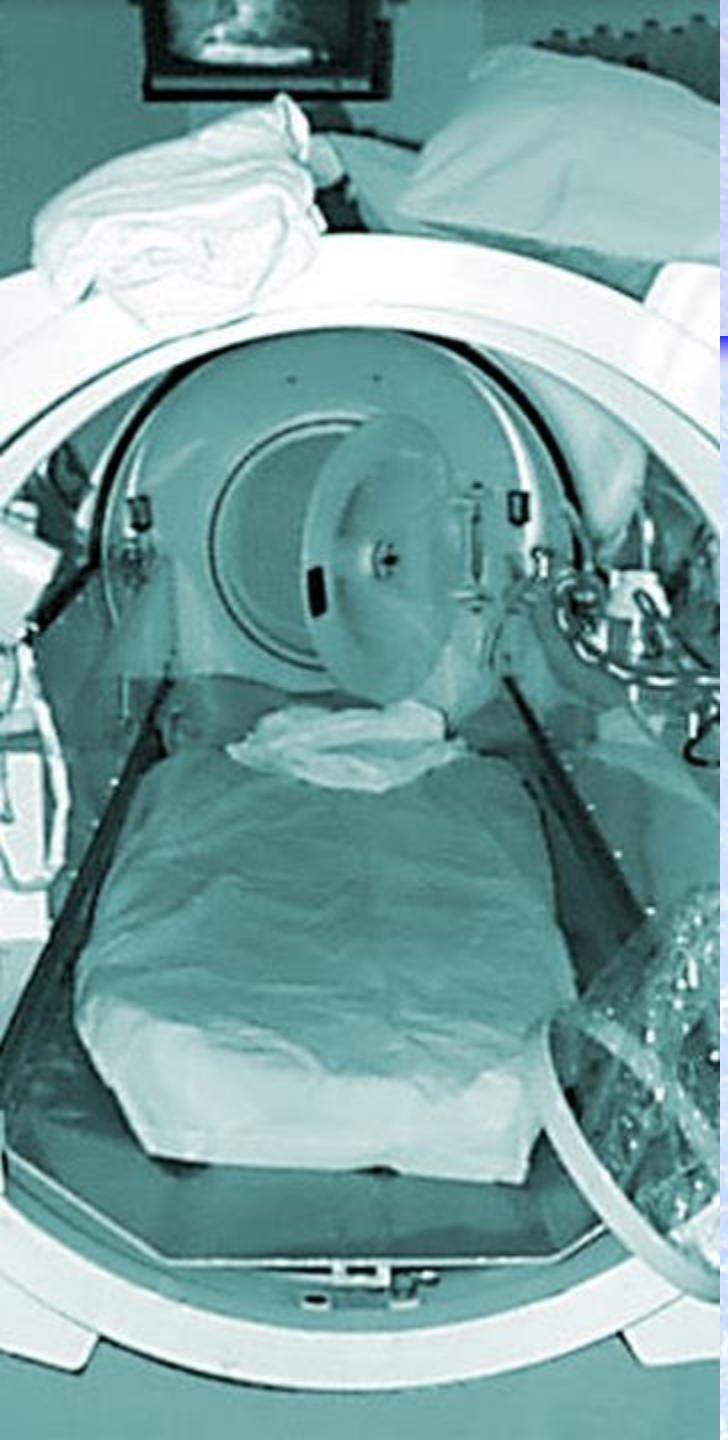
Decompression Planning Review

12. If a diver omits a mandatory stop at 3 metres for 2 minutes, what is the best course of action assuming it has only been 2 minutes?

    Assuming the diver is asymptomatic and the conditions permit, re-enter the water and remain at 3 metres for 1 ½ times the 2-minute stop, or 3 minutes. Most divers may actually stay a bit longer. Consider the use of oxygen at the surface also.

13. What are the disadvantages of in-water recompression?

    There are many disadvantages, including large gas supplies required, cold, rough seas (conditions), inadequate ability to control depth, the chance of worsening of symptoms, etc …



Decompression Sickness

Results from bubbles forming in blood & tissues.

Even stringent following of the tables is not a 100% Guarantee against DCS!

Factors contributing to DCS:

Rapid Ascent
Improper Monitoring of Time
Improper Monitoring of Depth
Cold ~ Workload
Dehydration ~ Diving (In General)

Occurrence of Symptoms

Results from bubbles forming in blood & tissues.

Onset of symptoms:

- 42% occurred within one hour.
- 60% occurred within three hours.
- 83% occurred within eight hours.
- 98% occurred within twenty four hours.

Type I DCS:

“Pain only bends”
Itching, redness, etc…

May be indistinguishable from Type II DCS.

Type II DCS

Central Nervous System DCS

Neurological symptoms:

Numbness ~ Paralysis
Vertigo ~ Tingling
Mental State Change ~ Dizziness
Weakness ~ Pins and Needles feeling
Ringing in the ears

Cardio Respiratory:

“Chokes” ~ Breathing Problems
Painful Inhalations ~ Fast Breathing Rate
Bloody-Frothy Sputum

5-Minute Neurological Exam

Diver Denial?

Orientation

Disoriented, Confused, etc …

Eyes

Focus, Pupil Dilation, etc …

Forehead

Numbness, Evenness of features, etc …

Face

Whistle, Smile Evenness of features, etc …

5-Minute Neurological Exam

Ears
- Hearing Tests

Gag Reflex
- Watch Swallowing (Adam's Apple)

Tongue
- Stick out, note drooping, offside, etc …

Shoulders
- Diver "Shrug", evenness of pressure?

Arms
- Checking for strength differences.

5-Minute Neurological Exam

Chest

Check for sensation, pain, etc …

Legs

Raise & Lower, note differences

Heel-to-toe

Balance Checking

Repeat exam as necessary and note any changes!

Decompression Sickness Review

1. List 5 factors that contribute to decompression sickness.
   - Ascent rate too rapid
   - Improper monitoring of depth
   - Workload
   - Improper timing of stops
   - Cold
   - Dehydration
   - Diving in general

2. What are the two categories of decompression sickness?
   - Type I Pain Only
   - Type II Neurological

Decompression Sickness Review

3. If a diver follows proper decompression, is it still possible to get decompression sickness?

   Of course it is

4. What are the primary symptoms of Type I DCS?

   Pain in the joints or muscles, itching, etc…

5. The majority of cases of DCS will show up within what time period?

   - 60% within 3 hours
   - 98% within 24 hours

6. What are the “chokes”?

   The Type II cardio respiratory DCS where breathing is restricted and painful due to excessive swelling and bubbles.

Decompression Sickness Review

7. What is the purpose of recompression therapy?

   To reduce the size and damage caused by excessive bubbles, to relieve pain.

8. What is “denial”?

   Denial is when a diver refuses to accept that the symptoms they are experiencing are related to a DCS event. Sometimes divers consider confessing symptoms to be a blow to the ego.

9. How often should the “5 Minute Neurological Exam” be performed?

   The test should be repeated every hour when there is a delay in transportation to the recompression facility for divers that are presenting DCS symptoms.

Equipment And Use

Regional Differences & Necessities

Quality of equipment.

Equipment can never take precedence over training.

Cylinders

Low Pressure vs. High Pressure

High Volume Singles?

Steel vs. Aluminum

Markings

Valves (Yoke, Din, Slingshot, “H”, etc …)

Doubles

Deco and Stage

Ponies

Regulators

Class ‘A’

Accessories

Pressure Gauges

Primary Regulators (2)

Backup

Hose Lengths

Deco Bottle Regulators

Air Integrated Pressure Gauges

Buoyancy Compensators

Standard BCDs

Wings & Back Plates

Dry Suits

Redundancy

Lift Bags & Reels

Jersey Up Line

Spools

Low Pressure Inflator Hazards

Jonline

Lift Bags

Redundant Depth & Time

Dive Computer

Computer Selection

Integrated Bottom Timer and Depth Gauge

Independent watch and Depth Gauge

Environmental Protection

Dry Suit

Wet Suit

Tools

Z-Knife

Knife With Lanyard

EMT Scissors / Shears

Lights

Clips

Equipment & Use Review

1. What are two types of steel cylinders?
   - Low Pressure
   - High pressure

2. A decompression diver should use how many primary regulators?

   There should be two primary regulators.

3. What is a “slingshot” valve? An “H” valve?

   A single cylinder valve with dual outlets, the slingshot is in a Y configuration, the H valve tends to be a modular dual outlet.

4. What is one disadvantage of a “high volume single”?

   If a burst disc ruptures, there is no chance of redundancy for loss of air.

Equipment & Use Review

5. What are the two types of valve connection?

   Yoke and DIN

6. Can a 200 bar DIN regulator be used with a 300 bar cylinder valve?

   No, the stem is too short, by design

7. The decompression regulator should have what items attached?

   A pressure gauge

8. What are two types of buoyancy compensators?

   Standard integrated and back plate with wings

Equipment & Use Review

9. What are two types of back-up buoyancy devices?

   Dry suit and an emergency a lift bag

10. What colour(s) should a lift bag be to ensure visibility?

    Signal Yellow or Signal Orange, reflective tape enhances the visibility

11. Name two types of dive monitoring devices:

- Dive computer
- Integrated Bottom Timer and Depth Gauge
- Independent watch and Depth Gauge

Congratulations!!!

Let's Go Diving!!!