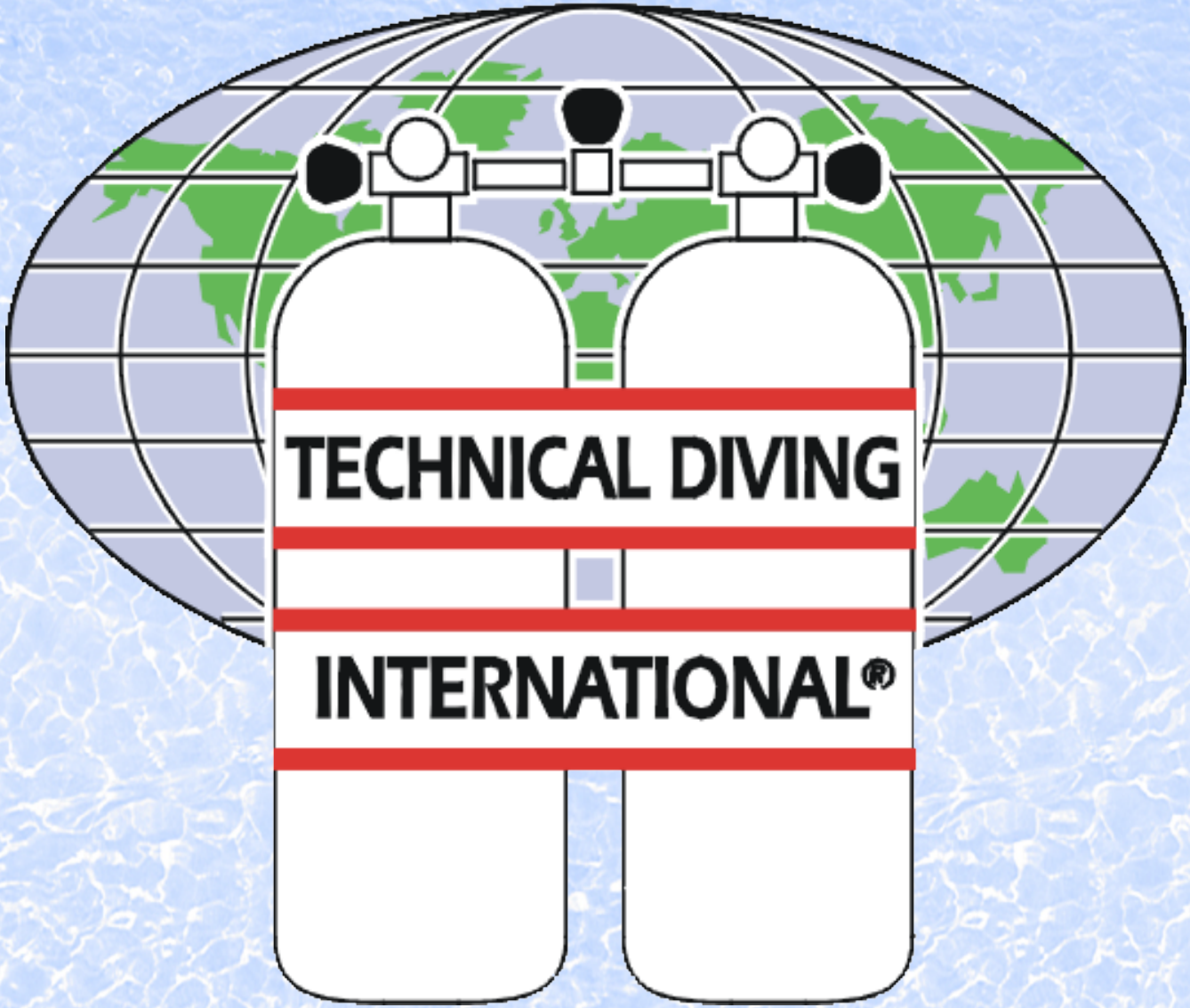
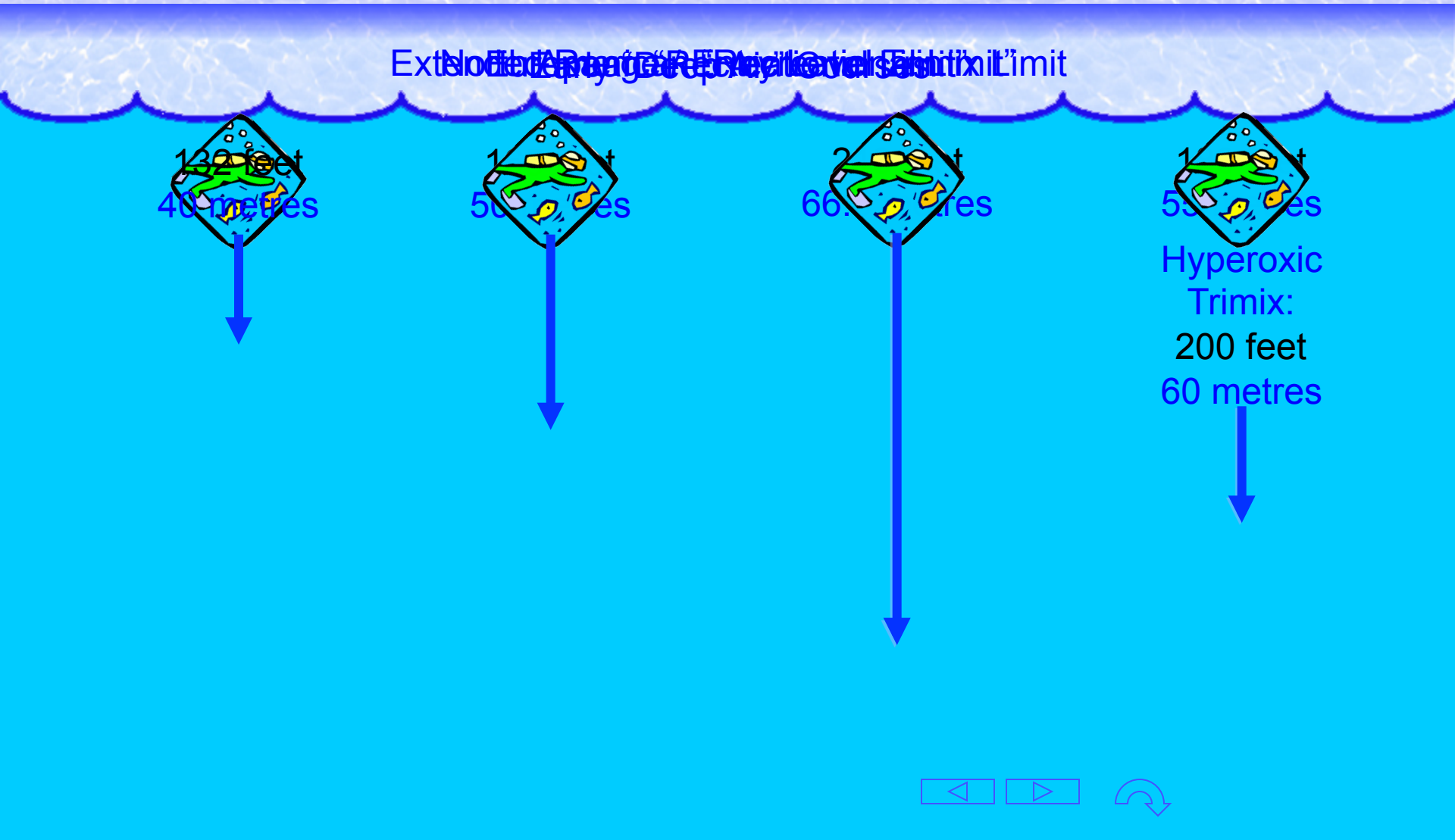

TECHNICAL DIVING
INTERNATIONAL®

# Evolution of Extended Range Diving



# Realities of Extended Range Diving

Hazards
+ Planning
+ Equipment
= One Challenging Endeavor!

If at anytime you feel uncomfortable or that you have reached a limit, inform your instructor!

"The superior DIVER is the one that uses his/her superior judgement to avoid those situations that require his/her superior skill!"

# Formula Review

Boyle's Law

Pressure <-> Volume

Charles' Law

Volume <-> Temperature

Guy-Lussac

Pressure <-> Temperature

…

General Gas Law

# Formula Review

## Dalton's Law

$$P_{(total)} = P_{(gas1)} + P_{(gas2)} \ldots + P_{(gas(n))}$$

$$P_{(gas)} = f_{(gas)} \times P_{(total)}$$

## EAD Formula

$$= \left\{ \left[ \frac{1\text{-}fO_2}{.79} \right] (D+33) \right\} \text{-33feet} \qquad = \left\{ \left[ \frac{1\text{-}fO_2}{.79} \right] (D+10) \right\} \text{-10metres}$$

# Diving Physiology

The body is complex, it is not just a “single unit”, there are at many times complex, difficult to understand biochemical processes taking place.

## Preventative Conditions:

Rest – Proper Hydration – Proper Diet

## DCI Classifications

**Type I** : Pain Only – Skin Bends

**Type II** : CNS Involvement – Neurological Deficit

**Type III** : Vestibular DCS

**Type IV** : Dysbaric Osteonecrosis

# Other Problems & Extended Range Diving

Facial Paralysis

Dental Problems

Heart Attack

Stress & Panic

Exhaustion

# Chapter 2 – Nitrogen Narcosis and Oxygen Toxicity

Humans are sensitive to environmental changes.

At depth no gas is “inert”!

“Inert” Gas Narcosis : Nitrogen Narcosis

“Forgetting” A Part of The Dive = Narcosis

Loss of Select Motor Skills

# Oxygen

**Pulmonary Oxygen Toxicity**

"Lorraine-Smith Effect"

OUT/UPTD Calculations Not Required.

**CNS Oxygen Toxicity**

BAD!!!

ConVENTID ???

**PLAN YOUR DIVE, DIVE YOUR PLAN**

# NOAA Tables

| NOAA Oxygen Pressure Time Limits (Minutes) | | | |
|---|---|---|---|
| $PO_2$ (ATA) | 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 |

# Oxygen Exposure

Track Oxygen Exposure Carefully!
Remembering to include:

Bottom Mix

All Travel Gasses

All Decompression Gasses

Exceeding 1.6 ATA $PO_2$…

Be aware of the “Off Oxygen Effect”

Stay Within the NOAA Guidelines!

# Carbon Dioxide

Waste Product of Respiration

Factors Contributing to Excessive $CO_2$:

Work Load

Regulator Performance

Excessive Depths

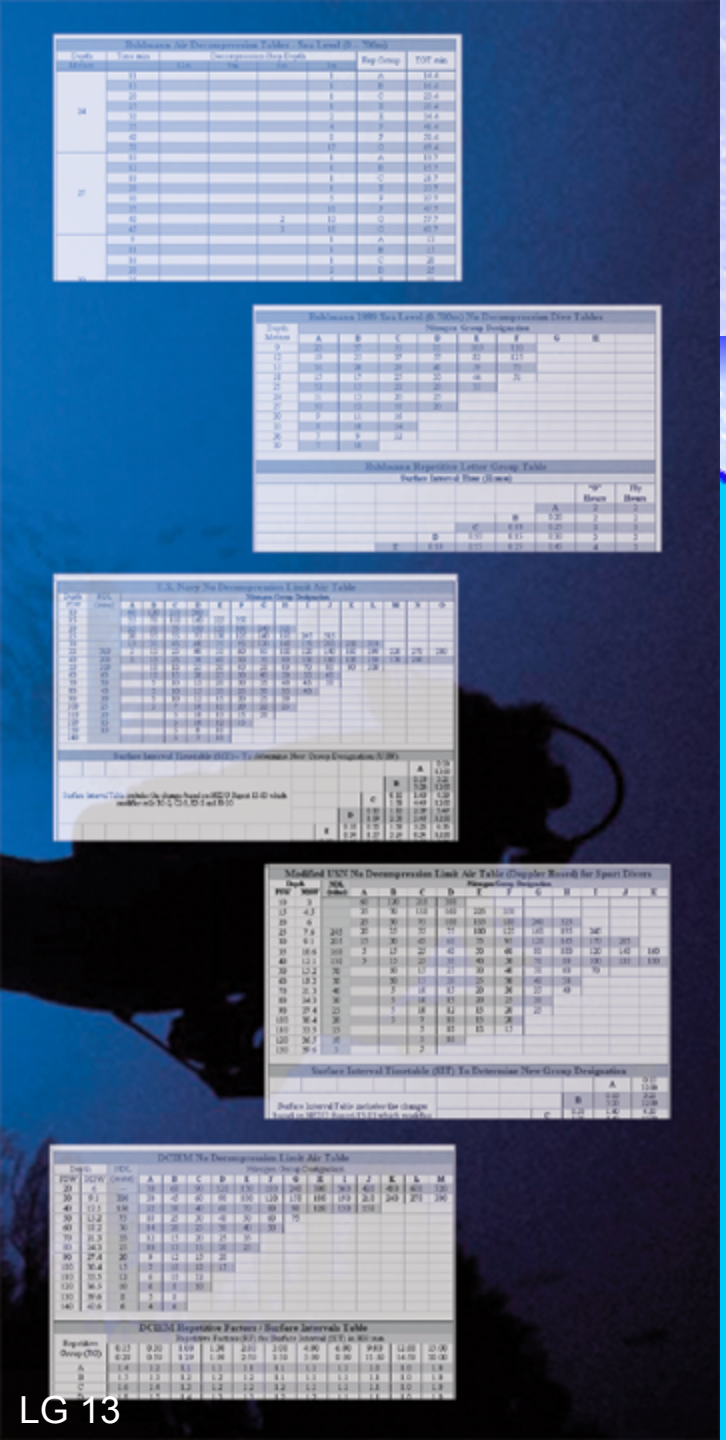
Antagonist to: Narcosis & CNS Toxicity

Results in…

Headache

Breathlessness & Laboured Breathing

Anxiety & Panic



# Chapter 3 – Dive Planning and Dive Tables

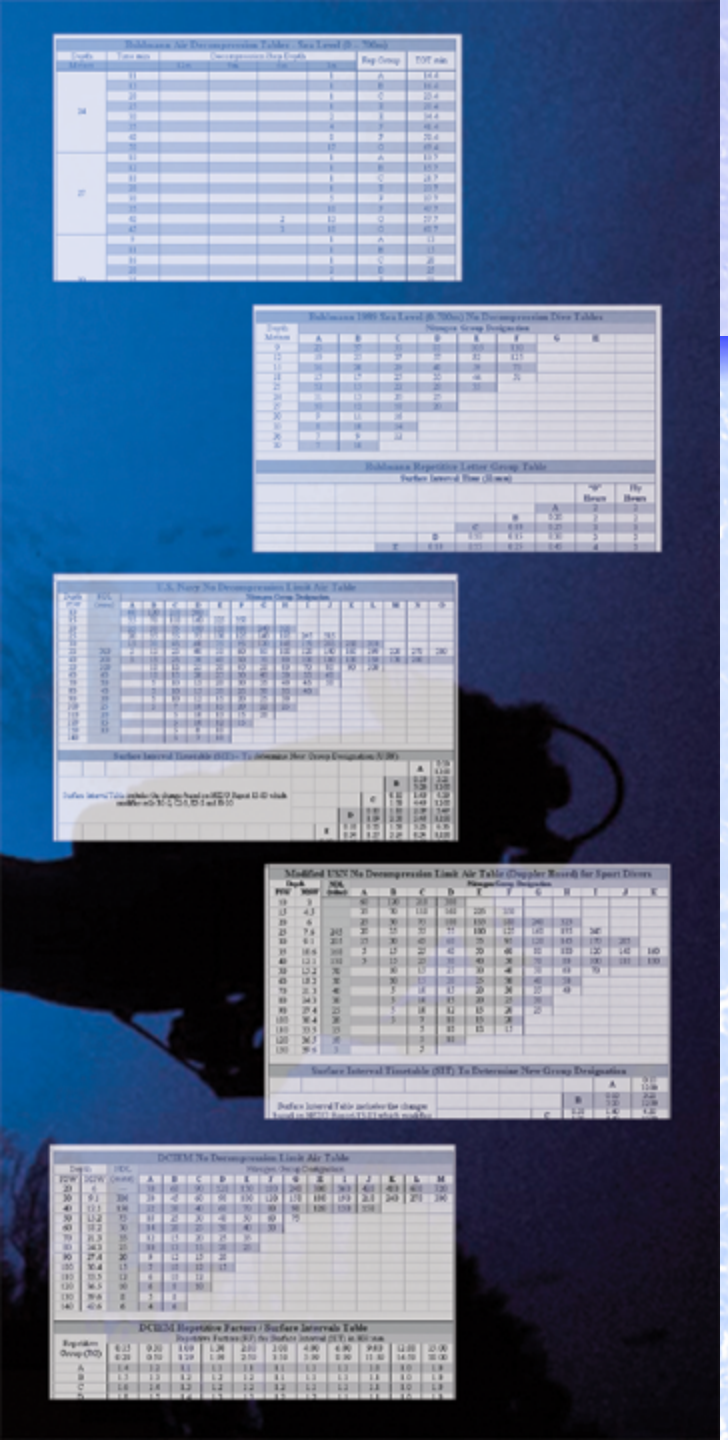
Most people fear the use of tables.

Dive tables are actually easy to use, given the proper training.

Which table? … “Pick a table, any table”

NO tables “guarantee” freedom from DCI!

Start with the table, then plan the dive.



# Tables

Be Aware, each table has its own “Rules”

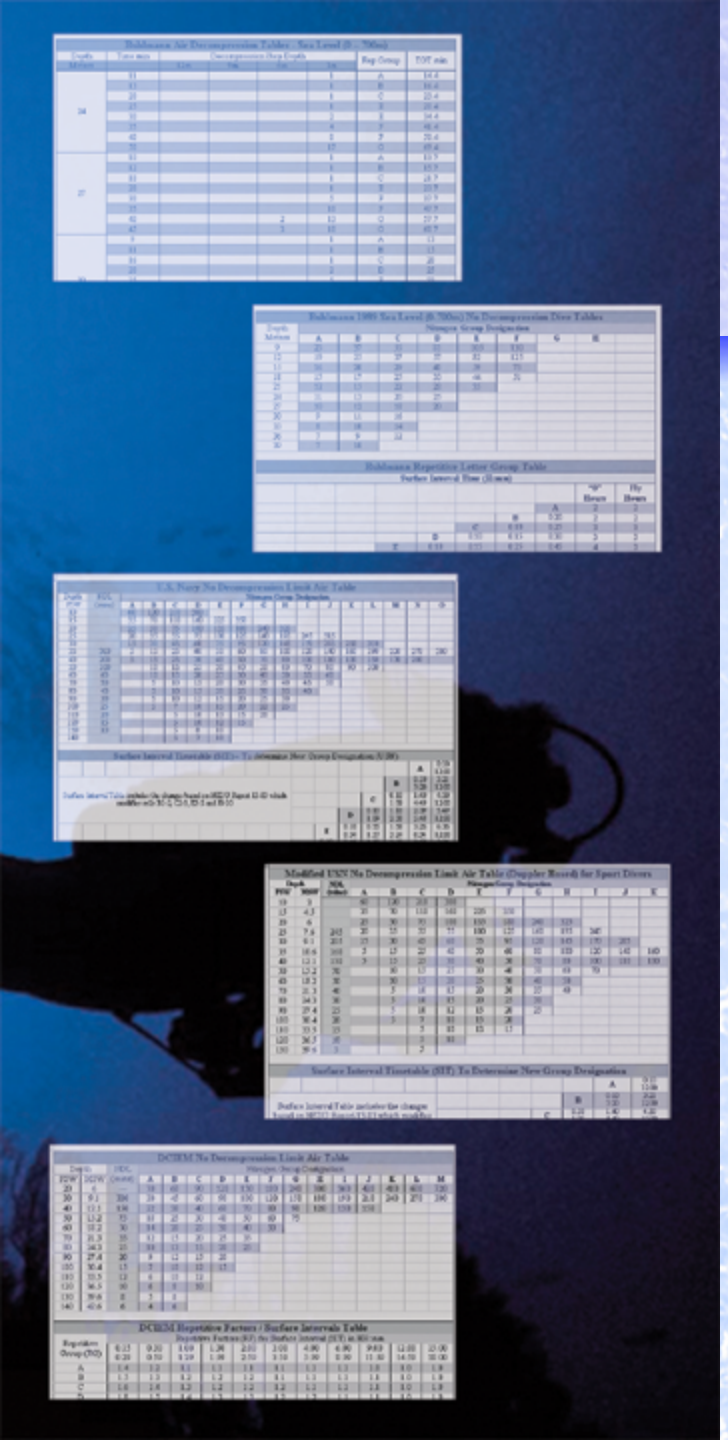
Example: USN Deco Tables:

Bottom time starts when descent starts

Maximum decent rate: 75 fpm – *22 mpm*

Maximum ascent rate: 30 fpm – 9 *mpm*

Deco stop timing starts on arrival of each depth



# Tables & Alternate Gases

EAN 40, EAN 60, EAN 80, EAN 100… ????

Accelerated decompression schedules only available with computer generated decompression profiles or custom mix dive computers.

$O_2$ Users Need Air Breaks!

Don’t Forget CNS Calculations!!!

# Deep Stops?

2-3 minutes
½ way from depth to Deco Stop 1

Recalculate Deco for added Deep Stop Time

If distance to Deco Stop 1 > 30 feet / 9 metres
Go Back

Employment of deep stops is up to the individual

# Planning

**Gas Consumption:**

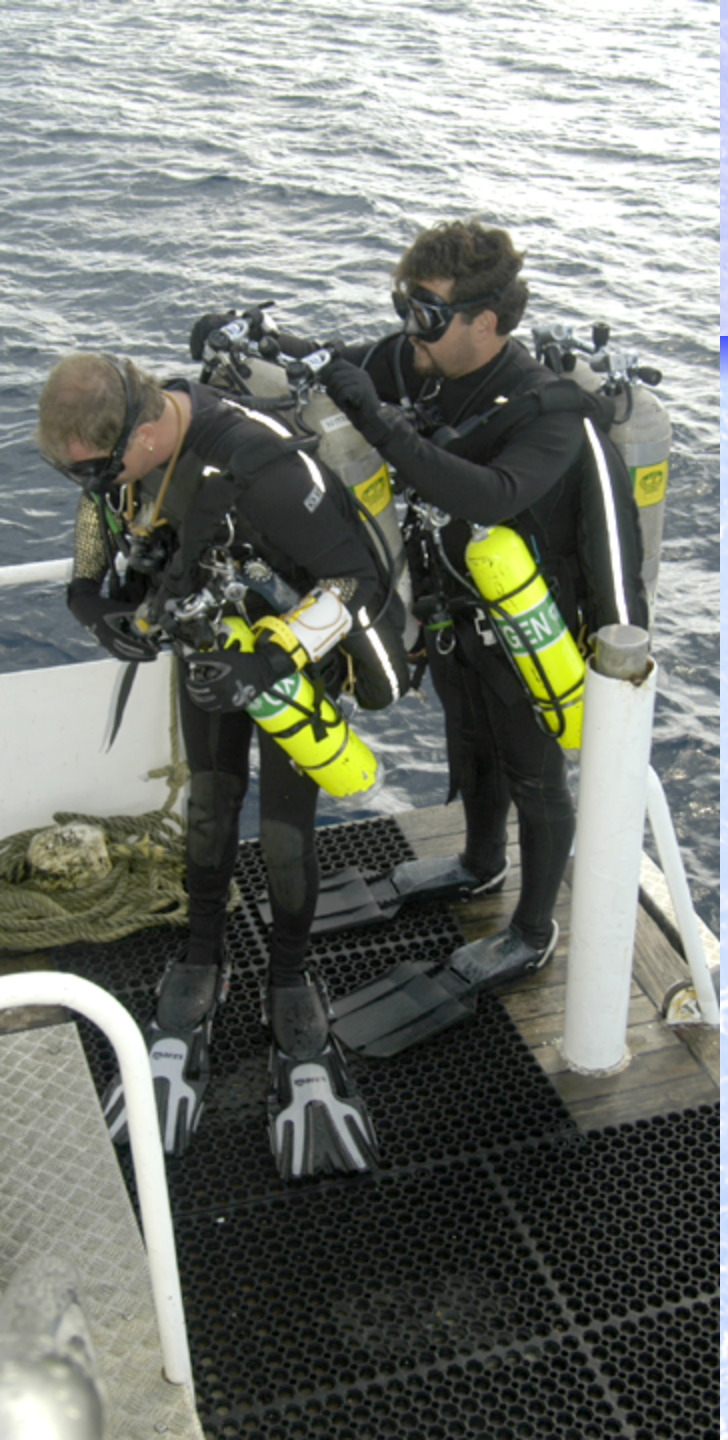
Determine Reserve Rule

Include Bottom Gas & Reserves

Travel Mix (If Any) & Reserves

Deco Mix(s) & Reserves

Include enough gas for:
Any contingency plan
Buoyancy / lift bag inflation etc…



# Contingency

Contingencies vs. Buddies???

Running out of gas …
NOT AN OPTION!!!!

DO NOT use the contingency plan as an alternative dive plan!!!!!

Diving is NOT LUCK … It is a SKILL

# Chapter 4: Equipment Considerations for Extended Range Diving

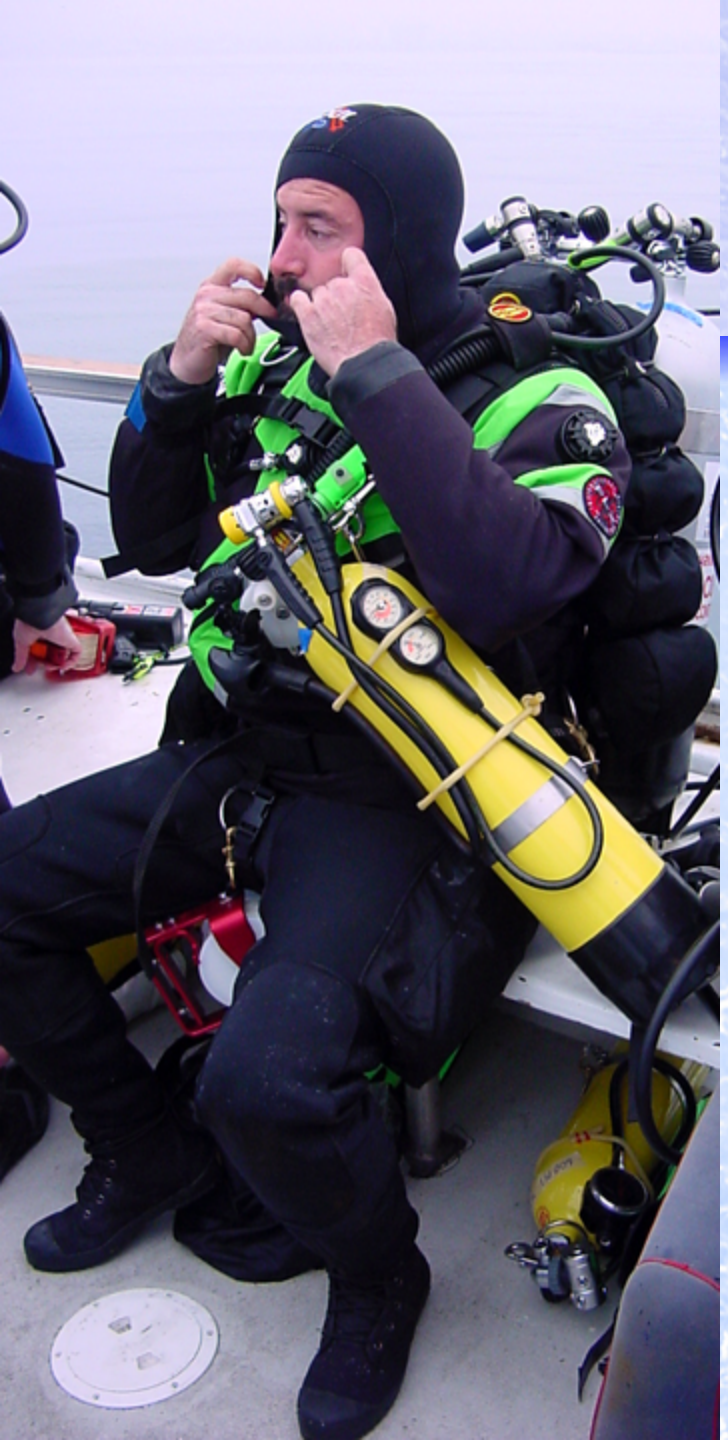
And now for something completely different…

A discussion on ER Equipment!

Quite simply…

Many times, one particular style does not always lend itself to every type of diving!

"A properly trained Extended Range diver should be able to assess a situation and apply their knowledge and experience to changing situations."



# Configuration

Configuration Options

More Review Examples During Open Water

# Influences On Gear Configuration

Most configurations stem from the original “Technical Divers”, the Cave Divers.

Even the BCD and Octopus can be traced back!

Configuration choices major influence:
The Instructor!

Ultimately, YOU, the diver, choose your own configuration(s)

# Ohhh Nooooo
# Outta Gas?????

WHAT ARE YOU DOING RUNNING OUT OF GAS!!!

1. Catastrophic failure of the manifold and/or isolator.

2. Catastrophic failure of BOTH the independent regulator systems.

3. Failure to monitor the pressure gauge.

Remember:

"Extended Range" refers to
Extending DEPTH and/or TIME of a dive!

# Cylinders

ER Diving = More Gas

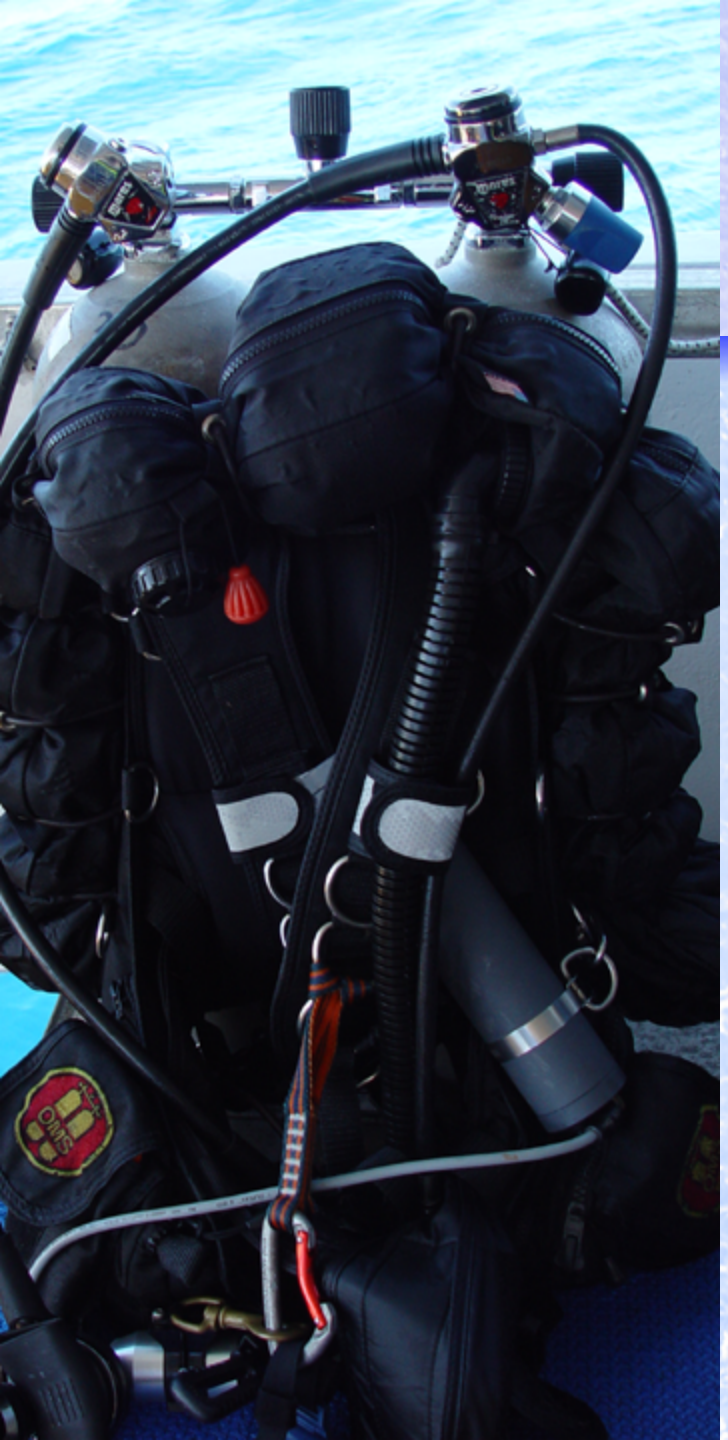
Large Volume Singles

Doubles

Deco Cylinders : 30 $ft^3$ - and up

Valve Selections:
DIN – Yoke – “Y” – “H”

Manifold Selections:
Independents – Isolation



# Buoyancy

Wide Selection

Lift Capacity?

Redundancy?
Second Bladder
Dry Suit
…
Inflation Gas?

Accessories
i.e.
Clips, Rings, etc…

# Regulators

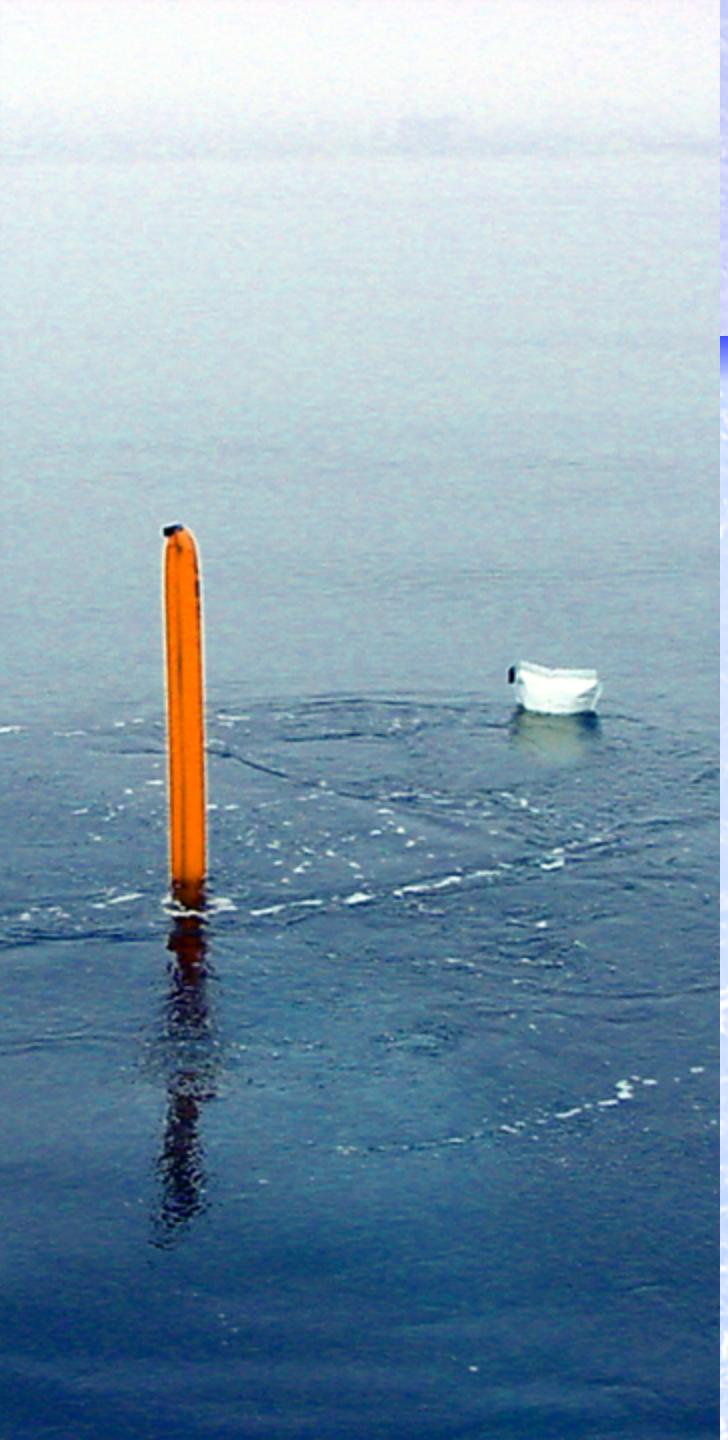
Again, Many to choose from!

$CO_2$ Loading

Differentiation:

Color Coding
Different Styles
Different Mouthpieces
Regulator Bags

Take care if altering
current configuration!



# Surface Marker Buoys

Reels / Lift Bags / Buoys

In Water Decompression
Location Device

Reel:
Operable with single hand.
Avoid too much line.

If line jams on inflation…
LET IT GO!

# Gauges & Computers

Depth & Time Monitoring

2 Independent Depth Monitors

and

2 Independent Time Monitors

LEARN YOUR COMPUTER!!!

# Accessory Items

Jon Line

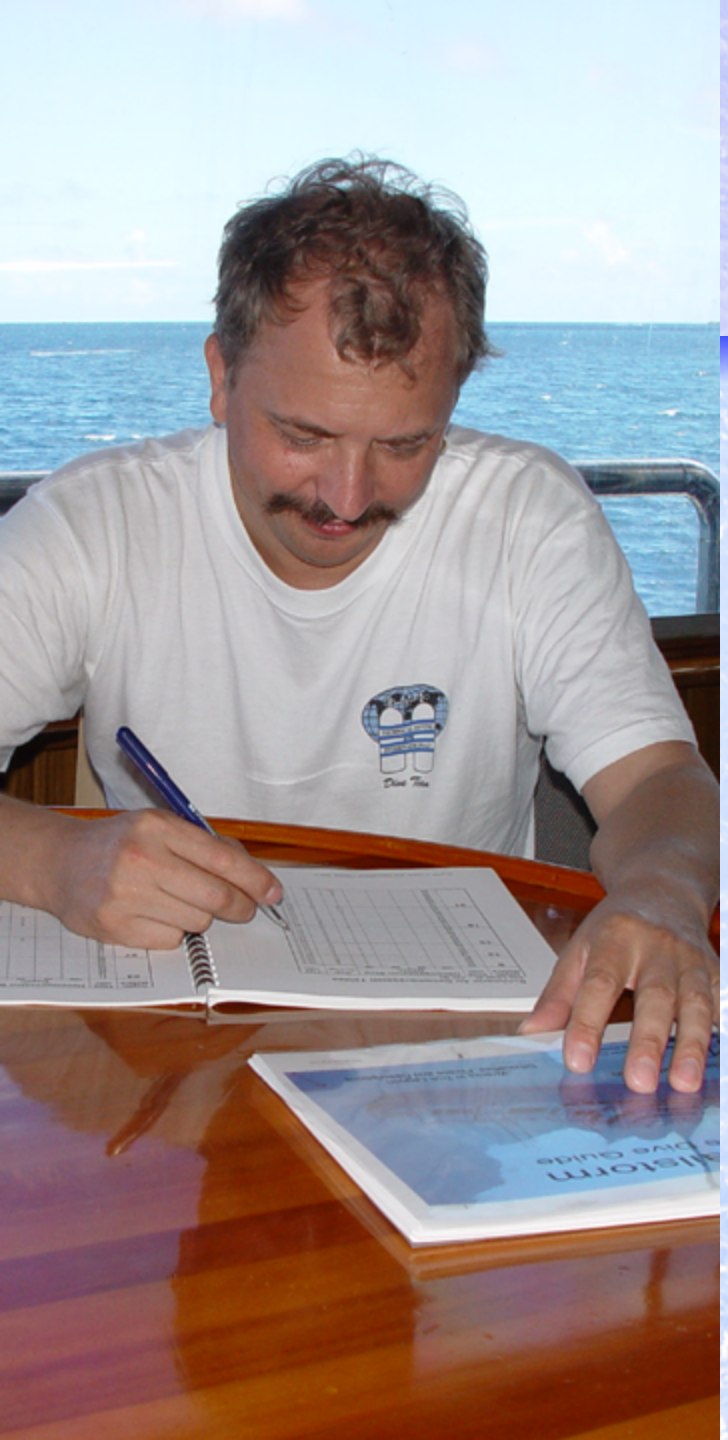
Submersible Tables

Slate / Pencil

Thermal Equipment

Z-Knife

Lighting



# Final Review
# Extended Range

Review
Answers

# Chapter 5: Introduction to Basic Trimix Principles

Introducing… Helium

Nitrox; Decreasing $N_2$ =

- Decreased Narcosis
- Decreased Depth

Adding Helium =

- Increased Depth
- Increased Complexity
- Increased Heat Loss
- Increased Deco Stops
- Increased Responsibility

# Trimix Considerations

END = EAD

Helium replaces Nitrogen in Trimixes.

Added responsibility:

More Deco
More Stops
Diver Cooling
Added “Pressure”

Just as we had a “Best Mix” for Nitrox,
the same exists for Trimix

# Trimix Considerations

Determine the Best Mix For:
200 feet – *60 metres*
1.5 $PO_2$
END = 4 ATA

Step 1: 1.5 $PO_2$ ÷ 7 ATA = 21% $O_2$

Step 2: 4 ATA END ÷ 7 ATA = 57% $N_2$

Step 3: 57% + 21% = 78%

100% - 78% = 22% He

Mix: 21-22-57 “21/22” mix

# Diving With Trimix

Trimix vs. Heliox vs. Heliair vs. Hyperoxic Trimix

Executing a Trimix dive is virtually identical to any other Extended Range dive.

Because Hyperoxic Trimix > 21% Oxygen:
Travel Mix = Bottom Mix

Hyperoxic Trimix Tables are usually computer generated.

Pre-Planning Hyperoxic Trimix Dives is a MUST!!!

# Cylinder Considerations

Proper Labelling!
"Custom Mix"

Contents Label

Oxygen Cleaning Necessary

Long term storage of Hyperoxic Mixes not advised.

Necessity of separate dry suit inflation cylinder.

# Final Review
# Introductory Trimix

Review
Answers