Techreational Diving Workshop

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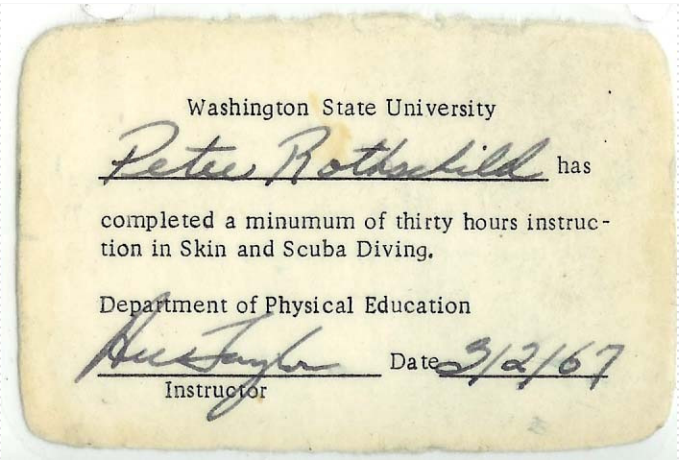

Washington State University

Peter Rothschild has

completed a minumum of thirty hours instruction in Skin and Scuba Diving.

Department of Physical Education

Instructor

Date 3/2/67

Topics To Be Covered

- Administrative stuff
- Definition of Techreational Diving
- Gear Choices
- Fundamental Diving Skills
- Gas Management
- Decompression Theory

Administrative Stuff

- Who is Peter Rothschild and why does he think he can teach this stuff?
- I got my start in Scuba diving by taking Scuba as P.E. as a freshman at Washington State University in the fall of 1966. After 15 weeks of classes, I became a Scuba Diver.
- Over the years since then, I have trained with several different training agencies, PADI, NAUI, GUE, TDI and UTD and have obtained ratings in both recreational scuba diving and technical scuba diving (including training in deep and decompression diving and cave diving).
- Full training resume: www.belowandbeyond.biz

More Admin Stuff

- Why am I doing this workshop?
- Why are YOU taking it?

More Administration

- Liability Releases
- Medical Form
- Class Times/places
- Cove 2 for Open Water Work?

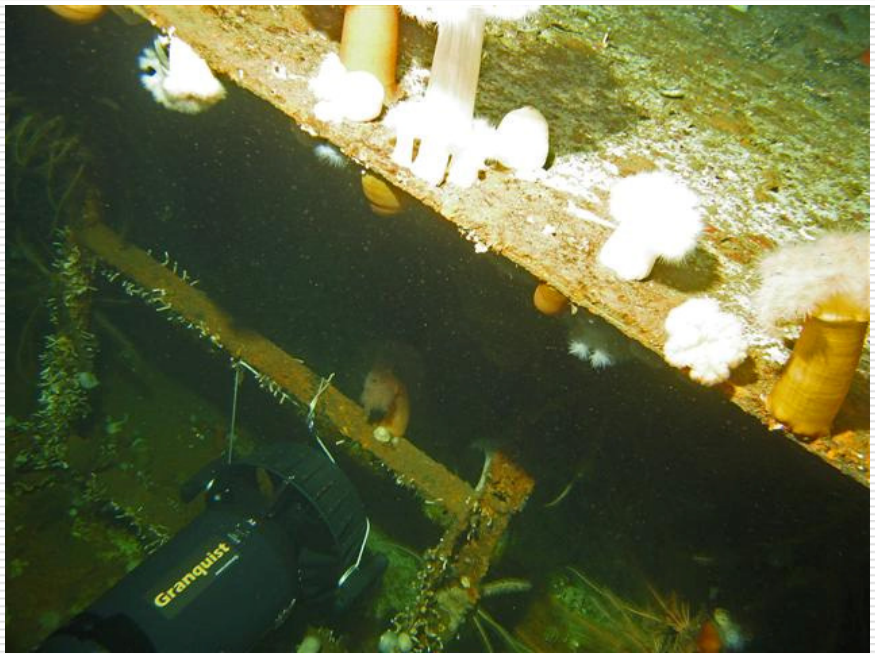
By the End of This Workshop You Will Be Exposed To:

- The concept of Techreational Diving

  There is no bright line between Recreational Diving and Technical Diving.

  The farther one gets from the surface, the more one needs to be able to solve problems where you are – Surfacing may not be the best solution to a problem.

By the End of This Workshop You Will Be Exposed To:



- Gear Choices

  We'll review Tanks, BCs, Fins, Regs, Lights and Exposure Protection

  We'll discuss pros and cons of various gear.

  By the end of the discussion, you will understand why some gear is preferable to other gear

By the End of This Workshop You Will Be Exposed To:

- Fundamental Techreational Diving Skills
  - We will do some pool work on basic skills, mask clearing and air sharing while neutral and maintaining position in the water column & with your buddy
  - We will introduce non-silting kicks – frog, mod flutter, back and helicopter kicks.
  - We will work on team dynamics and situational awareness

By the End of This Workshop You Will Be Exposed To:

- Gas Management

  Emergency Air Reserves – how much and why

  Gas usage strategies – all available, halves and thirds

  Gas planning for your dive

Plan your dive and Dive your plan!

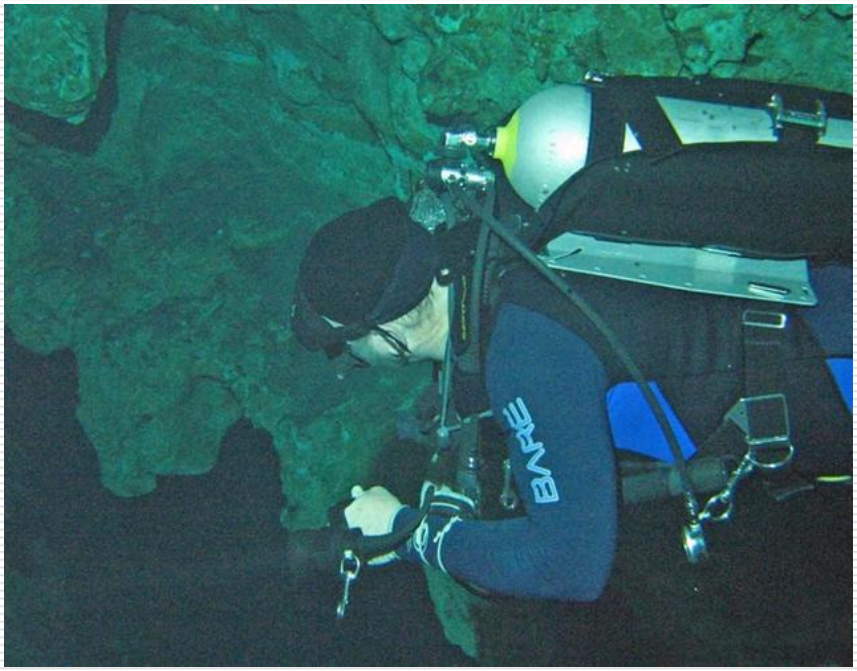
By the End of This Workshop You Will Be Exposed To:

- Decompression Theories – EVERY Dive is a Decompression Dive!
  - We'll review the basic Decompression Theories, Haldanian and RGBM
  - We'll review some dive planning strategies that take into account the concept that every dive is a decompression dive – the concept of Minimum Deco as a planning and operating tool

What is Techreational Diving?

- What is Recreational Diving?
- What is Technical Diving?
- The “Tweener” Dives are Techreational!

The Two "P's"



- Preparation
- Precision
- In Techreational Diving, the Preparation for the Dive and the Precision in the Dive are much more important than a "typical" Recreational Dive

Preparation

- Training
- Gear
- Dive Planning
- Self-preparation

Pre-Dive Prep

- BWRAF
- SADDDD
- Ready to Go DDDDiving
- GUE EDGE

Begin With Review and Friend

- B – BCD
- W – Weights
- R – Releases
- A – Air
- F – Final

Does it do enough?

Have you read what is on the DM Card?

SADDDD

- S – Sequence of the Dive – Roles and the basic plan
- A – Air – How much, What, Turn Pressures
- D – Depth
- D – Direction
- D – Duration
- D – Decompression Strategy

Ready to Go DDDDiving

- R – Roles of the Team
- G – Gas supply and turn pressure
- D – Depth
- D – Direction
- D – Duration
- D - Deco

GUE EDGE

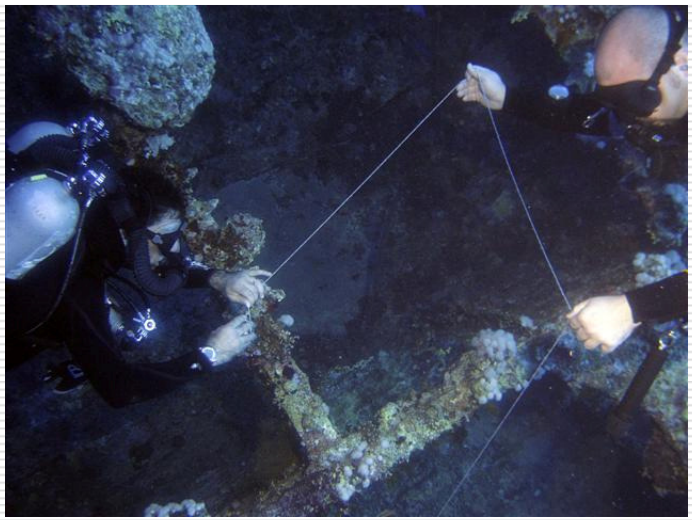
- G – Goals of the dive
- U – Unified Team
- E – Special Equipment
- E – Exposure – Depth & Time
- D – Deco Obligation
- G – Gas – what, how much, etc.
- E – Environment

Head to Toe Check

- Take 60 seconds and check all the gear, head to toe
- Breathe both (all?) regs IN THE WATER
- Do Bubble Checks – 1st stage and all connectors
- Make sure all lights work

Precision

- In the dive itself
- In the operation of the team
- At all times
- The essence of Techreational Diving is that it is just “more” than a “Recreational” Dive



Gear Choices

- Tanks
- Why steel or why aluminum?
- Why high pressure or why low pressure?
- What size?
- When redundant and how?

Gear Choices

- BCs
- Jacket BC
- Back Inflate "traditional"
- Backplate and Wing
- What type of Wing?

Gear Choices

- Fins
- Soft fin or hard fin?
- Split fin or blade fin?

Gear Choices

- Regulators and Hoses
- Donate primary or not?
- Long hose or not?
- Din or Yoke?

Gear Choices

- Lights – what good are they?
- Signalling – what and how?
- Buddiness and team dynamics
- Can lights vs. everything else
- HIDs vs. LEDs

Gear Choices

- Exposure Protection
- Wet vs. Dry – Why and When?
- Can you get yourself back to the surface if X, Y and Z fails?

Fundamental Skills

- Back to Precision
- Key is to be able to do the various skills while maintaining your place in the team and the water -- doing things in a three foot window while maintaining horizontal trim

Buoyancy Control

Frog Kick

Modified Flutter Kick

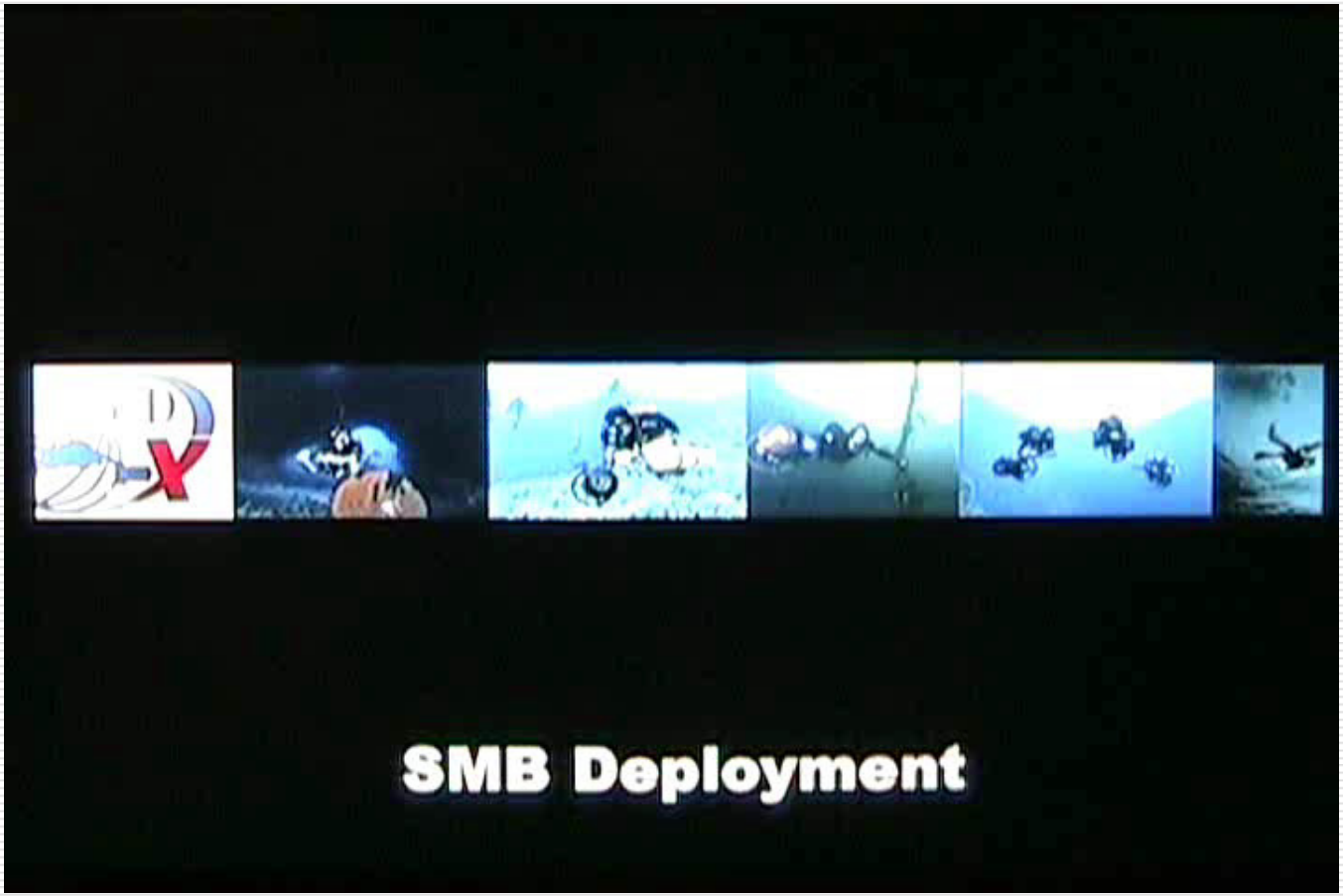
Back Kick

Helicopter Turn

Air Sharing

Controlled Ascent

Shooting a Bag



Air Supply Management

How to Plan Your Dive

So that

You Can Dive Your Plan

A Tale of Two Dives

- Two Couples decide to Dive the Boundary Line between Coves 3 and 2
- Couple “A” decides that Diver A will use an AL 80 and Diver B will use an HP 100 plus a pony
- They go diving

- Couple B takes a few minutes to Plan Their Dive and decide:
- 10 minutes to 100’ -- 15 minutes at 100’ -- 15 minutes back to surface
- They will use EAN 32%
- They estimate their air usage based on personal history and compare with amount in their tanks
- They go diving

What Were the Outcomes?

- Couple A
- Couple B

- Which Couple Planned Their Dive and Dived Their Plan?

Why Practice Air Supply Management?

- Maybe because you don't have gills?
- One should always have enough air (gas) to get to where you want to go

--

AND GET BACK!

The Objectives of the Talk Are to Provide You with Simple Tools To:

Plan Minimum Air Reserve

- Show you how to plan for emergencies by establishing a "Minimum Air Reserve" for every dive
- The M. A. R. is the amount of air you need to safely get you, and your buddy, back to the surface

Manage Air During Your Dive

- Develop the appropriate "Air Supply Management" strategies for using the air during your dive

SAC Rates and All That

- Calculate how much air you need to do the dive you think you are going to do
- Compare that calculation with how much air you are taking with you

Minimum Air Reserve

- M.A.R., aka, “Rock Bottom” aka Minimum Safety Reserve
- The amount of air you need to get you and your buddy safely to the surface while making all appropriate stops
- M.A.R. **does NOT count** as “available air supply” when planning your dive

Assumptions Used for Making M.A.R. Calculations

- Stressed SAC rate – 1 cubic foot/minute
- Minimum of 1 minute to "figure out" the issue
- Standard ascent profile which depends on personal preference
- Minimum M.A.R. is 500 psi

Examples

- Planned dive to 100 feet – What is the M.A.R.
- “PADI” ascent profile – 60’/minute & 3 minute SS at 15 feet

- 1 minute at 100’ to figure it out
- 100’ = 4 ATA at stressed SAC of 1
- 4 ft3 per diver or 8ft3/minute total

- Ascent avg ATA = about 60 feet = 3 ATA = 6 cubic feet per minute
- Ascent from 100’ to 15’ = 2 minutes
- 2 minutes times 6 ft3/minute = 12 cubic feet of air needed

- Safety Stop = 1.5 ATA
- 3 minutes times 1.5 = 4.5
- 4.5 times 2 = 9 ft3 of air needed
- Ascent from SS to surface – 1 minute or 1 ft3 times 2 = 2 ft3 of air needed

Total M.A.R. From 100’

- Bottom = 8 cubic feet of air
- Ascent from 100 to 15 = 12 ft3
- Safety Stop = 9 ft3
- Final ascent = 2 ft3
- TOTAL NEEDED for Reserve = 31 ft3
- I use 40 cubic feet as my Minimum Gas Reserve because I use a 30ft/min ascent rate and deeper stops

Common M.A.R. Numbers

- 100 feet – 40 cubic feet
  - Al 80 – 1600 psi
  - LP 95 – 1150 psi
  - HP 100 – 1350 psi
- 60 feet – 25 cubic feet
  - AL 80 – 1000 psi
  - LP 95 – 750 psi
  - HP 100 – 800 psi
- 30 feet – 500 psi

Strategies for Managing Air DURING the Dive

- Three different strategies
- All Available Air
- Halves Dive
- Thirds Dive

All Available

- Used when you can come up anywhere
- Drift Dive – Live Boat
- Remember, M.A.R. is NOT part of "Available Air"

Halves

- You plan to turn around when you have used half your available air
- This strategy is used when it is “nice” to return to a point certain
- Typical use would be in a shore dive
- Remember, M.A.R. is NOT part of the Available Air used for this

Thirds

Use Thirds when you must get back to a point certain – Moored Boat Diving

- With Thirds, one third of Available Air is used to "go out"
- One third is used to come back
- One third is for emergencies – i.e., your buddy goes OOA at the farthest point
- Is "Thirds" conservative?
- Remember M.A.R. is NOT Available Air

- Problems with Thirds:
- Perhaps not conservative enough
- Issues with “tank matching”

How Much Gas Do You Need?

What Do You Need To Know?

- Planned depths
- Planned times
- How much you breathe at the surface – your SAC or RMV
- With these you can estimate how much air you need for your dive

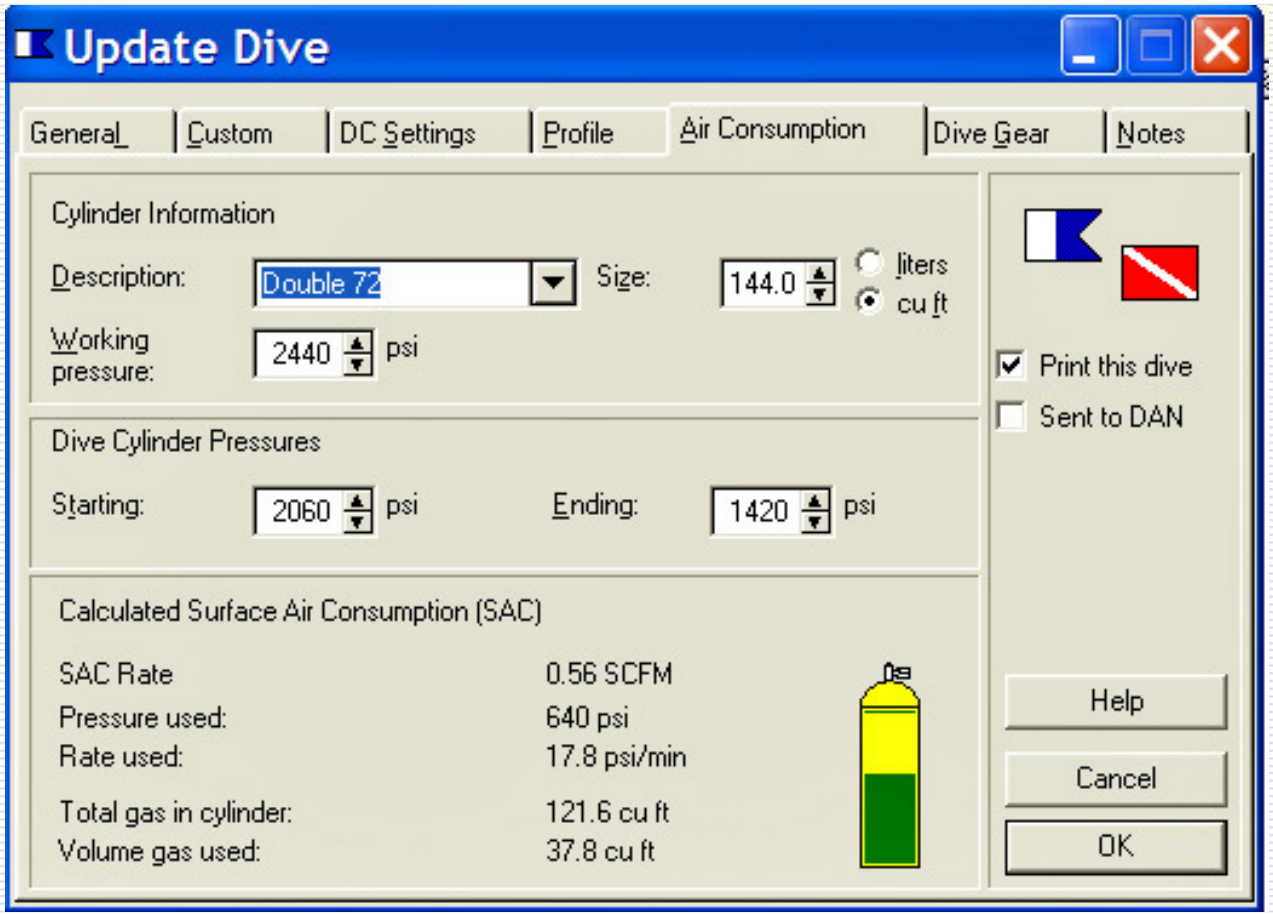
One More Thing

- You need to know how much air is in the tanks you are taking
- You also need to know how much volume equals 100 PSI – aka the Tank Factor

How to Find Your SAC Rate

- Two basic ways
- Get the readout from your air integrated computer
- Calculate it

The Easy Way


Update Dive
General
Custom
DC Settings
Profile
Air Consumption
Dive Gear
Notes
Cylinder Information
Description:
Double 72
Size:
144.0
liters
cu ft
Working pressure:
2440
psi
Dive Cylinder Pressures
Starting:
2060
psi
Ending:
1420
psi
Calculated Surface Air Consumption (SAC)
SAC Rate
0.56 SCFM
Pressure used:
640 psi
Rate used:
17.8 psi/min
Total gas in cylinder:
121.6 cu ft
Volume gas used:
37.8 cu ft
Print this dive
Sent to DAN
Help
Cancel
OK

The Harder Way

- Need to know:
- How much air you used on a dive
- What was your average depth for the dive

Air You Used

- Record your starting and ending pressure
- Convert the pressure into volume
- Remember, each tank will have different values!

Average Depth

- IF your dive computer provides you with an Average Depth for the dive, use that number
- If not, then estimate how much time at each depth and then “time weight” the average depth

SCUBA MATH!

- Scuba Math is the system I use to do these calculations
- I use whole numbers and halves and round up to be conservative
- Note – a lot of this is much easier in Metric – but, alas, I use Imperial

Calculate a SAC Rate

- Tank used – HP 100
- Pressure used – 2500 psi
- Average depth – 50 feet
- Length of dive – 45 minutes

Convert PSI to Volume

- HP 100 has 100 cubic feet at 3442 PSI – OR about 3 cubic feet for every 100 PSI – A "Tank Factor" of 3
- 100 cubic feet divided by 34.42 = 2.91 – and in Scuba Math 2.91 = 3!

Convert Depth to ATA

- Average Depth of 50 feet is equal to an average ATA of about 2.5
- 50 divided by 33 = 1.52 + 1 for an ATA of 2.5

Calculate Volume Used Per Minute

- You used 2500 PSI – convert to volume using the Tank Factor of 3
- Volume used was 75 cubic feet [3 times 25]
- 75 divided by 45 minutes = 1.67 cubic feet per minute

Convert Volume Per Minute to SAC Rate

- At depth you used 1.67 cubic feet per minute
- The Surface Air Consumption is 1.67 divided by the ATA of 2.5
- The SAC Rate is 0.67
- This is why it is easier to use the numbers from an Air Integrated Computer!

Scuba Math for Planning

- IF you know your SAC rate
- If you know how deep you are going to go
- If you know the time(s) of your dive
- You can calculate how much air you need

Dive Plan

- SAC of .67 – Scuba Math .7
- 10 minutes to 100 feet
- 10 minutes at 100 feet
- 10 minutes to surface
- How much air would you use?

- 0 – 100 feet – avg 50 or 2.5 ATA for 10 minutes
- 100 feet or 4 ATA for 10 minutes
- 100 to 0 feet – avg 50 or 2.5 ATA for 10 minutes

- SAC of .7 times 2.5 = 1.75 cubic feet per minute – times 20 minutes = 35 cubic feet
- SAC of .7 times 4 = 2.8 cubic feet per minute – times 10 minutes = 28 cubic feet
- TOTAL air needed – 63 cubic feet

Common Tank Factors

- AL 80 – 2.5
- LP 95 – 3.5
- HP 100 – 3
- HP 130 – 3.8 (OK, it's an odd number but it's my favorite tank)

Summary & Conclusion

- You now have the tools to:
- Always plan for a Minimum Air Reserve which is enough air to get you and your buddy safely to the surface
- Plan strategies for the dive – All available air; Halves; Thirds – and when each is appropriate

- And last, you have the tools to develop an appropriate Air Supply Management plan using your breathing rate, planned depths, planned times and amount of available air on your back

Back to Couples A & B

- Couple B – had a very pleasant dive and when they debriefed their dive, they discovered they used just about exactly the amount of air they had planned
- Couple A – had a very different outcome when Diver A went OOA, eventually panicked, bolted, embolized and died

Plan Your Dive & Dive Your Plan

- Use the tools so that you will be Couple B – We don't need any more Couple A's
- Diving safely is easy and just takes a few simple steps

Additional Resources

- My "Cheat Sheet" – www.tsandm.com/gm/gm.pdf

  A one page overview of "Basic Air Supply Management" with a few simple tables
- Lamont Granquist's -- www.scriptkiddie.org/diving/rockbottom.html

  A local diver's excellent explanation of Minimum Air Reserve and various calculations
- Bob Bailey's --www.nwgratefuldiver.com/articles/gas6.html

  Another local diver's thoughtful article on the whole topic
- NAUI Cave Diver Student Workbook
- NACD Cavern/Cave Workbook
- I used information from these and more to create this presentation

On To Decompression

- Much of the following is gratefully cribbed from my NAUI Tech 1/Advanced Decompression class with Scott Christopher
- Certain slides are used directly and with Scott's permission

My Personal Thoughts About Decompression Theory

- M Y G O
- My Eyes Glaze Over!
- Just tell me how NOT to get bent!!!
- Come up slowly – Spend at least as much time above 33 feet as you spent below it!

Techreational Diving and Decompression Theory – What?

- What IS a “Deco Dive?”
- Are ALL Dives “Deco Dives?”
- Are Techreational Dives Deco Dives?
- What causes DCS?
- How can we avoid DCS?
- Questions to be examined….

DCS/DCI – What is it?

- A non-diver may say: "I don't know."
- A diver may say: "The Bends."
- A Scuba Instructor may say: (What?)
- What do YOU say?

What do the Experts say?

- What is DCS? I don't know. It might be micro-bubbles, it might be big bubbles, it might be an immune response, it might be….

What Do We Know?

- We do know numerous factors that increase the likelihood of "getting a hit"
- Those factors include:
- Age, Dehydration, Cold, Bounce Dives, Rapid Ascents, PFO, Exertion

What may be the most significant factor in “getting a hit?”

- POOR DIVE PLANNING AND EXECUTION!
- Poor Depth Control
- Poor Ascent Strategy
- Poor Ascent Execution

A Brief Review of On-gassing and Off-gassing

- Why do we "on-gas?"
- Dalton's Law – In any gas mixture the total pressure equals the sum of the partial pressures for each gas
- Henry's Law – Gas will dissolve into a liquid in an amount directly proportional to its partial pressure

  Gas will move into/out of solution to maintain equilibrium between ambient and the dissolved partial pressures

On-Gassing

- As we go deeper, the partial pressures increase thus gas will move into the tissues

Off-Gassing

- As we ascend, gas will come out of solution
- What happens to the gas that comes out of solution?
- How much gas pressure can our tissues tolerate?

Half-times, Saturation and M-Values

- What are half-times and why do we care?
- My tissues are saturated with gas, how much more can they have?
- What is this "M-Value" anyway and why do I care?

Half-times

- Each “compartment” has a “half-time” which is how long it takes the compartment to be “half-way” saturated, and then half-way again, and again
- Effective saturation occurs after 6 half-times

Saturation

- Saturation occurs when the Partial Pressure of the gas in the tissue is equal to the Partial Pressure of the ambient (outside) gas
- Once saturated, no more net gas will move into, or out of, the tissue – UNLESS…..

M-Values

- If saturated and the ambient pressure increases, what?
- If saturated and the ambient pressure decreases, what?
- “M-Values” are the “super-saturated” state of a tissue that supposedly won’t cause DCS

History of DCS Research

- Caisson's Disease aka The Bends
- Trial and Error led to slowly bringing the workers back to the surface
- This was "discovered" several times before people finally connected the dots

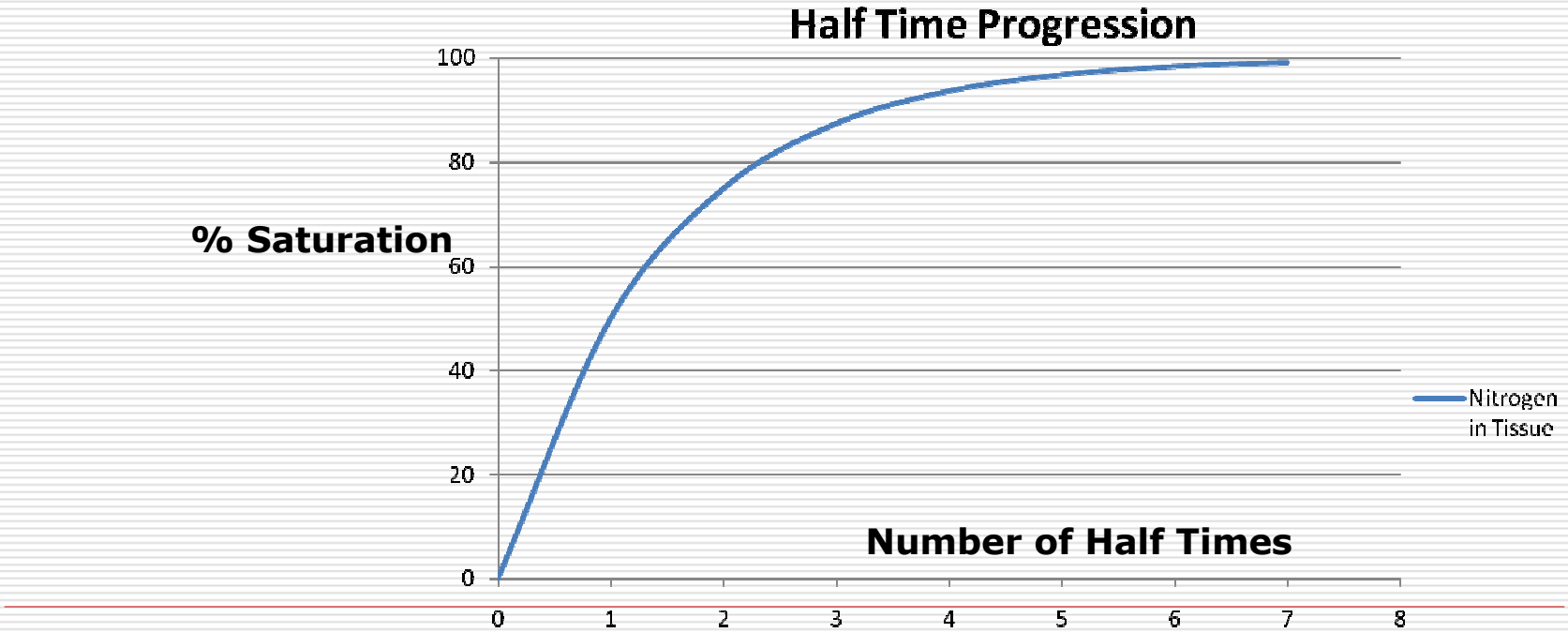
Haldane -- 1908

- Developed the first tables for the British Navy
- Concluded that there was unlimited time spent to 2 ATMs
- Concluded the body could tolerate a doubling of the "internal tissue gas pressure"
- Developed idea of "compartments"

SOUND AQUATICS

Haldane's Model

- Gas absorption or elimination by a given tissue happens exponentially



Haldane's Assumptions

- DCS is caused by bubble formation – the bubbles get into the joints and cause the bends
- Come up as fast as possible to "force" the N2 out of the system WITHOUT forming bubbles
- Five Compartments

Haldane Model and the RDP

- The RDP model for "decompression" IS a Haldanian model
- There is a fairly rapid ascent and then stop before final ascent to surface
- Much of the off-gassing is assumed to be done at the surface (after the dive)

Is this a good model for Techreational Diving?

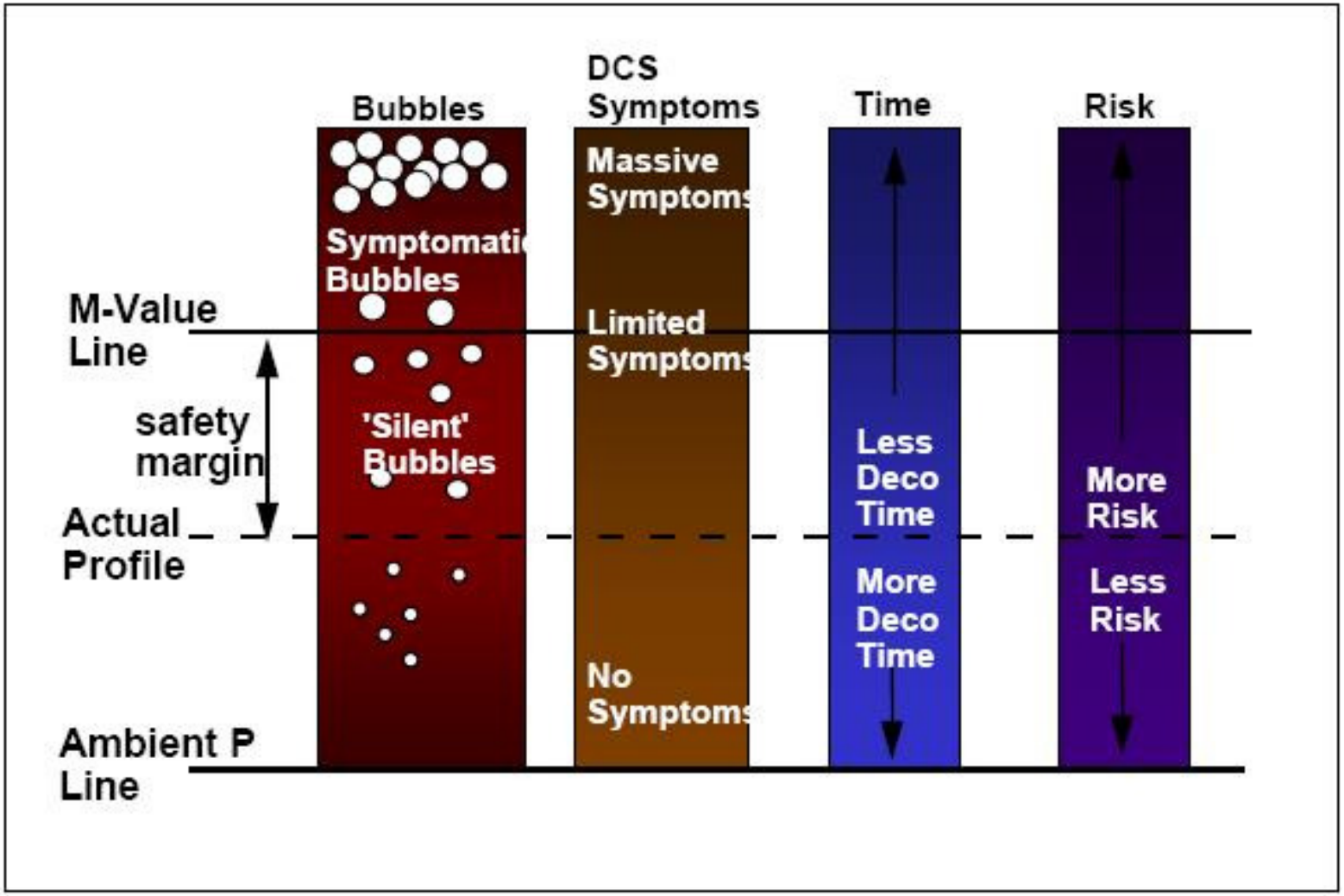
- What do YOU think?
- Why?

Bühlman's Model

- Added more tissue compartments
- Used by many (most?) dive computers
- Introduced the concept of the "M Value" -- the Maximum amount of gas within a tissue which won't cause DCS symptoms – supersaturated tissues

SOUND AQUATICS

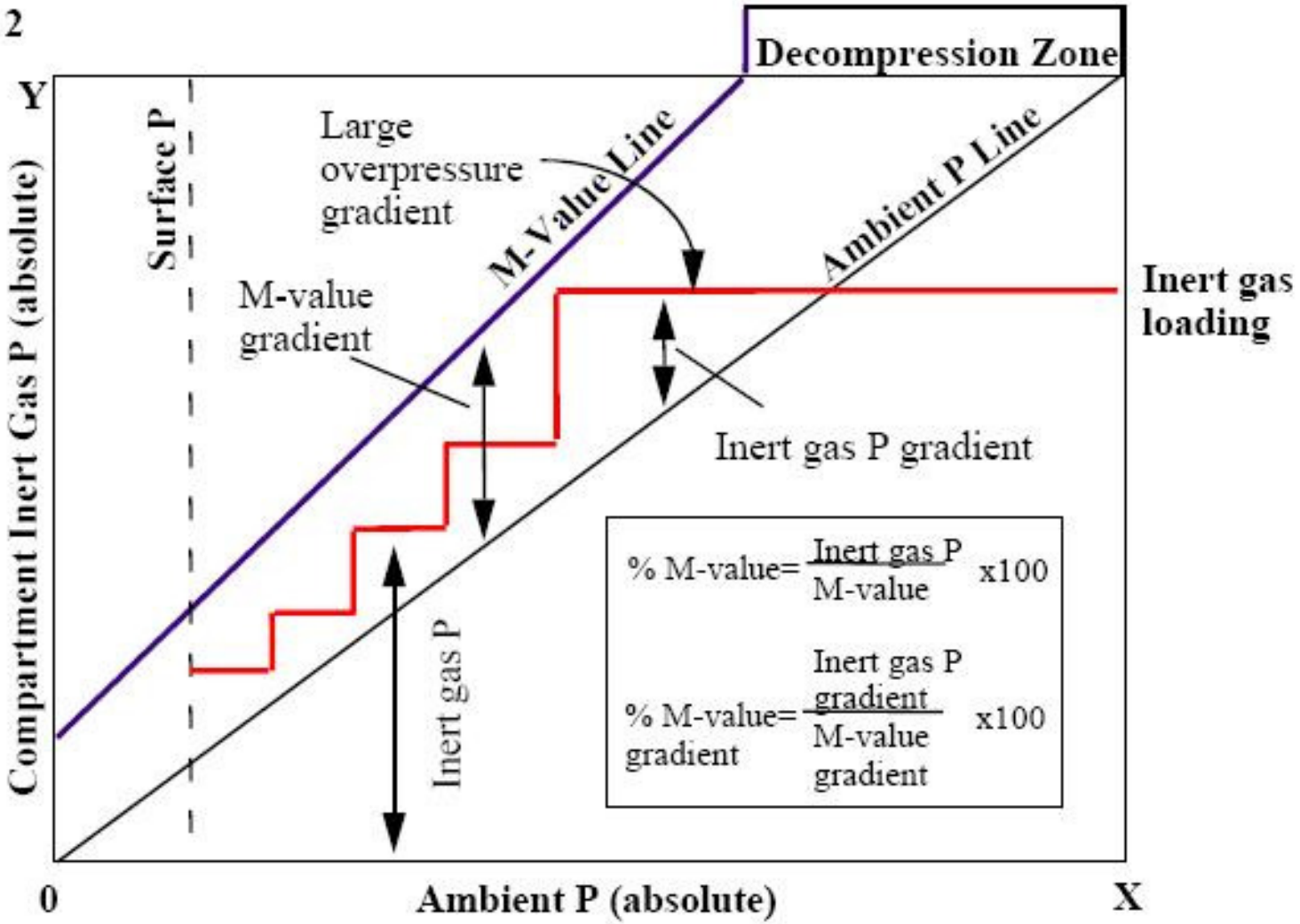
Bühlmann Model



SOUND AQUATICS

Bühlmann Model

Figure 2



Problems with Bühlman

- DCS still happened!
- Penalizes deep stops – assumes more N2 loading
- Ignores Micro Bubbles

Richard Pyle and Pyle Stops

- A researcher who did deep dives (>200 feet) looking for fish
- He had to stop fairly deep to decompress his specimens (fish) by emptying their swim bladders – did this by inserting a needle
- He realized that WHEN he did this, he felt better upon surfacing

Pyle Stops

- He started the idea of “Deep Stops”
- Brief stops – often at 80% of max depth
- Rule of thumb – brief stop at 2 ATAs above deepest point
- There is now controversy about the appropriateness of Pyle Stops on recreational dives

Bubble Models

- VPM – Varying Permeability Model
- RGBM – Reduced Gradient Bubble Model
- We have both free gas (bubbles) and dissolved gas in the tissues
- We "grow" bubbles as dissolved gas comes out of solution
- Small bubbles OK – Big not so much

Bubble Models Cont.

- The models probably do a better job of identifying issues related to:
- Repetitive Diving
- Reverse Profiles
- Multi-day Diving
- They try to model how the bubbles are created and how they grow

So What Should A Techreational Diver Do?

- Minimum Deco
- Techreational Diving assumes All Dives are Decompression Dives
- That is, every time you breathe a compressed gas while underwater, you are increasing your inert gas (N2) loading
- Excess inert gas must be off-gassed

Techreational Dives & MDL

- Minimum Deco – What is it?
- A strategy, NOT a "Theory" for maximizing off-gassing during a dive
- Incorporates concepts from Haldane, Bühlman, Pyle, Baker, Yount and Weinke
- BUT – Repeat – It is NOT a Theory

Minimum Deco Limits

- Just as an “NDL” dive has limits, “MDL” dives have set limits
- In general, Techreational dives are done on 32% -- “Air” is for tires!
- The “set point” is 100’ – 30 minutes
- Every 10 feet deeper, 5 minutes less
- Every 10 feet shallower, 5 min. more

MDLs for Various Depths

- 100 feet – 30 minutes
- 120 feet – 20 minutes
- 80 feet – 40 minutes
- 60 feet – 50 minutes
- IF you are on air – set point 100’/20:
- 100 feet – 20 minutes
- 120 feet – 10 minutes
- 80 feet – 30 minutes

Minimum Deco Profile

- In a nutshell you need the following information during a dive:
- A. Maximum depth
- B. Average depth (of the "working dive," that is, after your descent)
- C. Your gas supply (you do need to have enough to do the profile!)

General MDL Profile

- A. 30 feet/minute ascent rate
- B. First stop (pause) at 80% of max depth (but take note of the controversy re Pyle stops)
- C. Full stops at 50% of avg. depth
- D. 1 minute stops every 10 feet to surface – often done as 30 second moves and 30 second stops
- E. Double stops for repetitive dives

Benefits of MDL Profiles

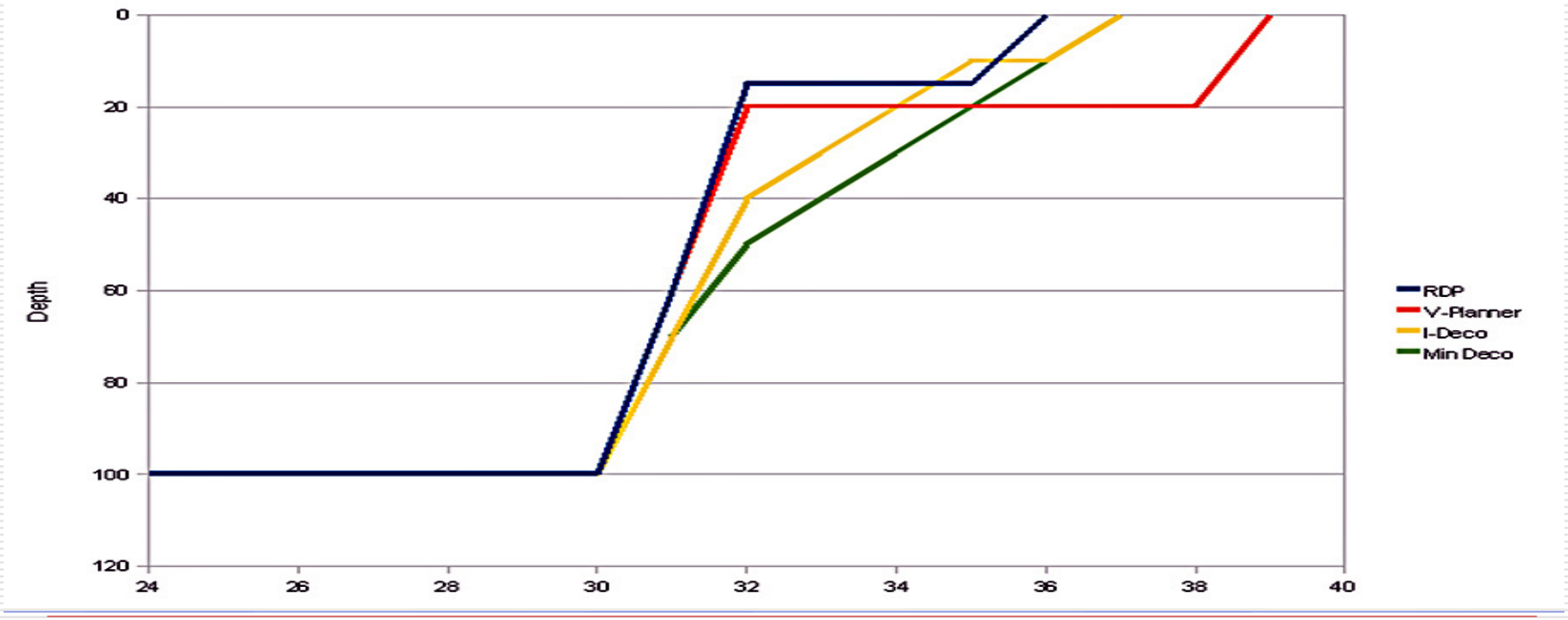
- The profile is easy to calculate
- You don’t need a computer
- It works and people who use it say they feel good upon surfacing

Cons of MDL Profiles

- I’m not sure I know any – BUT, it has not been “tested” except that it is tested every dive AND it was derived from running profiles against known deco programs
- It does require some thought
- It does require some skill to be able to hold the stops

Profile Comparisons

- Does it REALLY matter which ascent profile you choose?



What Next?

- Work on the physical skills
- Take Intro to Tech – GUE Fundamentals – UTD Essentials/Rec 1
- Go Dive

Resources

- *Deco for Divers* – Mark Powell
- *Tec DEEP Diver* – DSAT
- *Deeper Into Diving* – Lippman & Mitchell
- www.UTD.com – Become a member and take the online classes
- www.tds.com – The Deco Stop
- www.scubaboard.com – Instructor's Forum/DIR Forum
- www.divematrix.com – UTD Forum