Deep Stops

Introduction

We all remember from our open water training that a stop at 10 to 20 feet for three to five minutes is recommended before surfacing from every dive. You may have read or heard about “deep stops” or “Pyle stops”. My first exposure to this was from with Edwin B. a few years ago. Recommendations for deeper safety stops are now being adopted by some training agencies. If you have been shopping for a dive computer lately you may have even seen them featuring “VPM” (Variable Permeability Model) or “RGBM” (Reduced Gradient Bubble Model) algorithms. Some of you might be wondering what this all means for recreational divers. This isn’t to tell you to run out and buy a new computer or that you have to change the way you dive, but to present some current thoughts on how some others are finding ways to dive safer and feel better afterwards.

Bubble Trouble

When we dive, our bodies absorb additional inert gases, mostly nitrogen. We realize that eliminating the nitrogen is important so as not to form large bubbles in our blood and tissues that results in decompression sickness (DCS). Models have been made for tables and dive computers to allow us to safely ascend from dives without developing DCS. Recreational dive training uses these tables and dive computers to limit depth and bottom time so that decompression stops are not required. Even so, we must be aware that since off-gassing occurs with every dive, then every dive is a decompression dive. The reason all dives are decompression dives is simple - the diver is ascending from under pressure (i.e. decompressing).

What are these ‘models’ and how were they made? The early models were based on the work of Haldane. He surmised that different tissues absorbed and released nitrogen at different rates. Based on physical laws he devised mathematical equations to predict how the tissues would behave with the goal of preventing nitrogen bubbles from forming. Haldane’s equations were modified by Buhlmann and others to make up the tables and dive computers used by most divers today.

More recent studies on divers using an ultrasound technique known as Doppler have shown that even though a diver does not have DCS, there often are bubbles in our tissues and blood. Since these bubbles do not cause DCS, they are termed asymptomatic or “silent” bubbles; but are they still affecting us?

Did you ever finish a dive or a series of dives and feel, well, not to be too technical, like crap? This feeling is sometimes called sub-clinical DCS or “Diver’s Flu”. What you are feeling is not unlike the flu. Your body sees the micro bubbles as an invading horde and responds with antigens to fight them off much like it would a virus. It is the waging of this battle inside you that makes you sometimes feel so wasted after a weekend of hard diving.

The Haldanian models did not account for bubbles in the gas elimination equations. From the Doppler studies, we know that small bubbles are forming. The newer thinking in the VPM and RGBM takes the bubbles into account and manages them with greater safety.

But these are just models, not what really happens inside our bodies. How do we know that they work? Although it is true that these models just represent an educated guess, we know that the Haldanian models work very well because of the extremely low incidence of DCS in divers that follow these models. We think that the VPM and RGBM models work better because divers who follow these models, even when doing very demanding diving, multiple dives with mandatory decompression stops, claim to feel better following the dives.

Why do we limit ascent rates and incorporate safety stops into our dives? Most people think that it is to allow nitrogen to be removed slowly. This is simply not true. The reason for these practices is to SPEED elimination of nitrogen from the body. How does this work?

It’s simple, and then again it’s not. The way I understand it, and I don’t claim to understand it completely, is as follows: Bubbling does not occur in a diver under pressure, it only occurs when the pressure is reduced "too much". Once bubbling occurs, gas elimination is reduced. This is because the driving force for nitrogen elimination has diminished. The bubble now has to be reabsorbed before the nitrogen can be eliminated, which can be a time consuming process. However, if bubbling can be minimized or prevented, then the nitrogen stays dissolved in the body. If this can be maintained while surfacing, then the nitrogen pressure is maintained while the pressure surrounding the diver is reduced. When the nitrogen pressure is allowed to stay greater than the surrounding pressure, a driving force for nitrogen elimination is created and nitrogen will move out of the body at the greatest rate.

Repeated studies show that a diver that performs a 3 minute safety stop after a dive will have less nitrogen in their body immediately upon surfacing as compared to a diver that did not perform a safety stop, but has been on the surface "off-gassing" for 3 minutes. So, the safety stop doesn’t slow nitrogen removal, it speeds it up.

Using the deep stops recommended by the VPM and RGBM algorithms, technical divers are cutting their decompression times by as much as 40% while feeling better after the dive and reducing the incidence of DCS. Therefore, one of the best things a diver can do for themselves is to perform a safety stop. Incorporating a deep stop into the ascent, will keep the silent bubbles from forming and speed nitrogen removal even faster.

Where to Stop and For How Long

If we realize that all dives are decompression dives and that a deep stop will

- speed nitrogen removal,
- reduce bubble formation
- avoid DCS and
- make us feel better after the dive

Then what is a better safety stop practice?

The standard practice is to perform a safety stop at 10 to 20 feet for three to five minutes. Based on the information above, these recommendations are being modified by some training agencies to include a deeper safety stop. But how deep should we stop and for how long? The specific recommendations differ for a few reasons. Mares and Dacor computers using the RGBM model will incorporate a three minute safety stop at one half of your maximum absolute depth (maximum depth + 33 feet) for one minute as well as a three minute stop at 15 feet. NAUI recommends a one minute stop at half the maximum depth of the dive. PADI suggests a three minute stop at 40 feet to "keep it simple". Both of these agencies indicate that this be added to the 15 foot safety stop, not be used as a substitute for it. One technical agency recommends a one minute stop at two thirds the maximum depth in addition to a three minute stop at 15 feet. A Swedish technical agency outlines the DIR method of stops every 10 feet from 40 feet to the surface in a simple but comprehensive air / nitrox dive table. (See below).

"DIR tables
english_imperial_A.p

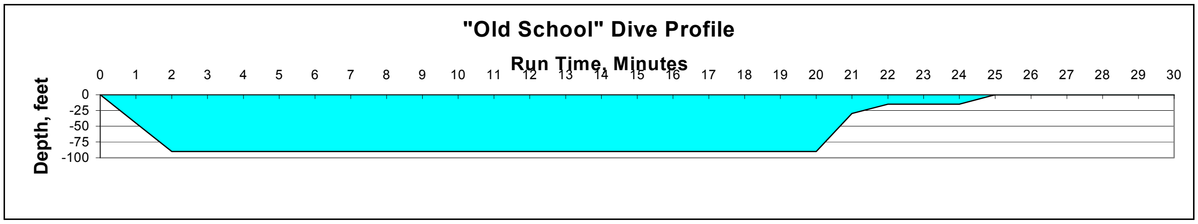
Putting it All Together

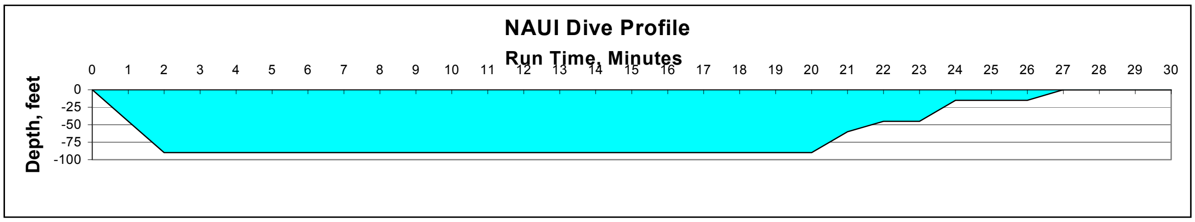
The different recommendations for ascent rates and stops may seem confusing. Which one is best? Consider this; none of them are any good to you if you don't use them. The best one is the one that you will follow.

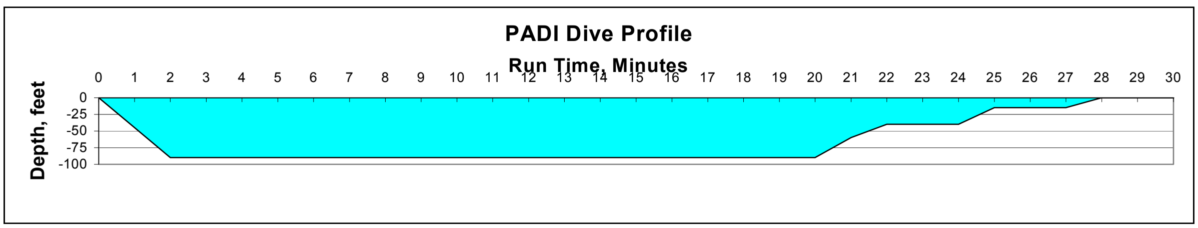
Consider that example of the single square profile 20 minute dive to 90 feet on the Niagara II. What would the dive look like? The table below shows what the dive profiles depending on which recommendations are followed.

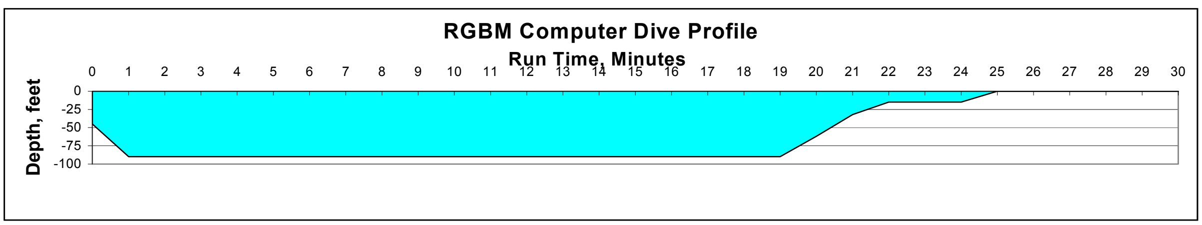
Reviewing these profiles, you'll see that the new recommendations will require you to be in the water from 2 to 5 minutes longer. You may also have to change your diving habits a little. You have to ask yourself if that extra time and trouble is worth it to dive safer and feel better after all of your dives.

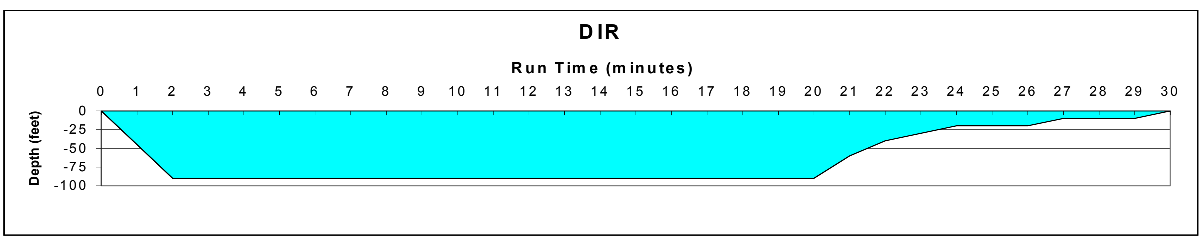
“Old School”		NAUI		DIR		PADI		RGBM Computer	
Time (minutes)	Depth (feet)	Time (minutes)	Depth (feet)	Time (minutes)	Depth (feet)	Time (minutes)	Depth (feet)	Time (minutes)	Depth (feet)
0	0	0	0	0	0	0	0	0	0
2-20	90	2-20	90	2-20	90	2-20	90	2-20	90
21	30	21	62	21	60	21	60	21	62
22	15	22	62	22	40	22	40	22	62
23	15	23	32	23	30	23	40	23	32
24	15	24	15	24	20	24	40	24	15
25	0	25	15	25	20	25	15	25	15
		26	15	26	20	26	15	26	15
		27	0	27	10	27	15	27	0
				28	10	28	0		
				29	10				
				30	0				


"Old School" Dive Profile
Run Time, Minutes
Depth, feet
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
0
-25
-50
-75
-100


NAUI Dive Profile
Run Time, Minutes
Depth, feet
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
0
-25
-50
-75
-100


PADI Dive Profile
Run Time, Minutes
Depth, feet
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
0
-25
-50
-75
-100


RGBM Computer Dive Profile
Run Time, Minutes
Depth, feet
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
0
-25
-50
-75
-100


DIR
Run Time (minutes)
Depth (feet)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
0
-25
-50
-75
-100