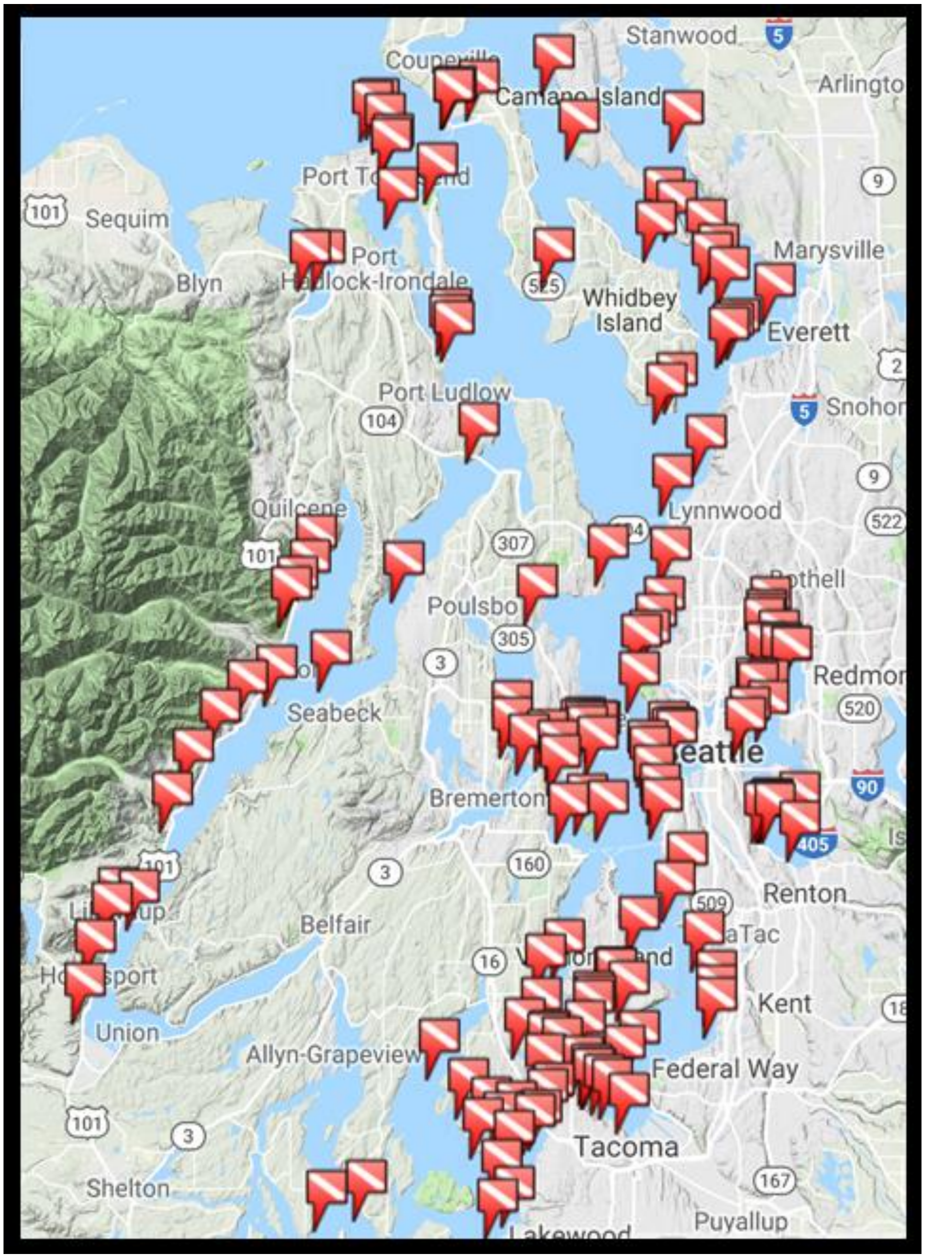
Dive Planning for Open Water Students

Puget Sound Edition



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Deep Adventures

SDI Open Water Instructor #25110

21 August 2018 version (Imperial)

ACKNOWLEDGEMENTS

I would like to thank the following individuals:

Ben Stanfield, SDI Open Water Instructor (Deep Adventures), Graham Savill (https://grahamsavill.wordpress.com), BSAC Instructor; John Downing, PADI MSDT; for reviewing this document and providing invaluable feedback.

Fritz Merkel for feedback on current sensitive websites, and the difficulty in determining accurate current predictions in the Puget Sound.

Scott Okumura and Ed McNichol for their permission for including their maps for Redondo Beach and Cove 3, respectively.

Jared Jenson, owner of PlanYourDive.com, for permission to use images and information from his dive planning website.

Gareth Lock (https://www.thehumandiver.com/) for allowing his article to be included in this document. Introducing open water students to human factors in diving helps instill awareness and safe diving practices in the new (and experienced) diver.

Disclaimer

This document is provided "as is" with no liability assumed for information provided herein. Scuba diving is an activity with inherent risks, which includes risk of severe injury or death. Proper and extensive training and experience are required to provide some level of safety. This document is not a substitute for either training or experience. The risk of injury, including death, is always a possibility that every diver must accept when diving. The diver alone is responsible for their own safety. The author of this document disclaims all liability, including for any injuries, deaths, or property damage that may result from the use of information provided in this document. This document has been reviewed for errors, but there is no guarantee that errors are not present. In addition, best practices evolve over time, thereby the information in this document may be obsolete. Due to the variations in which knowledge may be applied, the information in this document cannot be held to be universally valid.

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INTRODUCTION

Dive planning is an important topic for new divers to master. I have written this document as a supplement to the open water courses I teach. The information provided here has had a remarkable impact on my students' confidence to dive with their classmates after completing their open water course. I hope that it helps divers, from yet-to-be-certified open water students to instructors.

For you, the open water diver, I hope this document improves your ability to plan dives so you will go out with confidence and safely enjoy diving new sites within your level of training and experience. Scuba diving is one of the most amazing activities you will ever experience, one that will take you to amazing places all over the world, making lasting friendships with people you otherwise never would have met. Feel free to reach out to me at my email address with any questions: *Kosta { dot } Koeman { at } gmail { dot } com*.

For you, the open water scuba instructor, I hope this information helps you help your students to be confident and be able to thoroughly plan dives at new sites within their level of training. While the emphasis in this document is for the Puget Sound region, you can easily provide your students with an addendum for dive sites in your area. Feel free to contact me as well with the email address provided above with feedback or questions. I welcome any and all input.

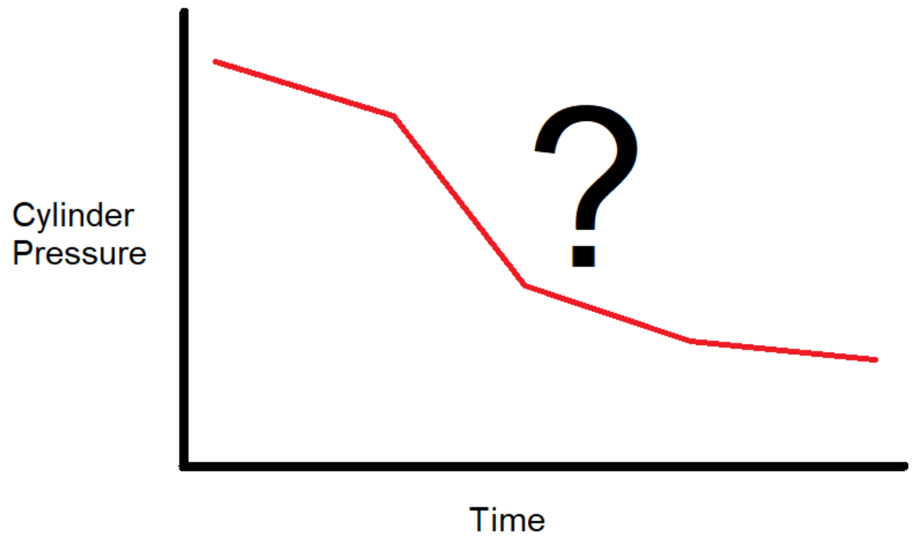
Future revisions of this document will be released based upon feedback and the addition of metric units.

OVERVIEW OF DIVE PLANNING

Basic dive planning consists of information gathering, choosing an objective for a dive, specifying maximum depth and time, and determining turn pressure. All aspects need to be discussed and agreed upon by all members of the dive team, typically of two or three divers. For four or more divers, it is best to break the group up into dive teams of two or three. It is important that everyone involved is comfortable with the dive plan. If at any time you do not feel comfortable with a dive, including during your open water class, it is imperative that you do not dive. Do not succumb to peer pressure or misplace trust in a pushy instructor that wants to shuttle you through the certification. Remember, any diver can end any dive for any reason.

Scuba diving should be fun, including all your courses. Though I will admit, I understand that students often find mask removal and replacement particularly unpleasant in cold water. I still wish to emphasize to the new or yet to be certified diver that you always have the right to call a dive and should be confident to exercise that right at any time. **Do not dive with people who fail to recognize and respect that right.**

The rate at which you consume gas is a key part for creating a dive plan, as you need to know approximately how much gas you should have in your cylinder throughout your dive. Not only do you need to ensure that you have enough gas in your cylinder to complete your dive, but also enough to be able to handle a catastrophic gas loss for one person in your dive team.



Gas consumption rates are typically described using two different terms: RMV: Respiratory Minute Volume, the volume of gas that passes in and out of the lungs in one minute; and SAC: Surface Air Consumption, the rate in terms of pressure that a person consumes gas at the surface. It is the RMV that is used to determine the SAC rate for cylinders of different sizes.

In non-emergency situations, you should return to the surface with a minimum of 500 psi in your scuba cylinder. When starting the 3-minute safety stop, you should have at least 700 psi.

In emergency situations where one diver suffers a catastrophic loss of breathable gas, it is still possible to have a 3-minute safety stop at 15 feet with proper planning. It is the intent of this document to provide guidelines on how to safely plan a dive such that if a catastrophic gas loss occurs, the dive team can calmly handle this emergency due to the knowledge that they planned their dive to have sufficient gas to return to the surface safely if this exceptionaly rare event occurs.

In the appendix, I've described a process for determining your own gas consumption rate. Throughout this document, I've used a standard gas consumption rate of 0.75 cubic feet per minute. Additionally, I have provided in the appendix rock bottom gas requirements calculations for several commonly used scuba cylinder sizes at depths from depths of 30 to 130 feet, also based upon an RMV of 0.75 cubic feet per minute. I recommend that you periodically determine your gas consumption rate as it will change over time and with significant equipment changes.

If this standard gas consumption rate is appropriate for you, you can print out the tables in the appendix for the cylinder sizes you use, laminate them individually, and secure whichever one matches your cylinder to your wrist using bungee cord. This information can also be recorded on a wrist slate or wetnotes. Being able to look at your wrist is more convenient that digging out wetnotes from a pocket.

An addendum to this document is the Excel file, *RockBottomGasCalculations.xlsx*, which provides the formulas for determining rock bottom gas values where the parameters can be modified so that you can create new rock bottom gas tables. These parameters are:

- RMV
- cylinder size
- ascent rate
- time it takes for two divers to share air and begin ascent
- safety stop time

I recommend that you study the calculations performed in that file to understand how different parameters affect gas requirements. You are encouraged to manually perform calculations when completing the knowledge reviews instead of the information provided in the appendix or the Excel file.

ASPECTS OF DIVE PLANNING

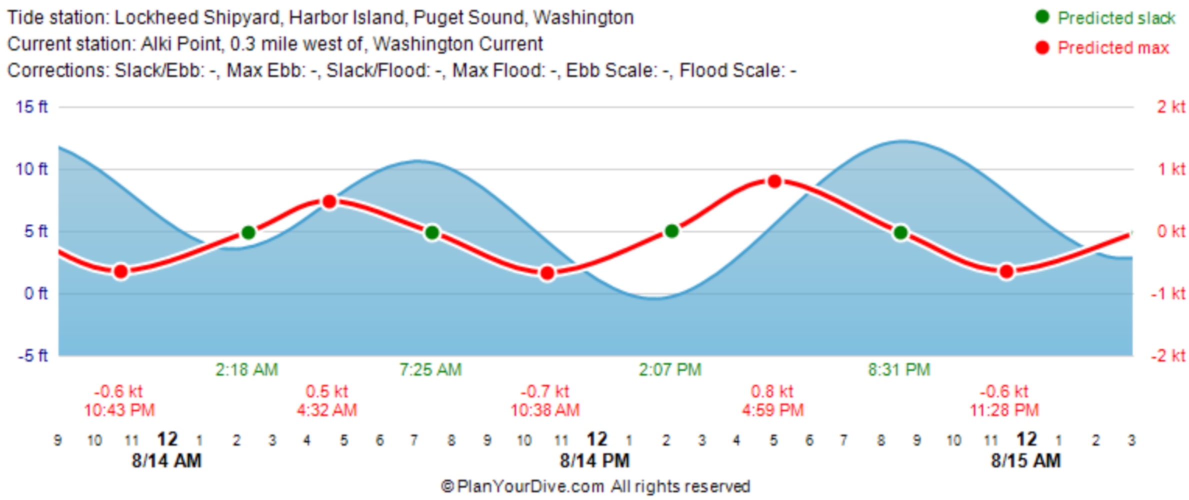
INFORMATION GATHERING

Once you have made the decision to go diving, there are a number questions that need to be answered.

- Where do you want to go diving? What is the site?
- Is there a map available of the dive site or a detailed description? Great references for dive site information in the Puget Sound include http://theperfectdive.com/ and http://www.boydski.com/diving/pugetsound.htm.
- What are the items of interest to see? How do you plan to navigate underwater? Are there any hazards to avoid? Example: a fishing pier, boat traffic, cement with exposed rebar. How will you avoid/mitigate those hazards? If you have a laminated map that you can take with you, do so as no one has a perfect memory.
- What are the recent conditions at that site? You can check social media sites to inquire about recent conditions like on Facebook, ScubaBoard.com, or nwdiveclub.com. Dive clubs, like the Marker Buoy Dive Club, are also excellent sources of information. You also can contact local dive shops to get advice. Dive shops are also an excellent resource for finding dive buddies during shop dives. Here is a partial list of local dive shops websites in the Puget Sound area:
    - 8diving.com
    - Hoodsportndive.com
    - LighthouseDiving.com
    - Octopusgardensdiving.com
    - Silent-World.com
    - TacomaScuba.com
    - TLSea.com
    - UnderwaterSports.com
- What is the predicted tide and current information? Dive planning for current sensitive sites (high peak currents) is beyond the scope of this document as it is an advanced topic and not appropriate for open water students. There are some amazing dive sites in the Puget Sound: Day Island Wall, Deception Pass, Skyline Wall, Sunrise Beach,

Keystone Jetty and others; that require additional knowledge determine when conditions are safest to dive. This knowledge includes understanding correction factors for nearby current reference stations and substations for flood and ebb slacks. If the term flood and ebb slack doesn't mean anything to you, that is okay, as you do not need to know for the dive sites that are appropriate for you. To learn more about planning for such dive sites in the future, I encourage reading Stephen Fischnaller's book, *Northwest Shore Dives*. A link for buying the third edition is provided in the appendix. I highly recommend this book as the author intended for it to be used for advanced dive planning.

For low current dive sites, an excellent and popular website is http://www.planyourdive.com. In the future, when planning dives that are more advanced due to potential current and thus require more precise planning, a better source is https://tidesandcurrents.noaa.gov/noaacurrents/Stations?g=698.



- What is the weather report for that day? What is the predicted wind? Is the dive site protected or exposed to the wind when coming in from the predicted direction?
- Do you have all the equipment required? Examples: DSMB with a reel or spool for boat diving or a dive flag when shore diving
- Is your equipment serviced and functioning? You should check your gear prior to reaching the dive site so you can address any unexpected equipment issues. Be sure to check that your batteries are charged.
- With whom will you go diving? What are their skill levels? Are their skill levels sufficient for the dive site with the expected weather, temperature, and current conditions? Are they interested in the dive site?
- Do all members of your dive team have a dive insurance policy, such as from the Divers Alert Network (DAN)?
- Do you have an emergency plan for the site? Does everyone have a means of calling EMS? Does everyone have DAN's number (+1-919-684-9111) programmed into their phones? Do you have an address to provide to EMS were you to have an emergency? Who in your dive team has emergency oxygen and who is certified to provide it

Once you reach the dive site, you will need to evaluate and discuss additional items

- Your personal physical, mental, and emotional condition. Are you up for diving? If any of those items is not good, it is best not to dive. The ocean will always be there. Be wary of dive buddies who pressure you to dive. These are not safe dive buddies and it is best to not dive with them in the future. A dive buddy can thumb a dive at any time for any reason, even before the dive. This is something that must always be respected. No exceptions.
- Weather and water conditions. As weather and wind prediction are not 100% accurate, you still need to evaluate if the conditions are safe for diving. Will they be safe at the end of your dive when you exit the water?
- Emergency oxygen. Do you have any and do all certified oxygen providers have access to it?
- Goal check. Are all members of your dive team in agreement on the dive objective?
- Entry/exit plan. Are you trained and experienced to deal with surge or waves if they exist? (a good reason to call the dive)
- Discuss lost buddy procedures: search for a minute and if you are not reunited with your dive team, ascend and meet up at the surface
- Equipment setup and self-check after assembly
- Hand signals review
- Buddy check

Once in the water, perform a bubble check where you look for bubbles leaking from the first and second stages and any hoses on your buddy. Your buddy will face down and face up for you to examine all the equipment. Also, you should breath three breaths from all second stages to ensure they are functioning properly.

OBJECTIVE

The objective is basically what does the team want to accomplish during a dive. This could be to see a wreck, do some work, take pictures (possibly in a small area), explore a large area, or simply just to have fun and look around at random! Whatever the objective may be, it must be performed within the limits of depth, time, and turn pressure. Ideally, the discussion of what to see would be based on a dive site map. I have included a few dive sites maps in the appendix and websites for finding additional ones.

DEPTH

The depth is specifying maximum depth for the dive. Do not exceed the maximum depth for which any of the team members are certified or experienced. The maximum depth is also important for selecting optimal enriched air gasses, a topic addressed in an enriched air specialty course.

TIME

The maximum dive time is determined from different constraints. The most important ones are the time in which you would consume the available gas in your cylinder and your no decompression limit (NDL) for the planned depth. Other time constraints can be caused by a diver's intolerance to cold or a personal obligation/appointment after the dive. For your NDL, dive tables are the most conservative, as these are based upon a square profile. Dive computers, compute the NDL continuously based upon an algorithm. Some algorithms are more conservative than others. You should always follow the guidance of the most conservative computer in your team when diving.

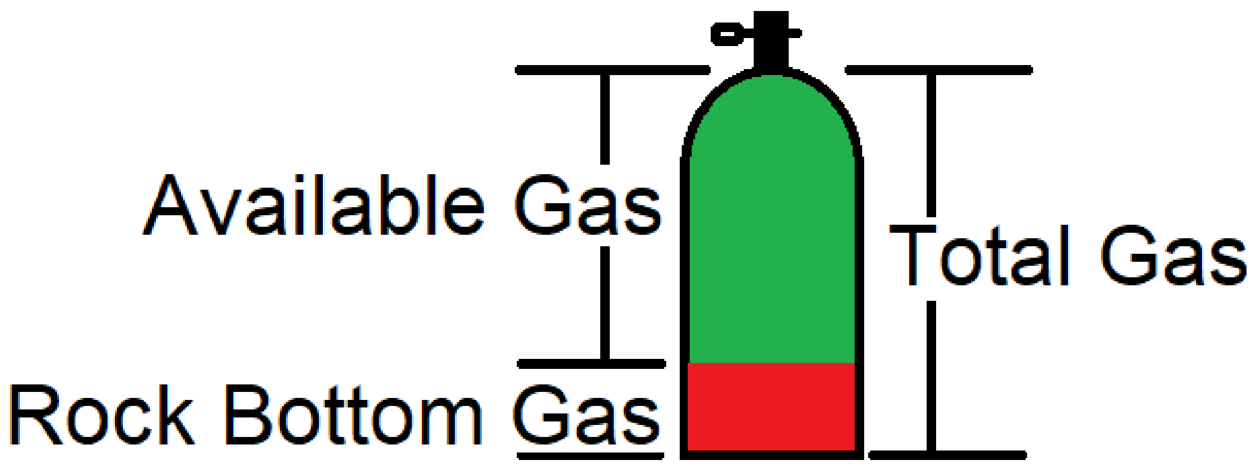
TURN PRESSURE

The turn pressure is the aspect that requires an extensive explanation. There are three types of gas volume which can be used in calculations, defined as follows:

1. Total gas: the entire gas in one's cylinder(s)

2. Reserve gas: the amount of gas that should be in your cylinder when you reach the surface to provide some safety margin. I recommend using rock bottom gas: the pure minimum gas volume required to ascend slowly from specific depths while sharing air. Sharing air is to address the worst possible scenario where the team starts to turn and a dive buddy has a catastrophic gas loss. Rock bottom gas is sometimes referred to minimum gas.

3. Available gas: the amount of gas that can be used during the dive, which is the total gas minus the reserve gas or rock bottom gas for a specific depth.



The three methods of calculating turn pressure that will be covered in this document are:

1. Rule of halves
2. Rule of thirds
3. Rock bottom gas

There are other methods used that are used for overhead (cavern, cave and wreck) environments that are beyond the scope of this document.

Rule of Halves

This method involves diving the available gas and dividing it in half. Half of the available gas is used on the way out, and the other half on the way in. The problem with this sort of a plan is that it does not take emergencies into consideration. If at the deepest depth (and usually the turn pressure is reached) there is a problem with an air source, the two divers may not have sufficient air to safely ascend. This method is not recommended except for shallow dives of 40 feet or less where the surface is not far for performing an emergency swimming ascent.

To determine the turn pressure with this method, one subtracts the reserve pressure required for a safety stop (700 psi) from the total pressure. The difference is divided in half and subtracted from the total gas.

Assuming a high-pressure tank is filled to 3400 psi, subtracting 700 psi yields 2700 psi. Subtracting half that amount (rounded down to 1300 psi) provides a turn pressure of 2100 psi.

Rule of Thirds

This method involves diving the available gas and dividing it by three. One third of the available gas is used on the way out, one third on the way in, and one third is reserved for emergencies. This method is often used in technical diving, such as a dive that has decompression requirements, inside a cave, or a wreck; and also, in recreational cavern diving which limits are often pushed due to divers having insufficient equipment and training for handling emergencies without direct access to the surface. In these cases, going to the surface in the case of a problem is not an option. Problems take time to be resolved, and this requires extra gas.

There are also virtual overhead environments, such as diving in an area where there is boat traffic. While divers must comply with laws with a dive flag, boaters often are unaware of these laws or outright disregard them. From a safety point of view, an open water dive in such an environment is categorized as a virtual overhead environment. Using the rule of thirds is appropriate for determining turn pressure for diving in these conditions.

If a high-pressure tank was filled to 3400 psi and keeping 700 psi in reserve for the start of the safety stop, one third of the difference is 900 psi. This results in a turn pressure of 2500 psi.

This method is typically not used in recreational diving, especially at tropical dive destinations, as people want to maximize bottom time and return to the surface with 500 psi. I recommend the next method, rock bottom gas.

Calculating Rock Bottom Requirements

The concept behind rock bottom gas is to ensure that in the case of catastrophic gas loss that a dive team can ascend safety sharing air, from depth. While modern, properly maintained scuba equipment is extremely reliable, every device has a small probability of failure. This is so small that the probability of two divers having their gear fail during the same dive is treated as zero probability.

Using rock bottom gas for determining turn pressure is appropriate for shore dives where there is not a virtual overhead environment caused by boat traffic, or diving directly below/from a boat.

To calculate the rock bottom gas in terms of volume, one must use the following equation:

Gas Consumed = C x A x T

The variables, C, A, and T stand for gas consumption rate for two divers sharing air (C), average pressure in ATAs (A) and time (T). This equation is used for the three stages of the ascent and the rock bottom gas is the sum of these values.

The stages of the ascent are:

- Gas consumed at depth when the divers share air and prepare for ascent
- Gas consumed during the ascent
- Gas consumed during the safety stop (optional)

Calculating Average Surface Air Consumption Rate

The standard average RMV rate used for a single diver is 0.75 cubic feet of gas per minute. Therefore, the value **C** used in the examples in this document for two divers is 1.5 cubic feet per minute. This value is higher than a diver's actual RMV rate, except in rare circumstances. In those cases, a larger RMV value, 1.0 or 1.5 or even more cubic feet per minute, should be used.

Calculating Average Pressure

The actual rate in which gas is consumed is proportional to the pressure at depth. For gas consumption purposes, we don't measure depth in feet or meters, but in absolute atmospheric pressure (ATA). The ATA at depth is calculated as Depth/33 + 1. The average ATA for when traveling between two points is:

$$\frac{D1 + D2}{2 \times 33} + 1$$

Equation 1. Average Pressure Between Two Points

For example, when diving in saltwater at 33 feet or 10 meters, the pressure is 2 ATA. The air consumption rate for two divers sharing air at that depth would double to 3 cubic feet per minute. If the starting or endpoint is the surface, one of the values will be zero and the equation can be simplified to:

$$\frac{D}{2x33} + 1$$

Equation 2. Average Pressure on Ascent/Descent To/From the Surface

If calculating the rock bottom gas requirements for a descent to 60 feet (the pressure at 60 feet is 2.8 ATA), the average pressure would be 60/(2x33) + 1 = 1.9 ATA.

Calculating Ascent Time

The ascent rate of 10 feet per minute is quite conservative, arguably too slow due to continued nitrogen loading by slow tissues. This is not a contradiction to the normal ascent rate of 30 feet per minute. This simply provides a safety margin as it compensates for increased gas consumption rates due to stress and allows divers sharing air to swim at an angle if needed. I am not aware of any published studies of the increase in gas consumption based upon stress, however empirical evidence has shown me that it can be significant. I just cannot refer you to scientific studies that show how significant. Using this rate, two divers are given 6 minutes to ascend from 60 feet.

Putting It All Together

Now that determining the combined surface air consumption rate, average pressure in atmospheres, and time to ascend has been discussed, an example of the rock bottom gas requirements for an ascent from 60 feet is calculated. Note that the gas required results are in cubic feet and always rounded up.

The gas requirement in terms of cubic feet for when divers share air and prepare to ascend from 60 feet is as follows:

Gas consumed per minute per ATA		Average ATA		Time in minutes		Gas Required
1.5	x	2.8	x	1	=	5

The gas requirement in terms of cubic feet for the ascent is as follows:

Gas consumed per minute per ATA		Average ATA		Time in minutes		Gas Required
1.5	x	1.9	x	6	=	18

The gas requirement in terms of cubic feet for the safety stop is calculated as follows:

Gas consumed per minute per ATA		Average ATA		Time in minutes		Gas Required
1.5	x	1.5	x	3	=	7

The rock bottom gas requirements for any depth is the summation of these three values. In this example, at a depth of 60 feet, RMV of 0.75 cubic feet per minute per diver, an ascent rate of 10 feet per minute, a 3-minute safety stop, and 1 minute of sharing air prior to ascent results in rock bottom gas requirement of 30 cubic feet.

The rock bottom pressure is determined by the equation:

$$\text{Rock bottom pressure} = \text{Cylinder maximum pressure} \times \frac{\text{Gas Requirement}}{\text{Cylinder Volume}}$$

Using an aluminum 80 (a commonly used tank in many dive destinations) as an example, this tank has 77.4 cubic feet of air when filled to 3000 psi. Using ratios, the rock bottom pressure would be (rounded up to the next highest 100 psi value):

$$3000 \text{ psi} \times \frac{30 \text{ cubic feet}}{77.4 \text{ cubic feet}} = 1200 \text{ psi}$$

The rock bottom gas method for depth method has the advantage in that once a team of divers ascends to a new depth, every member will have gas greater than the minimum gas value for that new depth, and thus there is more time to dive. However, one must ensure that NDL's are not exceeded.

The benefits of this method are shown with the following example and referencing the tables in the appendix with rock bottom gas/turn pressure values for various depths and cylinder sizes.

Two divers with AL80 cylinders dive to a depth of 60 feet. Once one of them hits the turn pressure of 1200 psi, they ascend to a depth of 40 feet where now the turn pressure is 800 psi. Both divers initially have 1000 psi in their scuba cylinders when they reach 40 feet, so they can continue to dive at that depth until one of their SPG values drops to 800 psi. The table in the appendix shows how in a deep dive, one can have a multi-level dive within a dive, ascending once the rock bottom gas value is reached or reaching no decompression limits, whichever comes first. Divers using these tables should also use a dive computer to track in real time their theoretical nitrogen absorption.

Example Dive Plans

Example Dive Site: Cove 3

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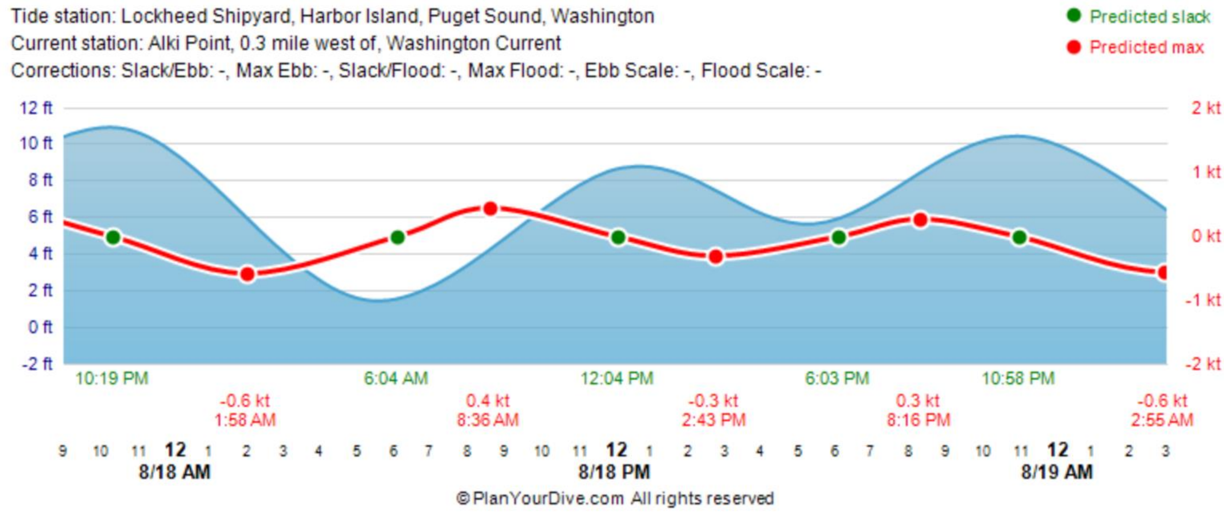
Let's say you are planning a dive at Cove 3 on August 18, 2018. You want to swim out to the bottle field at 55 fsw and work your way to the dilapidated boat about 150 feet away at 40 fsw.



For the sake of planning, you will use a swim speed of 25 feet per minute, an RMV of 0.75 cubic feet per minute. You plan on finishing each dive with a minimum of 500 psi in your cylinders. You will be using LP 85 steel cylinders (85 cubic feet of gas at the rated pressure of 2640 psi). Because the current will be parallel to shore, you will not need to take current into account as you will not be swimming with or against it all that much. If you were, you'd definitely want to adjust your swim speed appropriately, especially if it significant. If the current is significant, you will want to adjust your RMV, more so when swimming into the current. When swimming against the current, you may want to double or even triple your RMV to account to the additional physical exertion.

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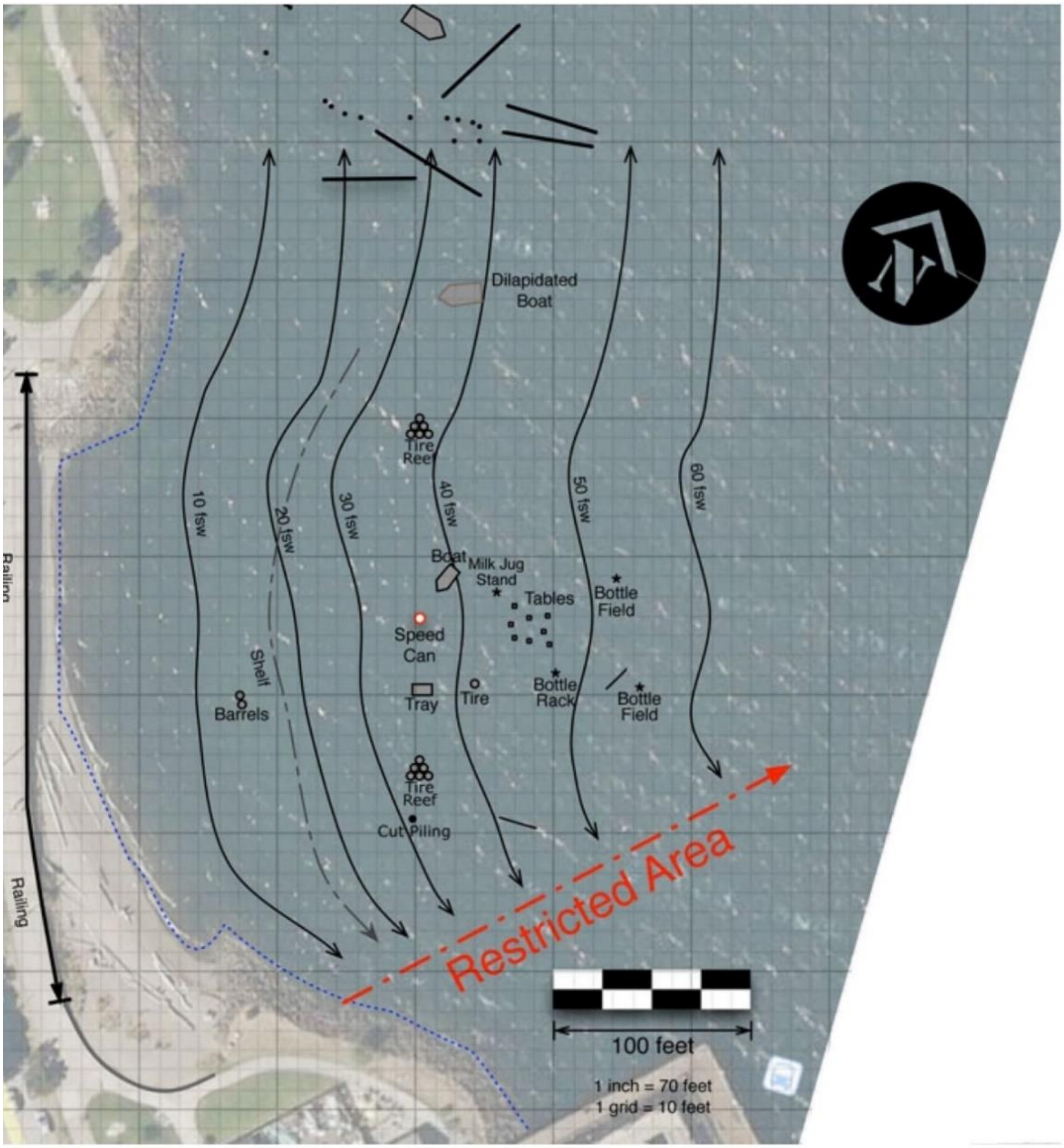
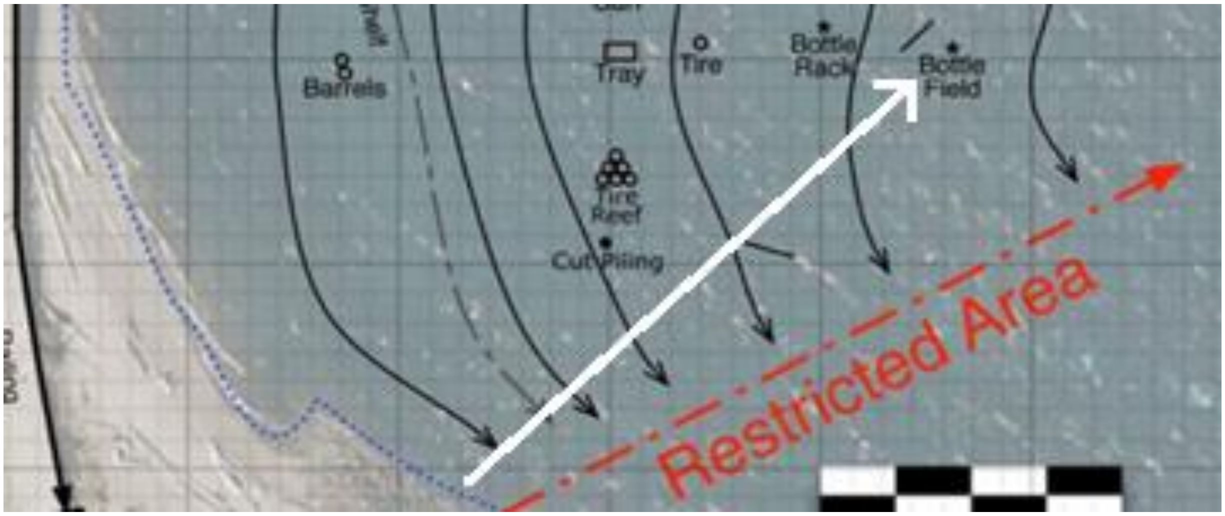


Alki Cove 3 Dive Map
Seattle, WA
Illustrated by Ed McNichol

This map can be downloaded at
www.ThePerfectDive.com

Map 1. Cove 3, West Seattle

You first will swim about 200 feet in 60 degrees east of north from the southern end of shore to reach 55 feet.



The average pressure in this part of the dive is calculated as 55 / (2 x 33) +1 = 1.8 ATA. The time is calculated by dividing the distance by speed = 200 feet / 25 feet per minute = 8 minutes. We will use the RMV of 0.75 cubic feet per minute. The gas expected to be consumed in this portion of the dive is calculated to be:

Gas consumed per minute per ATA		Average ATA		Time in minutes		Gas Required
0.75	x	1.8	x	8	=	11

To calculate the change in pressure, you will divide the expected volume of gas to be consumed by the rated volume of the tank multiplied by the rated pressure. The change is pressure is expected to be:

Gas requirement		Cylinder volume at rated pressure		Rated cylinder pressure		Change in pressure
11	/	85	x	2640	=	400

At this point, your SPG should read 2200 psi. We check the table in the appendix Turn Pressure Summary for Common Cylinder Sizes, and we see that the turn pressure for 60 fsw is 1000 psi, which we are well above by 1200 psi. Note: as you create your dive plan, always check the turn pressure for rock bottom gas to ensure that you are diving safely.

Next you will swim in a direction of 45 degrees west of north (315 degrees on your compass) and then follow the bottom at that depth to reach the tables (I like to call this area "Barroom Brawl"), exploring the items at that depth as you work your way over to dilapidated boat, a straight distance of approximately 150 feet, but we will use 200 feet to account for the exploration.

Because you are exploring, we will cut the speed in half to 12.5 cubic feet. The expected gas consumption for this portion, you use the average depth of 48 fsw which has a pressure of 48 / 33 + 1 = 2.5 ATA. The gas consumption rate is the constant 0.75 cubic feet per minute. The time is now calculated with the slower speed = 200 feet / 12.5 feet per minute = 16 minutes. The expected gas consumption for this portion of the dive is calculated as:

Gas consumed per minute per ATA		Average ATA		Time in minutes		Gas Required
0.75	x	2.5	x	16	=	30

The change in cylinder pressure for this amount of gas consumed is:

Gas requirement		Cylinder volume at rated pressure		Rated cylinder pressure		Change in pressure
30	/	85	x	2640	=	1000

Your SPG should now read 1200 psi. At this point of the dive, we go back to the appendix Turn Pressure Summary for Common Cylinder Sizes and we see that the turn pressure at 40 fsw is 800 psi, 400 psi below your current pressure.

Finally, you will return straight to shore (240 degrees), about 275 feet away.

You will again be swimming at a rate of 25 feet per minute. The average pressure in ATA is 40 / (2 x 33) + 1 = 1.6 ATA. Consumption rate is 0.75 cubic feet per minute. Time is calculated with distance divided by speed = 275 feet / 25 feet per minute = 11 minutes. The expected gas consumption is:

Gas consumed per minute per ATA		Average ATA		Time in minutes		Gas Required
0.75	x	1.6	x	11	=	14

The change in pressure is:

Gas requirement		Cylinder volume at rated pressure		Rated cylinder pressure		Change in pressure
14	/	85	x	2640	=	500

When you reach shore, your SPG will read 700 psi. But wait, you need to account for the gas consumed during your safety stop at 15 feet. The pressure at 15 feet was previously calculated at 1.5. The gas consumption expected for the safety stop is:

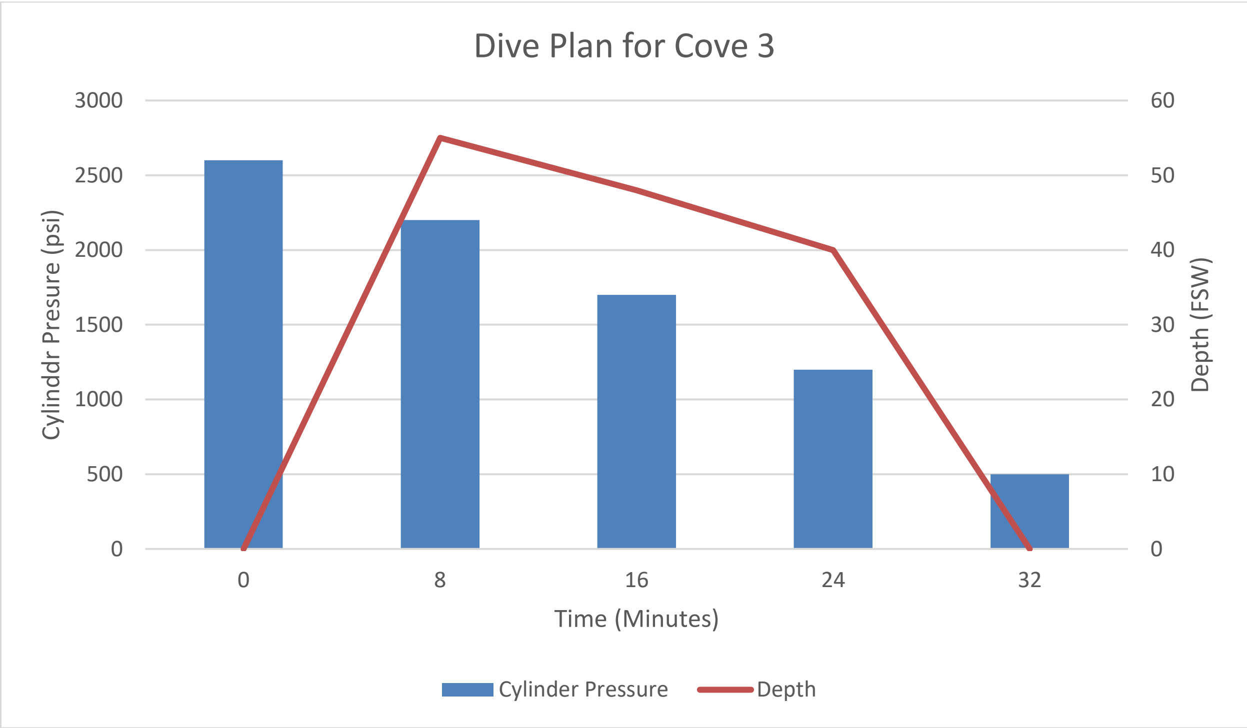
Gas consumed per minute per ATA		Average ATA		Time in minutes		Gas Required
0.75	x	1.5	x	3	=	4

The change in pressure is:

Gas requirement		Cylinder volume at rated pressure		Rated cylinder pressure		Change in pressure
4	/	85	x	2640	=	200

Factoring in the safety stop, you should be returning to the surface with 500 psi. This is why I like rock bottom gas calculations. As long as you stay within your NDL, you can maximize dive time while ensuring that you have a save amount of gas in your cylinder at all times during your dive.

The dive can be described with the following graph which provides a visual representation of as time versus tank pressure and depth. While it is perfectly acceptable to reach a specific depth earlier than planned but reaching the planned time pressure prior to the expected time requires a change in the depth.



Following this plan, you and your buddy should be back on shore with at least 500 psi. It would be recommended to record on a slate or wetnotes your plan as follows:

Direction	Ending segment time	Starting Depth	Ending Depth	Starting Pressure	Ending Pressure
060 degrees	8 minutes	Surface	55	2600	2200
315 degrees	24 minutes	55	40	2200	1200
240 degrees	32 (+3) minutes	40	Surface	1200	500

Your total dive time will be 35 minutes (extra 3 minutes for the safety stop).

While it is unrealistic for you to calculate the amount of gas for each dive when mapping out a route for a recreational dive (you always do this for technical diving) as it is admittedly a tedious exercise, However, I strongly recommend that you work through this exercise during the last dive of your open water course where you and your dive buddy plan and execute a dive. It will help you develop a sense of how much gas you consume for different portions of a dive based on depth and time. I strongly recommend to all divers to train beyond the way they will dive, as that introduces a safety margin in terms of skill and knowledge.

Addressing Fear

As an open water diver, you should be able to confidently plan dives that have similar conditions to the ones conducted in your open water dives during certification.

Sometimes divers experience fear due to a lack of skills. If that is the case, my recommendation is to go back to practice the fundamental skills you learned in your open water class while neutrally buoyant and trim. If you have difficulty in controlling your depth, you could be overweighted. Remember that the correct amount of weight is enough to keep you at your safety stop depth with an empty BCD and dry suit with a nearly empty cylinder (500 psi). If you empty your BCD (and dry suit if you are wearing one) with a nearly empty tank at your safety stop and you sink, remove some weight and try again. If you start to ascend while breathing normally, you removed too much weight. Make sure that your weight is distributed such that you can maintain the horizontal position in the water column without sculling your hands or fins.

If you find yourself nervous about a dive site, I recommend going through the exercise of calculating your cylinder pressure for the dive you are planning as you follow a route you have chosen on a map. You should be reassured that by having the cylinder pressure values you expect throughout the dive should instill a sense of confidence in you as you know you have sufficient gas to complete your dive. Over time, you will develop a sense of how much air you have based upon the time and depth of your dive.

If you go out and practice and still have fears for going out and diving with a buddy, reach out to me. It doesn't matter whether you are on the other side of the world and will not ever be a student or customer of mine. The purpose of this document is to provide you the knowledge to be a confident, autonomous open water diver.

BEYOND THIS DOCUMENT

As you advance as a diver, there are some topics I would like to advocate learning. Besides the obvious improvement in skills through a rigorous course, I recommend learning about how to determine the safest time to dive in areas that have high currents. As you grow in skills and knowledge, you can dive when the current is higher, but you want to do this gradually. I have enjoyed diving the Tacoma Narrows when the currents were wicked fast, fast enough to pull your mask off. It was much better than any roller coaster that I have had the pleasure of riding.

As I recommended earlier, please find Stephen Fischnaller's book, *Northwest Shore Dives* so that you may learn how to plan appropriate for diving Deception Pass, Keystone Jetty, and many other amazing dive sites throughout the Puget Sound.

Finally, I recommend to all divers, from the newly certified open water, to the seasoned technical or cave diver, to learn more about human factors in diving. Gareth lock provides unique training in this topic that improve your ability to process information and make better decisions, not just in diving, but in many aspects of your life.

REVIEW QUESTIONS

Q1. Planning Aspects

Which of the following statements represent the four primary aspects of dive planning as outlined in this course? Select four answers.

A. Objective

B. Current

C. Weather

D. Depth

E. Time

F. Turn Pressure

Q2. Rock Bottom Gas.

What does rock bottom gas requirement mean? What parameters are used to calculate rock bottom gas requirements?

____

____

____

Q3. RMV Rate of Two Divers Sharing Air

Which of the describes the most commonly used RMV rate when two divers are sharing air? Select one answer.

A. 0.75 cubic feet per minute.

B. 1.0 cubic feet per minute.

C. 1.5 cubic feet per minute.

D. 2.0 cubic feet per minute.

Q4. Ascent Rate

What conservative ascent rate is recommended for calculating rock bottom gas requirements?

___________________________ feet per minute

Q5. Safety Stop Gas Requirement

How much air is required for a 3-minute safety stop at 15 feet for two divers?

____________________________ cubic feet

Q6. Rule of Thirds

Describe the rule of thirds. When should this method be used for determining turn pressure?

____

____

____

____

____

Q7. Depth versus Pressure Table

Fill in the table for pressure in ATA at specified depths.

Depth	Pressure in ATA
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
130	

Q8. Average Pressure When Ascending from Depth Table

Fill in the table for average pressure in ATA when ascending from the specified depths.

Starting depth in feet for ascent	Average Pressure in ATA
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
130	

Q9. Total Ascent Time in an Emergency Where Air is Shared

Fill in the time required to ascend from the depths in the table. Do not include the time to donate a regulator and share air or the safety stop time

Starting depth in feet for ascent	Time (in minutes) needed to ascend
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
130	

Q10. Gas Requirements at Depth to Share Air at Depth for One Minute

Fill in the table with the air volume required for two divers sharing air for one minute at depth

Depth	Gas Requirements for Sharing Air
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
130	

Q11. Rock Bottom Gas Requirements for Ascending from Depth

Fill in the table for the rock bottom gas requirements for the depths.

Hint: the sum of the gas required for the safety stop (Q5), the gas used during the ascent (use the equation CAT: C is answered in Q3; A is provided in Q8; and T answered in Q9), and the gas required to establish sharing air at depth (Q10).

30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
130	

Q12. Turn Pressure for AL80

Fill in turn pressure for the depths listed in the table for an AL80 scuba cylinder.

Note: this cylinder has 77.4 cubic feet of air when filled to a pressure of 3000 psi.

Depth	Turn Pressure in PSI
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
130	

Q13. Turn Pressure for LP85

Fill in turn pressure for the depths listen in the table for an LP85 scuba cylinder.

Note: this cylinder has 85 cubic feet of air when filled to a pressure of 2640 psi.

Depth	Turn Pressure in PSI
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
130	

Q14. Turn Pressure for HP100

Fill in turn pressure for the depths listen in the table for an HP100 scuba cylinder.

Note: this cylinder has 100 cubic feet of air when filled to a pressure of 3442 psi.

Depth	Turn Pressure in PSI
30	
40	
50	
60	
70	
80	
90	
100	
110	
120	
130	

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Q15. Create a dive plan for Redondo Beach

Dive Plan:

REFERENCES

Dive Sites in Puget Sound

The Perfect Dive

Plan Your Dive

Emerald Sea Photography

Northwest Shore Dives, 3rd Edition by Stephen Fischnaller

Tide and Current Background Information

Tides and Water Levels (NOAA)

More Articles on Rock Bottom Gas and Gas Planning

Gas Management and Planning by Graham Savill

ROCK BOTTOM FOR RECREATIONAL DIVES by Brian Weiderspan

Understanding Gas Management by Bob Bailey

Basic Air Supply Management by Peter Rothschild

APPENDIX

Rock Bottom Gas Requirements for Various Depths

Depth	ATA at depth	Average Pressure in ascent to surface	Ascent time to surface at 10 ft/min	Gas Required for Ascent	Gas required for sharing air at 3 min safety stop	Gas required for 1 minute at depth	Rock Bottom Gas Required (at depth + ascent + safety stop)
30	1.91	1.45	3	7.0	7.0	2.9	17.0
40	2.21	1.61	4	10.0	7.0	3.3	21.0
50	2.52	1.76	5	14.0	7.0	3.8	25.0
60	2.82	1.91	6	18.0	7.0	4.2	30.0
70	3.12	2.06	7	22.0	7.0	4.7	34.0
80	3.42	2.21	8	27.0	7.0	5.1	40.0
90	3.73	2.36	9	32.0	7.0	5.6	45.0
100	4.03	2.52	10	38.0	7.0	6.0	52.0
110	4.33	2.67	11	44.0	7.0	6.5	58.0
120	4.64	2.82	12	51.0	7.0	7.0	65.0
130	4.94	2.97	13	58.0	7.0	7.4	73.0

Turn Pressure Summary for Common Cylinder Sizes

Depth	LP85	AL80	HP100	HP117	HP119	HP133
30	700	700	700	700	700	700
40	700	900	800	700	700	700
50	800	1000	900	800	800	700
60	1000	1200	1100	900	900	800
70	1100	1400	1200	1100	1000	900
80	1300	1600	1400	1200	1200	1100
90	1400	1800	1600	1400	1400	1200
100	1700	2100	1800	1600	1600	1400
110	1900	2300	2000	1800	1700	1600
120	2100	2600	2300	2000	1900	1700
130	2300	2900	2600	2200	2200	1900

Turn Pressure Values for Specific Tanks at Various Depths

Rated Pressure	2640
Volume	85

Depth	TP for MG in LP85
30	700
40	700
50	800
60	1000
70	1100
80	1300
90	1400
100	1700
110	1900
120	2100
130	2300

Rated Pressure	3000
Volume	77.4

Depth	TP for MG in AL80
30	700
40	900
50	1000
60	1200
70	1400
80	1600
90	1800
100	2100
110	2300
120	2600
130	2900

Rated Pressure	3442
Volume	100

Depth	TP for MG in HP100
30	700
40	800
50	900
60	1100
70	1200
80	1400
90	1600
100	1800
110	2000
120	2300
130	2600

Rated Pressure	3442
Volume	117

Depth	TP for MG in HP117
30	700
40	700
50	800
60	900
70	1100
80	1200
90	1400
100	1600
110	1800
120	2000
130	2200

Rated Pressure	3442
Volume	119

Depth	TP for MG in HP119
30	700
40	700
50	800
60	900
70	1000
80	1200
90	1400
100	1600
110	1700
120	1900
130	2200

Rated Pressure	3442
Volume	133

Depth	TP for MG in HP133
30	700
40	700
50	700
60	800
70	900
80	1100
90	1200
100	1400
110	1600
120	1700
130	1900

Determining RMV Rate

To determine your RMV, you need to swim at a sufficient (and constant) depth for a sufficient time period in order to have a sufficient change in pressure that is needed to calculate a reasonably accurate gas consumption rate.

Depths around 50 feet and times of at least 10 minutes are adequate. Longer dive times are helpful for determining one's RMV rate more accurately, but one is limited to the gas in one's cylinder and no decompression limits. The change in pressure from the beginning to the end of the timed swim is recorded. This is converted to volume by dividing the change in pressure by the rated pressure of the tank and then multiplied by the volume of that tank.

An example, a diver swims for 10 minutes at 50 feet and the difference in tank pressure from the beginning to the end of the dive is 500 psi. The diver is using an aluminum 80 tank.

The volume of air consumed is 500 psi / 3000 psi * 80 cubic feet = 13.3 cubic feet. The pressure at 50 feet in atmospheres is 50/33 + 1 = 2.5.

The RMV is calculated as 13.3 cubic feet / (10 minutes * 2.5 atmospheres) = 0.53 cubic feet per minute. Note that one would not use this value for rock bottom gas requirements, but rather determine what gas would be required for a specific dive.

Using a wrist mounted dive computer makes monitoring the time and depth more convenient and is recommended. A slate (preferably one on the wrist) or wetnotes are needed for recording the starting and ending pressures when doing the constant depth timed swim.

When dive planning, you may want to increase your RMV by multiplying it by some factor **k** to account for current and other stress factors. What is the value of **k**? The answer is that it depends and you need to determine that value over time for different dive conditions. When I teach, due to the psychological stress of monitoring my students for safety, my gas consumption rate is higher than when I dive for pleasure, even though I am typically moving less than when on a fun dive.

Determining Your Swim Rate

When taking the Underwater Navigation course, one of the tasks you will complete is determining your swim speed. This is important to know for dive planning. When planning for a dive where you decide to create a detailed dive plan as described in

Example Dive Plans

Example Dive Site: Cove 3, choose the value for the slowest diver. Also, as shown in that example, use an even slower swim speed for points of interest. After all, you want to spend the time to enjoy those areas, and you want to plan accordingly to create a realistic plan for your gas consumption.

To determine your swim speed, you need to swim a measured distance twice (often 100 feet) to account for the current. You may not need measuring tape. A spool or reel with 100 feet or so (you need to know the exact amount of line you will be using) is a reasonable means to gauge distance.

You will set up this line that is tight between two points at the same depth in order to accurately determine your swim speed. You will need to use a timer on your dive computer and a slate or wetnotes to record the time it takes you to swim the measured distance in both directions. The average time is what you will use to determine your swim speed.

A COUPLE OF MY FAVORITE LOCAL SHORE DIVES

Edmonds Underwater Park

Edmonds Underwater Park is the first marine park in the United States. Below I obtained a map from the official city of Edmonds website, however it is not to be used for dive planning. The correct map to be used for dive planning is obtained for $10 (cash only) at the Underwater Sports - Edmonds dive shop, just south of the park. This small purchase contributes to park maintenance and improvements, an effort driven by Bruce Higgins. For those interested in assisting, all you have to do is to meet Bruce at 9 am at the Edmonds Underwater Sports all Saturdays and Sundays. Do not call. Do not email. Just show up. Bruce is a wealth of knowledge for new and experienced divers alike.

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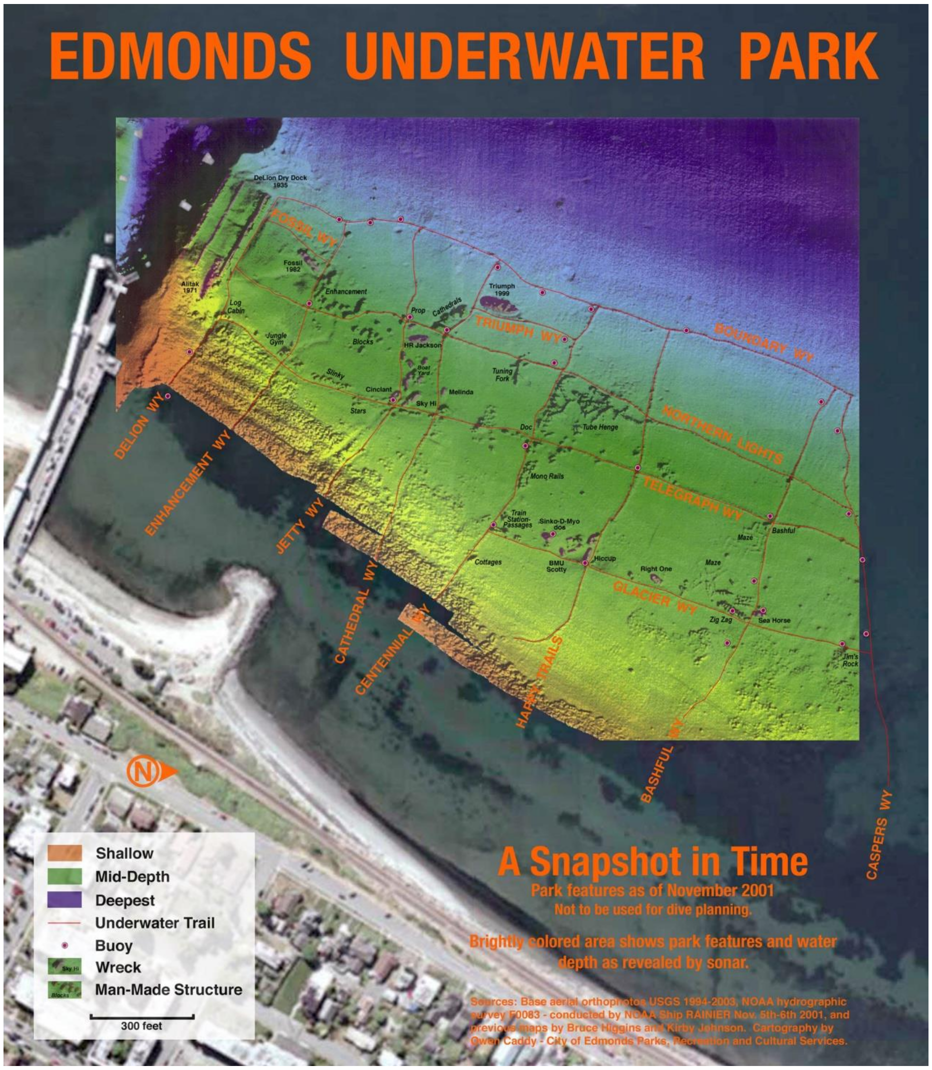
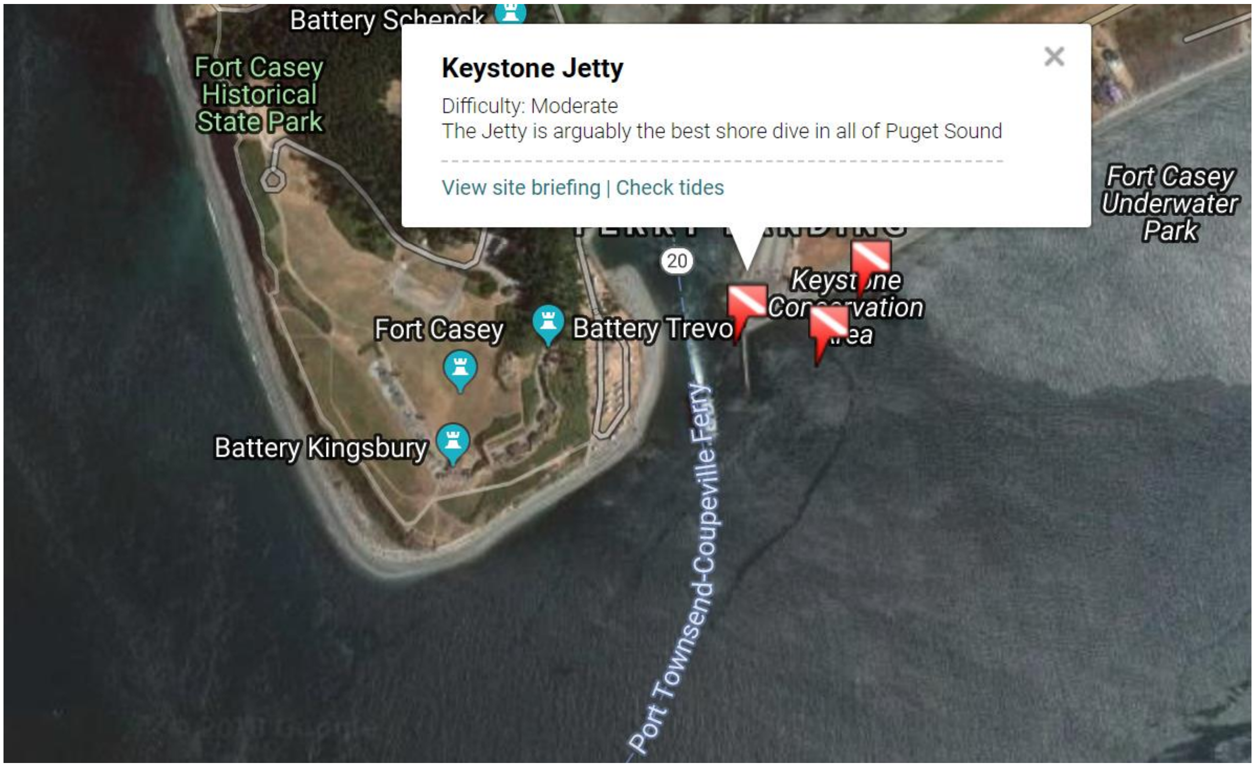


KEYSTONE JETTY



I am not providing an underwater map here, but some information that I feel is important for open water students to have for planning at more difficult dive sites like Keystone Jetty, my favorite shore dive in the Seattle area. On a Facebook dive page, I read from Eric Askilsrud the following advice for diving here:

"*If you want to make the drive up there more worth it with multiple dives with less current, go on days when the flood is ~1.5 knots or less at Admiralty. Splash an hour before low tide slack (it's best if the low tide isn't super low). Most importantly, check the wind forecast before you go... you don't want southerly winds.*

"Number one piece of advice you can give advice to ANY diver there is keep their reg in mouth on entrance/exit. The rocks are super slippery and often loose. Rogue waves come by. And if the wind picks up, it can get very bad. I've seen many people get turtled out there, and it's hard to get up. If you do get turtled best to have regs in mouth and then crawl backward to get in deeper water to stand back up."

Often it is best to join an experienced diver or a dive club when diving sites like Keystone Jetty. If you go to this site on a weekend and no one is there, you should take that as an indicator that the current conditions are not good for diving. You must be extra careful at Keystone Jetty as the last thing you want is for the current to drag you into the ferry lane. Always dive with a DSMB at this site for that particular contingency.

Authors note: Gareth Lock teaches an excellent seminar in Human Factors in Diving. I have taken this course and I recommend it to all divers, both brand new open water students to seasoned pros. It is hard to describe, but I experienced far greater growth in terms of awareness and the ability to analyze situations than anything in my formal and informal education.

WHY DO DIVERS KEEP BREAKING THE "RULES"?

By Gareth Lock

After a diving accident, it doesn't take long for the commentators and observers to look for the rules that were broken. "*They didn't monitor their gas.*" "*They weren't sufficiently experienced.*" "*They didn't do X, Y or Z…*" The design of rules, their application and subsequent rule-breaking is a complex topic. Applying a simplistic view to a complex problem won't help improve performance or safety.

Following an accident or near-miss, the speed by which the story is propagated across social media is staggering. Most of the early information transmitted is incomplete or false. Part of this is because it is just not known. It can also be that information which is available is converted using the internet version of the telephone.

"A friend told me…"

"I had a friend who told me this in confidence, don't pass it on. But this is what happened…"

The stories sometimes change beyond all recognition. For those who are involved, it becomes deeply distressing. This is especially true when stories gravitate to 'rule-breaking,' violations and just 'farm-animal stupid.'

Unfortunately, the real and honest truths rarely come out. This can be because society finds it easier to blame someone for breaking a rule (for a number of reasons) rather than looking to see why it made sense to them to do what they did.

If rules are regularly being broken in diving, wouldn't it be a good idea to understand why this is happening? It is if we want to improve diver performance and diving safety? Or is because we want to have the flexibility to manage the risks ourselves and not be constrained by more rules?

This article is the translation of a piece of work examining why anesthetists are likely to commit violations into the domain of diving. It shows there are often rational reasons behind these violations. If we want to really improve diving safety we need to understand what this local rationality is. Then we need to put measures in place to reduce the likelihood of their occurring. What we do not need to do is blame people for being stupid or apply the simplistic, "They should have known better…"

For those reading this who think you make conscious choices in all the decisions you make, including violations, the research from multiple domains shows this to be wrong.

Most of your decision making is not actively controlled; It is subconsciously influenced. Our behavior is a function of our personality and how the environment in which we operate impacts this.

What is a violation?

Professor James Reason's examination of human error created the well-known concept of the Swiss Cheese Model. This concept looks at failures within different levels of an operation or organization that could lead to an accident or incident. In this model, there are three layers of latent failures or conditions (organization, supervisor, and individual) and then a layer of active failures which included violations.

A violation may be defined as *a deliberate act that deviates from established protocols of practice*. However, to improve safety, this simplistic view doesn't help. This is because we need to take into account the *motivation* behind the *deliberate* aspect of this violation taking into account the social and physical environment in which the person was operating.

In other words, was the violation:

Situational: The only way to solve the problem was to break the rules (i.e., rescuing someone below the MOD of their breathing gas).

Routine: It had become the norm for the group to break the rules, making it easier to socially conform than to say no.

For a personal gain: Goal fixation or to gain something (i.e., time or money from the rule-breaking).

For an organizational gain: "You have to 'break these standards' because if you don't, I will find another instructor who will" (i.e., class sizes or the definition of *mastery*.)

To create a safer environment, we need to understand why the rules were broken. This need for greater understanding was the basis behind the paper I will be making reference to. (Phipps et al,(2008). Identifying violation-provoking conditions in a healthcare setting. Ergonomics, 51(11), 1625–1642. doi:10.1080/00140130802331617 (for those who are able to access academic papers).

The Risk/Benefit Argument

As we will see, breaking rules to achieve goals is often about determining how much benefit the actor (diver) will get by breaking/following the rules compared to the benefit/loss by not following them. This is risk management at its core. The majority of the time these decisions are being made on a fight/flight or emotional level and not on a rational, logical one.

The work by Kahneman and Tverskey on Behavioral Economics won them a Nobel prize. It showed that much of our decision-making is not rational nor logical. The challenge for diving safety and learning from experience is that, after an adverse event, we are able to apply logic and rationale using information which was not necessarily available to those involved. This is why it is easy to see that "those breaking the rules were *stupid*!" Critical thinking requires mental effort and humans are efficient (or lazy) depending on your viewpoint.

As part of this risk management process, we use biases and mental shortcuts to speed up the process. One of which is called outcome bias. The premise is that the more severe the outcome, the harsher we judge the (errant) behavior even if the activity itself is almost identical.

New research has also shown that 'near misses' are internally rationalized as success stories and not 'near failures'. Unless we are trained to recognize this fallacy and have a growth mindset (always looking for improvement which we can influence), we will continue to focus on the positive aspect of the outcome (*'we survived'*) and not how close to real failure we were. Consequently, we don't change our behavior. This is the start of the normalization of deviance process.

What did Phipps and his team find out about anesthetists breaking the rules?

The research team interviewed and observed 27 anesthetists during their normal work. They also interviewed the anesthetists using a set of standardized questions and then developed themes which highlighted three key areas and a number of subsections which would need to be addressed if safety and performance were to be improved.

The high-level topics are:

The Rule: This can be summarized as who (person or organization) wrote the rule, how much credibility do they have, and what punishment would occur if the rule was broken and they were caught. And, finally, clarity of the rule.

The Anesthetist: The themes that came from this subsection are the risk perception of the anesthetist, their experience and their expertise and the professional group norm when it comes to violations.

Situational or Organizational factors: Finally, the topics which related to this subsection were the time pressures the anesthetists were under, the amount of resources available, the design of the equipment and whether there were concurrent tasks which needed to be managed.

The Rule

In the context of diving, no published research has been carried out to understand why divers break rules. The majority of published data focuses on outcomes and not failed processes. In immature safety cultures, it is easy to blame individuals rather than look at the system and whether the rules are supporting positive or negative behaviors.

As such, we need to understand:

- What the rules consist of
- Who wrote them
- Their credibility in the context of the diver
- What the disciplinary or social castigation consequences would be if divers break them and they get caught

How clear the rule was to the diver

In the majority of cases, the rules are not really clear because there are so many varied standards across the industry. Defining what is 'right' is often difficult. We only know it was 'wrong' after the adverse event. Then we have the benefit of hindsight bias to join the dots and outcome bias to attribute severity.

An example would be *Always use a checklist' before a rebreather dive*. What checklist? Who wrote it? Is it operationally relevant and based on the application of effective training? Or is it seen as a liability limiting exercise to make up for ineffective training and attitude towards safety and performance?

The Individual

Moving to the individuals themselves we need to consider their own risk perception, experience, and expertise. We also must consider what the social norm is of the group if we want to understand why violations happen.

Risk perception is a funny thing. We can perceive the risk associated with an activity very differently than another diver who might be equally qualified and experienced. We can even perceive the risk differently at different times in our own lives, often becoming more risk-averse as we age.

The real difficulty is when we have never encountered a situation before and we try to assess the risk. In so doing, we make a 'best guess' using emotion rather than logic. This is why real experience, as well as technical skills, are so important.

You cannot be taught everything in a class and therefore you have to learn on the job. Crucially, *"…risk is seen as inherently subjective. It does not exist "out there," independent of our minds and cultures, waiting to be measured. Instead, risk is seen as a concept that human beings have invented to help them understand and cope with the dangers and uncertainties of life." (*Slovic, 1987*)* and therefore applying your measure of risk to someone else's situation is likely to end up with a flawed outcome.

As discussed in the human factors in diving micro-class, many of our decisions are not made in slow-time and with logic (System 2), but rather, are emotionally-biased based on mental shortcuts and the cognitive biases we use to navigate our complex and uncertain world (System 1). If we have the wrong information coming into the decision-making process because of a lack of experience, we shouldn't be surprised if the outcome is flawed. Such flawed outcomes are therefore likely to lead to violations or 'at risk' behaviors.

Finally, we need to consider the social norm of the group. Humans are simple beings. We like to be part of a group, a behavior developed thousands of years ago. This is because a group is more likely to be able to survive than a single person on the savannah.

However, to remain part of the tribe/pack, we needed to comply with the social norms. If those norms weren't complied with, you were ejected to be left fend for yourself. We still see this behavior in troops of primates now.

Despite millennia of development, our brains haven't moved on much. If the social norm of the group of divers we are part of, or want to be part of, is to take risks, it is much harder to be 'safe' and follow the rules. If a newcomer joins the group, he or she will conform too. This is why effective leadership is so important, especially when it comes to instruction.

Situational or Organization Factors

Human behavior is a product of the personality of the person and the environment they are in.

If people are rewarded for a certain activity and punished for something else, don't be surprised if they conform. This includes social media commentary by the way and not just employment or litigation punishment.

If instructors are rewarded for the number of certs issued by their manager (wages/keeping their job) or their organization and 'punished' if they don't achieve a throughput, don't be surprised if the instructors put quantity over quality.

If the client expectation is that they can take an Open Water Diver course and become a 'qualified' autonomous diver in two days, don't be surprised if that drives dive center behaviors because *'everyone else is doing it.'*

If reportable incidents are seen as a negative rather than an opportunity to learn and manage risk effectively, don't be surprised if accidents, incidents and near-misses, especially those involving violations, aren't reported.

As there is no real quality control in diver training that ensures what is in the standards is taught in every course by instructors across the globe, then drift is likely. Violations are a normal outcome of drift.

This lack of adherence to standards also applies to graduates of training courses. How do you maintain standards and reduce risk-seeking behavior in the real world when effective debriefs and defined standards are missing?

Finally, optimizing behaviors for organizational gain, which might include violations, should be seen as a positive way of improving the system for the local environment. However, it requires an understanding of the factors present.

Drift is normal, but understanding why the drift has happened and modifying processes accordingly in a proactive and informed manner is a good thing. It is normally known as innovation. Enforcing rules for the sake of them, without understanding the unintended consequences, can lead to safety and performance being compromised.

Summary

Solving complex problems with simple solutions never works. Divers are part of a complex system of human interactions with other divers, with organizations, with equipment, and with the environment. You can't write rules for complex environments, especially when you don't have an effective feedback mechanism so that lessons can be learned without fear of litigation.

So, before you look at violations or at-risk behaviors following an accident, incident or near-miss, consider the rule itself and the person involved and their peer-group. Finally, look at the situational or organizational factors present.

As I have written numerous times, divers don't get up in the morning and decide "Today is a good day to die." As such, whatever they were doing at the time will have made sense to them, even if that meant breaking the rules…whatever 'rules' mean in the context of a leisure activity with an inherent risk of death and a lack of supervision and quality control.

What now?

The Human Diver provides globally-unique training which encourages a change in perspective to look at high performance in divers and dive teams by applying knowledge, skills, and materials from high-risk domains such as military aviation to recreational and technical diving.

These programs are delivered via eLearning, webinar and face-to-face classroom-based sessions. They have gained praise from some of the world's top divers. You can find out more about how to improve your performance, and safety as a consequence, by following this link www.thehumandiver.com. Apply Human Factors. Master the Dive.