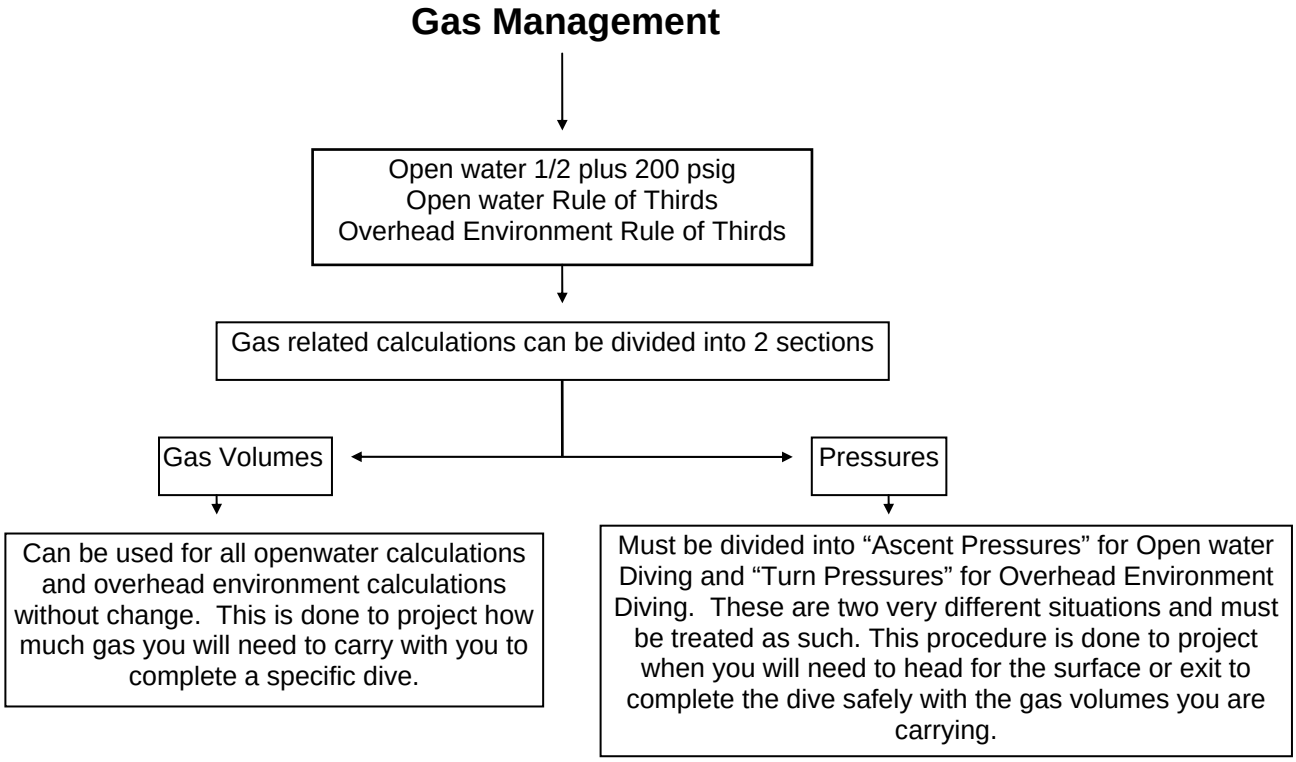
Gas Management

Gas Management Procedures for Open Water Diving

The whole concept of gas management can be explained in chart form.



*This section only deals with finding **Open Water Ascent Pressures**.*
For detailed information on the overhead environment rule of thirds, please refer to an approved Overhead Environment Instructional Manual, Cave Diving Manual or Wreck Diving Manual.

If this program is being taught in conjunction with an Overhead Environment, Cave or Wreck program, please refer to the applicable manual(s). These procedures ARE NOT to be used in an Overhead Environment of any kind. To do so puts you and your buddy at risk of serious injury or death.

Student Notes

Applications of Gas Management Procedures For Openwater Diving

Modifications to all gas management procedures are due whenever

- Current patterns change
- Other Environmental Considerations

Gas management requires functioning consistently, you must always maintain

- Normal Swim Pace
- Normal Breathing Rate

Gas Management must be planned through the use of

- Matched Gas supplies
- Gas volume must be based on the diver with the highest RMV and Lowest Volumes

Student Notes

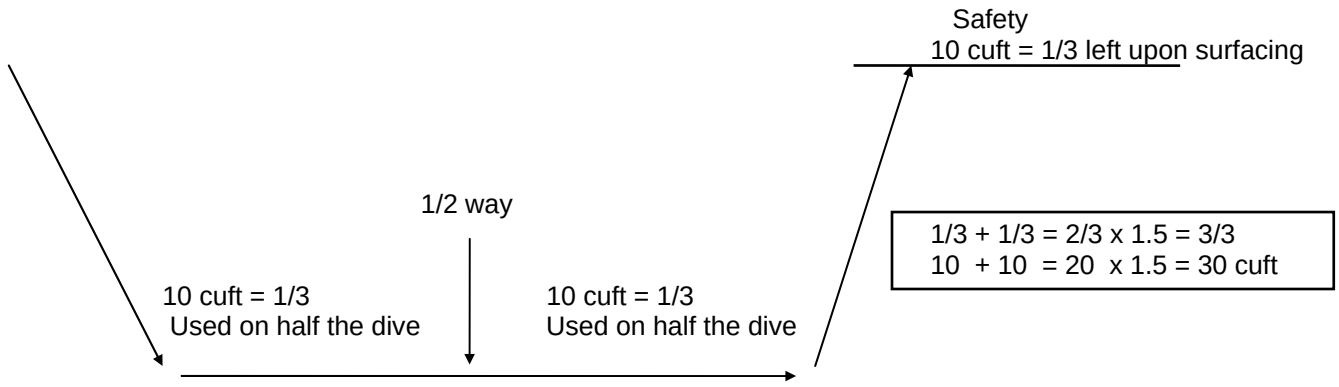
Gas Management Procedures for Openwater Diving Rule of Thirds

For use in

- openwater
- below 130 FSW
- in decompression situations
- anytime there is a need for a greater margin of safety

The openwater environment utilizes the rule of thirds to predict the gas volumes needed by calculating the total gas to be used on a dive and then multiplying this number by 1.5 to arrive on the surface or at your 1st stop with 1/3 of your gas supply left in your tanks.

EXAMPLE



This example shows the total dive to the first stop (or the surface) will take 20 cuft of gas. If we assume that the gas used is 2/3rd s of the total gas supply then we must multiply the gas supply by 1.5 to add the needed third.

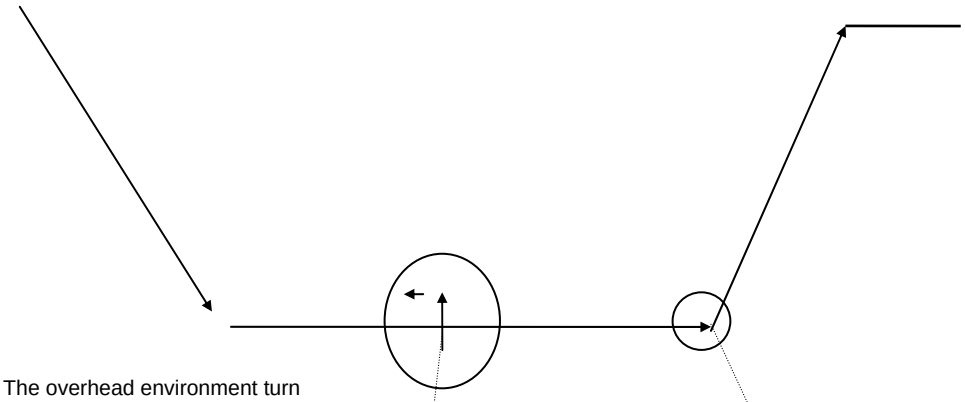
Student Notes

Gas Management Procedures for Openwater Diving

With the advent of deep open water diving a new rule and set of charts had to be developed to more realistically represent the open water divers gas management planning problems and help predict a **Minimum Ascent Pressure or MAP.** The openwater rule of thirds concept converts the dive planning information into a true and RMV adjusted MAP.

In an open water environment, the diver has the ability to continue in any direction and commit an immediate ascent to the stop depth or surface, should the need arise. The MAP is the absolute minimum psig a diver can use before the need to ascend, it is always recommended that you are more conservative. Any ascent committed before the diver reaches the calculated MAP is considered more conservative.

For this reason, a diver in openwater needs a reference point as to when they should leave the bottom to arrive at the surface or 1st stop depth (regardless of the stop depth) with 1/3rd of the gas supply left in their cylinders. The diver needs a MAP.



The overhead environment turn pressure has no application in open water environments as it signals the point where the dive has to be turned and the diver must exit in the same direction as they came into the dive.

The openwater diver does not need to turn the dive so the turn pressure only signals that they used 1/3rd of their gas supply. It gives no reference as to when an ascent must begin.

The ascent pressure is what a diver in open water needs to know to complete the dive safely.

Student Notes

Gas Management Procedures For Openwater Diving

This gas management system is relatively simple to use and understand. The MAP system was specifically designed after the original IANTD overhead environment gas management procedures as published by Tom Mount, President IANTD Inc., in the IANTD Deep Air and Advanced Deep Air Manuals. By maintaining a standard of presentation in the gas management procedures it should remain easier to go back and forth between openwater and overhead environment rule of thirds. There are several step to planning your gas management for a dive, they are as follows;

1. Find your personal SAC
2. Convert your SAC to RMV
3. Match gas supplies between divers with different SAC rates - Surface Ratio Factor - SRF
4. Pick the Dive Profile
5. Projecting the Gas Volumes for the dive - Gas Volume Projection - GVP
6. Finding the minimum ascent pressure - MAP

Let's look at them individually.

1. Calculating SAC - The 1st step is to calculate your Surface Air Consumption (SAC).

Formula
SAC = AC / (ATA x Time)

Reason
A diver must know their SAC to accurately perform any gas management procedures.

Example - To find Sac, swim at 30 FSW for 10 minutes and record how much gas (in psig) used. For this example the diver uses 300 psig.
SAC = AC / (ATA x Time)
SAC = 300 / (1.90 x 10)
SAC = 300 / 19
SAC = 15.79 psig per minute used on the surface
This means the diver would breathe the equivalent of 15.79 psig per minute on the surface. PSIG is the most important starting point so volume is not referenced yet.

2. Calculating RMV - The next step is to know the divers RMV in cuft.

Formula
RMV = SAC / (Tank Pressure / Tank Volume)

Chart
IANTD Gas Management Chart - GM-9 Standard Measurement Version
GM-10 Metric Version

Reason
This calculation will recalculate the SAC into a volume of gas used per minute, adjusted for the size of tanks being used.

Example - To find the divers RMV let's say they (from above) are using a single 80 cuft tank for the dive. Fill in the formula below.
RMV = SAC / (Cylinder Working Pressure/Cylinder Working Volume)
RMV = 15.79 / (3000/80)
RMV = 15.79 / 37.50
RMV = .42 cuft per minute
This means that this diver will breath .42 cuft per minute from this tank on the surface. This number will change depending on the size of the tank because 1 psig in a 30 cuft tank is not the same as 1 psig in an 80 cuft tank.

Special Rule
The RMV should be divided by two if breathing off of twin tanks manifolded together. Meaning, if you RMV is .42 cuft/min. on a single 80 cuft tank, then it would be .21 cuft/min. on twin 80's.

Gas Management Procedures For Openwater Diving

3. Calculate the Teams SRF - The next step is to match the gases between you and your buddy.

Chart

IANTD Gas Management Chart - GM-1 Standard Measurement Version
GM-2 Metric Version Chart

Reason

The SRF Chart modifies the rule of thirds to represent true turn or ascent pressures for divers with different SAC rates. If you have a higher SAC rate than your buddy, the rule of 1/3rds works fine. If your buddy has a higher SAC than you, this would not allow enough gas to finish the dive based on the basic rule of 1/3rds.

Example

See the chart for reference and examples.

Special Rule

Find the buddy with the highest RMV across the top of the chart. If the exact RMV is not there, round up. Find the buddy with the lowest RMV across the left side of the chart. If the exact number is not there, round down.

4. Picking the Dive Profile - Once the SAC and RMV have been calculated and the SRF has been found, the next step is to pick the dive profile from the appropriate dive tables. This will vary depending on certification level.

Student Notes

Gas Management Procedures For Openwater Diving

5. Projecting Gas Volumes for the Dive (GVP-Gas Volume Projection)

Once SAC and RMV are calculated and the appropriate dive table have been picked, it is time to calculate the volume of gas needed for the dive. This can easily be completed through the following steps and chart.

Step by Step

1. Fill in the depth and times from the chosen profile in the columns provided.
2. Fill in the ATA (D/33+1) column.
3. Fill in the RMV at Depth (RMVD) column by multiplying RMV x ATA. This will tell how much gas will be breath at depth based on the RMV at the surface.
4. Multiply RMVD x minutes for each depth to get the gas consumed at each depth and time.
5. Add up each gas supply in the space provided on the bottom.
7. Follow the multiplication rules on the chart to get volumes needed to carry on the dive.

Example

A diver plans a dive to 160 FSW for 30 minutes with an RMV of .21 cuft/min. The dive profile is taken from the IANTD 21% table. The diver is switching to 50% Nitrox at 30 FSW to increase the safety factor. Fill in the GVP chart to find the gas volume needed for this dive.

Special Rule

If calculating bottom mix by the rule of 1/3rds, the diver should carry the usable volume x 1.5. If calculating decompression mixes, the diver should carry usable volume + 1/3rd.

THIS IS YOUR GVP CHART

RMV .21						
Mix	**Depth**	**ATA**	**Time**	**RMVD**	**21%**	**50%**
21%	160	5.48	30	1.15	34.50	NA
21%	50	2.51	02	0.53	01.06	NA
21%	40	2.21	03	0.46	01.38	NA
50%	30	1.90	06	0.40	NA	02.40
50%	20	1.61	13	0.39	NA	05.07
50%	10	1.30	28	0.27	NA	07.56
Total 21% used on the dive					36.94 cuft	
Total 50% used on the dive						15.03
Total 21% the diver needs to carry						36.94 x 1.5 = 55.41 cuft
Total 50% the diver needs to carry						15.03 + 1/3rd = 20.04 cuft

This chart can be adjusted to any profile and any number of mixes.

Gas Management Procedures For Openwater Diving

The next step is to calculate MINIMUM ASCENT PRESSURE or MAP, needed to arrive at the surface or 1st stop depth with a minimum of 1/3rd of the gas supply left in the tank(s).

6. Calculating MAP

Step by Step
Follow all of the steps below and record your answers into the MAP chart on the following page.

1. **Record your SAC at the top of your MAP. Chart (GM-9)**
   Find your tank size at the top of the page and go down the chart until you find your RMV. Follow that column to the left until you find your SAC.

2. **Record your Sac at depth or SACD on your MAP. Chart (OW-1)**
   Find your SAC on the far left and cross-reference it with the depth of your dive across the top. This intersecting number is your SAC at depth or SACD.

3. **Record your ascent time to surface or 1st stop on your MAP. Chart (OW-2)**
   Find your depth on the far left side of the chart and cross reference the depth you are ascending to across the top of the chart. This number is the time in minutes it should take you to ascend to that depth at a rate not to exceed of 30 fpm.

4. **Record your openwater SRF on your MAP. Chart (GM-1)**
   Find the diver with the lowest RMV's corresponding RMV on the far left side of the chart. If the exact number is not found round down. Find the diver with the highest RMV's corresponding RMV across the top of the chart. If the exact number is not found round up.

5. **Record the minimum psig you will need at the surface or 1st stop. Chart (OW-3)**
   Find your SRF across the top of this chart. Find your existing tank pressure along the far left side of the chart. This intersecting number represents the total pisg you will need left in your tank at your stop depth to have 1/3 of your gas supply remaining.

6. **Record your psig needed for ascent. Chart (OW-4)**
   If necessary, refer to the IANTD Openwater Gas Management Find your SACD that was previously recorded down the far left side of the charts and the number of minutes it will take you to ascend to your stop depth across the top of the chart. The intersecting number represents the psig you will use on the ascent from depth.

7. **Refer to your MAP. Next Page**
   Add your answer from step # 5 to the answer from step # 6. This number represents the MINIMUM ASCENT PRESSURE needed to leave the bottom and arrive at your stop depth with 1/3rd of your gas supply remaining.

The following steps are to be completed only after you have confirmed that you are carrying enough gas for the dive. Your SAC and RMV calculations must be accurate to make this or any other gas management procedure work properly and safely. Your life depends on it.

"EVEN IF YOU PLAN YOUR DIVE AND DIVE YOUR PLAN....
YOU STILL NEED A MAP !!"

Erika-Leigh Haley

Gas Management Procedures For Openwater Diving

Example
On a dive to 200 FSW a diver has a SAC of 20 psig/min. The diver is wearing twin 80 cuft tanks pressurized to 3000 psig. The SRF = .68. The dive calls for 200 FSW for 20 minutes and your 1st decompression stop will be at 50 FSW. What's the MAP for this dive ?

THIS IS YOUR MAP CHART

Step #	Chart #	Name	Answer
1.	GM-9	SAC	20 psig/min.
2.	OW-1	SACD	141.21 psig/min.
3.	OW-2	Ascent Time	5 minutes
4.	GM-1	SRF	.68
5.	OW-3	Min. psig	1020 psig
6.	OW-4	Ascent psig	725 psig
7.	**MAP**	**Minimum Ascent Pressure**	**1725 psig**

Answer
To arrive at 50 FSW with 1/3rd of the gas supply left, this diver must leave the maximum depth by the time their pressure gauge reads 1725.

A good rule of thumb would be to round this MAP to 1800 psig or higher.

"IT'S EASIER TO DIVE YOUR PLAN...
IF YOU FOLLOW A MAP !"
Reg Creighton

Gas Management Procedures For Openwater Diving

Gas Management Summary

To properly plan gas management you must;

1. Find your personal SAC
2. Convert your SAC to RMV
3. Match gas supplies between divers with different SAC rates - Surface Ratio Factor - SRF
4. Pick the Dive Profile
5. Projecting the Gas Volumes for the dive - Gas Volume Projection - GVP
6. Finding the minimum ascent pressure - MAP

It is always a good idea to be more conservative.