

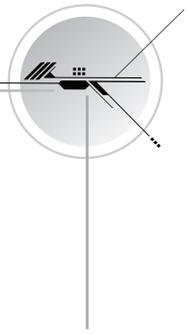
Other Delivery Content, Tec 40-5

Study assignment: Tec 40 Handout 5

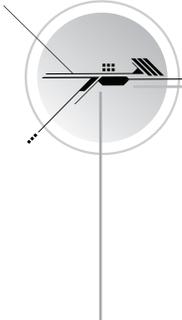
Learning Objectives

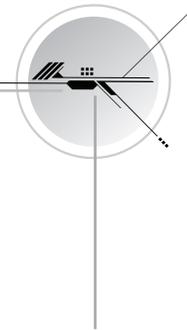
1. *How do you use desk top decompression software to plan a decompression dive based on a single gas, with no more than 10 minutes of decompression and a maximum depth of 40 metres/130 feet?*
 2. *How do you use decompression software to determine your gas supply requirements?*
 3. *What is the minimum reserve gas you should have on a technical dive?*
 4. *How do you set your dive computer to follow the plan you made with your decompression software?*
 5. *How does your team stay together when using dive computers to provide decompression information?*
 6. *What limits tell you it is time to end your dive?*
 7. *How do you calculate turn pressure?*
 8. *How do you account for your oxygen exposure when using a gas with a higher oxygen content than you set your dive computer for?*
 9. *What do you do if your desk top decompression software and dive computer differ significantly in their decompression information, or if your gas requirement calculations appear to be off?*
- A. Starting with Tec 40 Practical Application Two, you'll begin planning decompression dives using desk top decompression software.
1. Your dive planning will continue throughout the course and be the basis for simulated and actual decompression dives you make.
 2. The methods you learn also form the foundation for all your subsequent technical dive planning. However, gas and decompression planning becomes more complex as you go deeper and have longer decompression.
- B. You will follow these basic steps:
- [Note: Your instructor will take you through this, step by step, during Tec 40 Practical Application Two, followed by you and your team mates planning a dive.]
1. Launch the desk top decompression program (may be iPhone or PDA based as long as it provides decompression and gas supply calculations, as well as the ability to choose different gases).

2. Set the dive characteristics and presets.
 - a. Select metric or imperial, open circuit (not closed circuit rebreather).
 - b. Working and decompression SAC rates
 - You will determine your working (bottom) SAC rate during Tec 40 Practical Application Two based on the data you gathered during Tec 40 Training Dive One.
 - You will gather decompression SAC rate data during Tec 40 Training Dive Two. In the meantime, use $\frac{2}{3}$ thirds your working rate.
 - Your program may refer to SAC as RMV.
 - c. Select the single gas you want to use for decompression calculations
 - You will probably use an EANx blend for bottom gas.
 - Use the Maximum Depths tables in the *Tec Deep Diver Manual* to find the highest oxygen percentage for the EANx to your planned depth (PO₂ 1.4)
 - Set the program for the EANx blend you will use, or for one with lower oxygen. At the Tec 40 level, it is simplest to set for air most of the time (21%).
 - You will probably use another EANx with higher oxygen for decompression. Do not set the program for this gas at this time.
3. Enter your planned depth and time into the program.
 - a. Have the computer calculate your decompression. If it is longer than 10 minutes, enter a shorter time, a shallower depth or both.
 - Remember, as a Tec 40 diver, your limits are 10 minutes total decompression time and 40 metres/130 feet maximum depth.
 - For simplicity, your dives will be planned as though the entire dive will be made at the deepest depth. At higher training levels, however, you will learn to add planned depth changes.
 - b. Enter depths/times until the total decompression time required is 10 minutes or less.



4. Use the program to determine your gas requirements based on your SAC rates, for the planned dives.
 - a. Some programs do this each time they calculate decompression.
 - b. Most programs will show you the gas requirements before and after calculating your reserve.
 - c. In technical diving, the standard minimum reserve is 33 percent (rule of thirds), meaning that one third of all your gas is for emergencies only. That is, the minimum amount of gas you should have on a dive 1.5 times the amount predicted for the dive and the decompression, based on your bottom and decompression SAC rates.
 - d. If your program doesn't determine reserve, simply multiply the predicted gas requirements by 1.5 to get the minimum gas volume you should have with you on your dive.
 - If you need a pony bottle or a decompression cylinder to meet the required minimum volume, it should be at least 1/3 of your total gas supply.
 - Note: At higher tec levels (Tec 45 and up), you will calculate individual gas blends independently and have to have 1.5 times the predicted requirements for each individual gas. Planning your decompression based on a single gas at the Tec 40 level simplifies this.
 - e. If the minimum gas volume is greater than the capacity of the cylinder(s) you have will available, then plan a shorter/shallower dive until the gas requirements (including reserve) are within the available capacity.
 - f. Because divers have differing SAC rates, each diver on the team calculates gas requirements for the team's planned dive.
 - The *team* works together with the program until arriving at a depth and time that meets the gas supply requirements for everyone.
 - A common strategy is to plan the dive based on the highest SAC rates (bottom and deco), with all divers carrying the predicted amount of gas (including reserve). This is acceptable, because it simply adds reserve for divers with lower SAC rates.

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- g. After you have a final decompression schedule with gas requirements that work for the team, print out the decompression schedule and gas requirements for use at the dive site.
- If using only a single computer, print out backup tables to laminate (or list them on a slate) and use with a timing device and depth gauge in the event of computer failure. It is recommended that you print schedules for your planned depth and time, as well as plus and minus five minutes and plus and minus 3 metres/10 feet (nine schedules total).
5. During equipment setup for the dive, set your dive computer(s) for the EANx blend or air that you used in the decompression software.
- a. Your *actual* EANx blend may have a higher oxygen content, provided you don't exceed a PO_2 of 1.4 at your deepest depth.
 - b. Your decompression cylinder may have EANx50 (or a blend with less oxygen). Do not decompress with it at a depth where the PO_2 exceeds 1.6.
 - c. These gases with higher oxygen content simply make your decompression more conservative.
 - d. During the dive, you and your team mates may have slightly different decompression schedules due to slight variances in your depths, as well as differences in your dive computer's decompression models.
 - To stay together, the team stays at each stop until all computers clear all divers to ascend to the next stop or surface.
 - If using tables (back up situation), team stays at each stop until all computers clear all divers to ascend, or for the table stop time, whichever is longest.
6. Limits that end the dive.
- a. In technical diving, your dive ends when anyone on your dive team reaches **any** of the following, **whichever comes first**:
 - you reach the planned bottom time (what you used in the decompression software)
 - your or a team mate's dive computer shows 10 minutes decompression time required (or less if the planned decompression was less)



- **It is important to turn the dive with the planned decompression time showing, even if the bottom time is less than planned and the required decompression is still less than 10 minutes, because your decompression gas volume requirement is based on the *planned* decompression time.**

- you or a team mate reaches *turn pressure* on your gas supply
7. Turn pressure is the reading on your SPG that indicates it is time to head up. It is calculated based on the cylinder pressure of the gas volume your software predicts you'll use on the bottom. Knowing your turn pressure and having it written on a slate assures that you head up with the gas for decompression and reserve intact.
- a. Almost all software will tell you the required gas for all individual gases, but many do not tell you how much you use on the bottom, or calculate turn pressure.
 - b. To determine your turn pressure, you may therefore have to do so with a calculator and the tables in the *Tec Deep Diver Manual*.
 - c. You will use turn pressure formulas, as well as what you already learned about SAC and actual gas supplies in Tec 40 Knowledge Development One.
 - Note: For simplicity, treat your descent as time on the bottom. This gives you a slightly higher reserve.
 - d. Formulas:
 - Metric: Turn pressure = start pressure – (bottom volume ÷ cylinder capacity)
 - Imperial: Turn pressure = starting pressure – (bottom volume ÷ baseline)
 - e. Examples

Metric example:

Your working SAC rate is 19 litres per minute. You plan a dive to 40 metres for 10 minutes. Your decompression software shows that using an 11 litre cylinder, working pressure 205 bar, and a 9 litre deco cylinder will provide the gas volume you need. By what pressure should you start your ascent?

First, find your bottom volume.

$$\text{Bottom volume} = \text{minutes} \times \text{SAC} \times \text{conversion factor}$$

$$\text{Bottom volume} = 10 \times 19 \times 5.2$$

$$\text{Bottom volume} = 988 \text{ litres}$$

Assuming your 11 litre cylinder is full (205 bar), then:

$$\text{Turn pressure} = 205 - (988 \div 11)$$

$$\text{Turn pressure} = 115 \text{ bar}$$

To manage your gas appropriately, you should begin ascending when or before your SPG reaches 115 bar.

Imperial example.

Your working SAC rate is .8 cf per minute. You plan a dive to 130 feet for 10 minutes. Your decompression software shows that using an 80 cubic foot cylinder, working pressure 3000 psi, and a 65 cubic foot deco cylinder will provide the gas volume you need. By what pressure should you start your ascent?

First, find your bottom volume.

$$\text{Bottom volume} = \text{minutes} \times \text{SAC} \times \text{conversion factor}$$

$$\text{Bottom volume} = 10 \times .8 \times 4.9$$

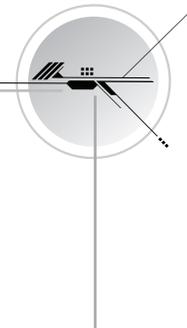
$$\text{Bottom volume} = 39.2 \text{ cubic feet}$$

Next, find the baseline for an 80 cubic foot cylinder. Recall that to get the baseline, you divide the working capacity by the working pressure

$$\text{Baseline} = \text{cap} \div \text{working pressure}$$

$$\text{Baseline} = 80 \div 3000$$

$$\text{Baseline} = .0267$$



Assuming your 80 cubic foot cylinder is full (3000 psi), then:

$$\text{Turn pressure} = 3000 - (39.2 \div .0257)$$

$$\text{Turn pressure} = 1474 \text{ psi.}$$

To manage your gas appropriately, you should begin ascending when or before your SPG reaches 1474 psi.

- f. Note that in both examples that your deco cylinder is required to meet the required reserve (rule of thirds).

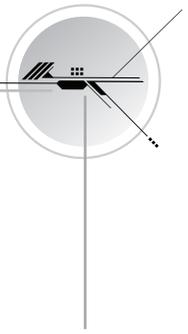
C. Oxygen exposure calculations

1. If your dive computer was set for air or EANx with less oxygen than your actual bottom gas and/or you switched to a higher oxygen decompression gas for conservatism, you have to account for your oxygen exposure after the dive, because your dive computer didn't know how much oxygen you actually had in your cylinder(s).
2. After the dive, use desktop software and enter the dive as you actually made it – actual depths, times and gases used. Record your OTUs and CNS clock for planning subsequent dives.

D. Repetitive dives

1. Plan repetitive dives as you did the first dive, but recall that you must enter the first dive data and your surface interval so the program can account for residual nitrogen.
2. When planning a repetitive dive, enter the actual dive as made. You may also use the previous dive as planned if it yields a more conservative repetitive dive plan.
3. If OTUs or CNS could approach their maximums – unlikely within Tec 40 limits, but possible if you make several repetitive dives – after planning your dive based on a single gas, enter the planned depths, times and stops based on the actual gas blends to make sure you will remain within oxygen limits.

- E. Making software line up with your dive computer
1. After a few decompression dives, you may find that your decompression software is more conservative than your dive computer, or vice versa.
 - a. Be sure your backup computer and/or your team mate's computers are similar to your computer to rule out a problem with your computer.
 2. If you don't spend the majority of the time at the deepest depth, your dive computer would be expected to be less conservative than your software, because it calculates the slower nitrogen absorption. Don't make any adjustments on this account.
 3. If you do spend the majority of the time near the deepest depth, there may be some difference in the required stops and some variation in the total decompression time due to minor differences in the decompression models. This is normal.
 4. If there is a large difference between your decompression software and your dive computers (enough to substantially throw off gas supply calculations etc.), contact the software author and/or the dive computer manufacturer. You can adjust safety factors above the default settings to make software more conservative, but do not make it less conservative unless advised to do so by the software manufacturer.
 5. Assuming no unforeseen emergencies, you should surface from a dive with your reserve gas supply intact. If you have substantially more or less gas:
 - a. First, confirm your working and decompression SAC rates. Adjust your SAC rates in the software if necessary.
 - b. If your SAC rates are accurate and you're coming up with a bit less gas than you should, it is typically that your software predicts less decompression than does your computer.
 - c. Check your decompression software setting and adjust it so it is more conservative and predicts a bit longer decompression.
 - d. If the decompression seems to be in line (close match between your dive computer and the software), it may be how the software calculates gas use. Increase your SAC rate setting even if that makes it high compared to your calculations.
 - e. Do not adjust anything if you have too much gas, unless the surplus is extreme. Too much gas is seldom a problem.

**Exercise, Other Delivery Content, Tec 40-5**

1. At the Tec 40 level, the recommendation is that you use EANx for your bottom gas and set your decompression software dive
 - a. for the gas you're using.
 - b. for an EANx blend with more oxygen.
 - c. for at least two different gases.
 - d. for air or an EANx blend with less oxygen.
2. To determine your gas supply requirements, you must enter your _____ into the software.
 - a. decompression profile
 - b. SAC rates
 - c. bottom gas
 - d. dive computer model
3. The minimum gas reserve you should plan for on a technical dive is _____ of your total gas supply.
 - a. a quarter
 - b. a third
 - c. half
 - d. two thirds
4. At the Tec 40 level, you set your dive computer to follow the plan you made with your decompression software by setting it for the EANx blend you used for your decompression planning with the software.
 - True
 - False
5. When using computers to provide decompression information, the team stays together. All divers stay at each stop until all computers clear all divers to ascend to the next stop.
 - True
 - False
6. When you or a team mate reaches any of the following, you should begin your ascent (choose all that apply):
 - a. your planned bottom time
 - b. a dive computer shows 10 minutes decompression required
 - c. you have a decompression stop at 18 metres/60 feet
 - d. turn pressure on your SPG

7. You calculate turn pressure by determining how much cylinder pressure you would use for the volume software predicts you will consume on the bottom.

- True
- False

8. To account for your oxygen exposure when using a gas with a higher oxygen content than you set your dive computer for

- a. you needn't do anything because the difference is negligible.
- b. you need to dive with a third and fourth dive computer set to the actual content.
- c. you enter the actual dive with the actual gases into your software.
- d. All of the above.

9. If your gas requirement calculations appear to be off, your first step is to confirm your working and decompression SAC rates.

- True
- False

How did you do?

1. d. 2. b. 3. b. 4. True. 5. True. 6. a, b, d. 7. True. 8. d. 9. True