

Advanced Scuba Diver



Buoyancy and Trim



Navigation



Deep Diving

SCUBA

Courses & Publications

Advanced Scuba Diver
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Introduction

The Advanced Scuba Diver course is designed as a continuing education program for autonomous divers. The

Describe the intended scope of the Advanced Scuba Diver course.



course is intended to prepare Open Water Scuba Divers for expanding the parameters of the dives in which they can participate. The Advanced Scuba Diver programme is the second autonomous level. Training is not intended (and could not be) to train divers for all circumstances. The limitation that an introduction is required for all dives in circumstances that were not yet encountered in training remains in place.

The course is aimed as a preparation to plan and execute dives with a buddy of equal or higher certification to a maximum depth of 30 meters. More important than expanding the maximum depth is the intended preparation to eliminate dependence on physical depth limitations. A key objective of the Advanced Scuba Diver course is to train participants in complete control over their positioning and movement in the water. Those skills will allow access to exiting drop-offs and blue water diving. The preparation is challenging, but worth the effort. It is

likely that completion of the Advanced Scuba Diver course will also increase the feeling of control and comfort for all diving activities. Furthermore, in-

creased control over movement and positioning can substantially reduce air consumption.



The Advanced Scuba Diver course consists of three theory modules (covering the chapters in this book), a pool session and five open water dives. The first dive deals with buoyancy and trim, the second with navigation. The remaining dives are a preparation for participation in deeper dives. Students who opt not to do the last two dives (or cannot participate because of minimum age requirements) are eligible for the Basic Advanced Scuba Diver certification. The minimum age to participate in the last two dives of the course (the only dives in which the depth exceeds 20 meters) is 15. Junior divers (12, 13 or 14 years old), may participate in all other portions of the course. Successful completion of those parts fulfils requirements for Basic Advanced Scuba Diver.

Basic Advanced Scuba divers can participate in an upgrade to achieve Advanced Scuba Diver certification.

Expanding the depth limit and improving control over position and movement in the water requires additional knowledge that was not included in the Open Water Scuba Diver course. However, the quantity of additional theory is minimal and easy to master. The Advanced Scuba Diver course places emphasis on skills. The first part of the course focusses on movement and positioning. Mastery of the skills in this section is a preparation for the next course segments. The second part of the course deals with navigation and the last part with deep diving.

Describe how the intended scope of the Advanced Scuba Diver course affects the course requirements.

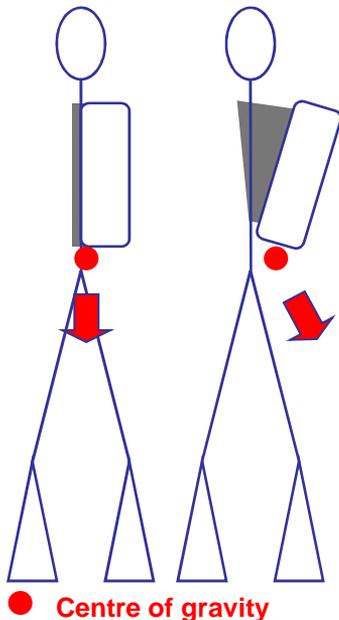
Buoyancy and Trim

As Advanced Scuba Diver or Basic Scuba Diver, you are allowed to dive at sites that lack physical depth restrictions, such as drop-offs. Such dives require that you have complete control over your position in the water. At this level you should also have a high level of mastery over your movement. An increased feeling of control, a reduced air-consumption rate and having no need for support to be stable in the water are the goals of this chapter and the corresponding pool session and dive.



As learned in the Open Water Scuba Diver course, water is about 800 times denser than air. The higher density restricts movement. This is the reason why divers must move slowly and deliberately. A streamlined position in the direction of swimming will reduce drag. Being hydrodynamic involves keeping all equipment close to the body and wearing a BCD of the correct size. In addition to these equipment considerations, divers should pay special attention to the distribution of weight. The distribution of weight is decisive for the “trim” of a diver. “Neutral buoyancy” only affects the depth at which you stay. “Trim” affects your body position while being neutrally buoyant.

Describe the difference between neutral buoyancy and trim and what actions this requires from a diver.



Your equipment must allow you to hover in both a vertical and horizontal (face down) position. This means that the centre of gravity must be more or less in the centre of your body. If the weight of your cylinder is pulling you in a face-up position, then the equipment must be adjusted to allow minimal drag when swimming. If a cylinder is pulling you in a face-up position, it can be that the cylinder is too heavy or has too big a diameter (this is often the case with short 12 litre cylinders). A more common reason is that the BCD is too big. This allows the cylinder to lose contact with your back, which brings the weight of the cylinder too far behind you. A last consideration is the distribution of weights. It may take some time and work to adjust your equipment, but it is worth your while.

The next step with respect to the equipment is to see if you can assume different positions underwater without creating a need to move your arms or legs in order to maintain that position. A dry suit is ideal for this purpose.



The air in the suit will always go to the highest point, which will stabilize you in the position of your choice. In that case you are able to hover horizontally with the head down, head up, on your left, on your right, etc. If the water is too warm for a dry suit, then you should opt for a BCD that has only limited obstructions for the air passing from one location to the other within the bladder.

Assuming a position of your choice in mid-water does not only depend on your equipment, but also on working with your spinal cord and the positioning of your legs. You can train yourself by taking a 2kg weight in your hands and while hovering stretch your arm with the weight in different directions. The idea is to keep your upper body in the same position while changing the direction in which you stretch out the arm with the weight. You do this by compensating with your bodyweight. By moving your spinal cord in the opposite direction, you can keep the centre of gravity in the centre of your body. It will take some work to get the feeling for the use of your spinal cord, but those who use this technique during their dives do it as second nature.

When no movement is needed to maintain your position in the water your air consumption will reduce. Your air consumption will be reduced further when you move slowly when swimming to another location. Swimming at twice the speed will take four times the energy.

In most cases, divers descend without swimming. A neutrally buoyant diver exhales to start a downward movement. On the way down, air must be added to the BCD to maintain an acceptable descent speed and to assure that the diver is neutrally buoyant when approaching the bottom. Failure to add air to the BCD every few me-

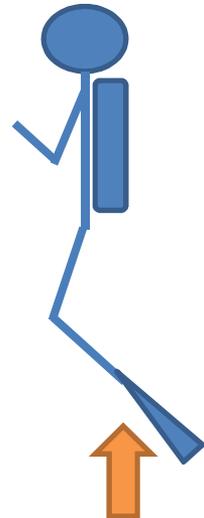
Describe how a diver keeps control over body position while descending.

ters during the descent can cause too fast an approach to the bottom, resulting in stirring up silt and thus ruining the visibility. On deeper dives, especially on dives with a thick wetsuit or a dry suit, failing to add air can cause a dangerous situation. Maintaining neutral buoyancy throughout a descent is a key skill for all participants in deeper dives.

Although the diver is not swimming down, the fins should be used to keep control over body position. The descending diver is moving (downward), hence, maintaining position is not only a matter of trim. Trim only takes “static” forces into account (distribution of weights). When moving, the diver is also affected by dynamic forces. Taking dynamic forces into account during the descent requires positioning the fins (and legs) so that the flow of water aids in “pushing” the diver in the desired position. Because of the weight of the cylinder, there is already an important force to “push” the diver in a face-up position. If the fins of the diver point forward, the water movement affecting the fins would support that change of position.

While descending the diver should bend the legs slightly backward and point the tips of the fins slightly to behind. This position counters the weight of the cylinder and allows the diver to maintain a feet down position without any effort. Only a few descents are needed to get a feeling for the effect of the position of the fins. It will not take long before a diver is able to do small corrections in positioning by slightly moving the position of one or both fins. For an ascent such adjustment is not needed. During an ascent, the fins follow “behind the centre of gravity” and have far less influence on body position.

It is common to teach beginning divers the flutter kick. This is the normal use of fins creating propulsion by moving the fins up and down with stretched legs. The flutter kick is useful because it brings the diver into a (near) horizontal position. Being streamlined allows moving forward in a straight line with minimal effort. Unfortunately, most dives are not meant for moving from “A” to “B” in a straight line. Divers move around at a dive site, changing



Describe how to move efficiently underwater.



direction as they see interesting features of the site to explore. If there is any straight line swimming to do, it is normally only at the beginning and the end of the dive, to move away from the entry point or to go to the exit point.

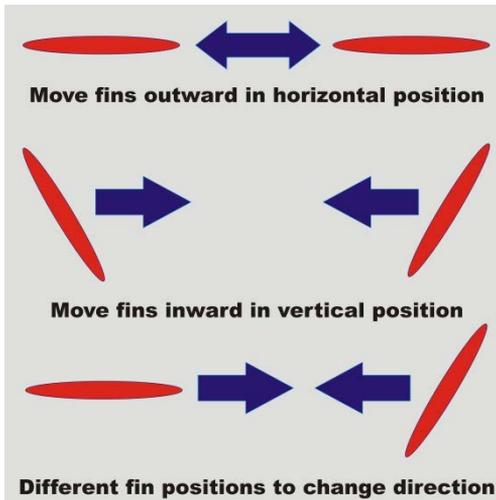
For exploring a site, the flutter kick is not appropriate. It does not lend itself very well for manoeuvring. If you want to move backward or turn in another direction, the flutter kick is at the least useless and probably even a hindrance. The flutter kick does not allow you to move in confined spaces and comes with a high risk of stirring up sediment. Learning how to control positioning and movement requires switching to another type of propulsion. There are many different types of swim strokes available, but the most common for experienced divers is the frog kick.

The frog kick is actually not a single swimming movement. The term frog kick refers to different movements sharing some characteristics. The key characteristic is moving your fins horizontally through the water to bring you in a position to perform a swim stroke. By moving while your fins are perfectly horizontal, they are “cutting” through the water without exerting force. The actual swim stroke is made by moving the blades, generating propulsion. Just to get a feeling for it. Spread your legs with the fins horizontally. Then turn your ankles so that the underside of your fins face each other and move them inward. Trying this simplified technique gives you an idea of the resulting forward thrust.



The above example shows the general idea, but most divers use the frog kick in “double action”, adding stretching the knees to the movement from the hip. While moving the fins to the side (the blades move horizontally through

the water) the diver is bending the knees as well. During the swimming stroke the diver does not only move the fins toward each other, but stretches the knees at the same time. The result is a double action of fins moving backward (resulting in forward thrust) and the water forced out behind between the two fins (also resulting in forward thrust). You could repeat the movement immediately after completing it, but it is common to pause between kicks.



A key advantage of the frog kick over the flutter kick is the increase control over direction. The flutter kick can only be used for swimming in a straight line. The frog kick can be used to change direction by forcing more with one leg than the other, or to turn by performing the same movement with one leg only. With a little experimentation, you will find that there are many variations to the “standard” frog kick, each one of them useful in certain situations. An extremely altered movement

even allows swimming backward. In this case, the actual swimming movement is made with the ankles. Move the fin horizontally inward and then scull outward.

Another advantage of the frog kick is that the bottom is not stirred up. Silting is avoided because the fins do not cause any downward water movement (as is the case with the flutter kick). Moving the legs outward does not result in any substantial movement of water. When making the actual kick, the fins are ideally in a perfect vertical position, but anatomy objects. You can only put your fins in a near vertical position. When forcefully moving the fins inward, water movement will be directed behind (providing propulsion), and upward. Since there is no downward water movement, silting is not an issue.

Once you have found where the heavier parts of the equipment need to be placed to maintain a good trim, you will not want them to shift position. For the cylinder this means that you need a stable BCD of the correct size. Select a BCD that does not allow the cylinder to move (too much) to the left and right. Also pay attention that the BCD has the correct size. Stand upright with a cylinder attached to the BCD and bend backward. The cylinder must stay in contact with your back (especially the upper end of the cylinder).

Describe practical examples of weight distribution for consistent underwater positioning.



Normally integrated weights in the BCD can move a bit. The allowed movement may disturb your trim. For that reason, many divers never put more than 4 kilos in an integrated system (2 kilos on each side). Additional weights needed are then worn on a traditional weight belt. The weights on the belt must be fixed in place. This can either be done by weight stoppers, or by simply folding the belt on top of the weight. If a lot of weight is needed in front, two weights can be placed on top of each other.

Next to the integrated weights and weight belt, there are some additional options. Some BCDs have weight pockets on the back. Aluminium cylinders can have positive buoyancy toward the end of a dive. Weight pockets on the back are meant to avoid the uncomfortable sensation of being pushed forward by a near empty aluminium cylinder. If a BCD is not equipped with such pockets, some divers attach a weight to the strap that holds the cylinder. Weight pockets on the back of the BCD should not be used when diving with a steel cylinder.

Due to positive buoyancy of fins or booties, or the use of certain types of suits can result in the legs of the diver floating up. To compensate for the lack of weight of the legs, some divers wear ankle weights. Ankle weights are especially popular with dry suit divers.

Navigation

Guided divers enjoy the luxury of having a Scuba Guide to bring them to the best dive spots. As an autonomous diver, you have to take care of your navigation yourself. Good navigation skills allow you to make the most of every dive.

You should be able to use the direction you get from other divers about the most exiting spots on a dive site. Another navigation challenge is to plan your dive after having been shown a map of the dive site. In short - navigation skills get you to the best spots without delay and avoid long swims at the end of a dive, just because the dive was mistakenly ended far away from the exit location.





Navigation skills allow divers to make better use of

their time underwater. With good navigation skills, less time will be lost in finding the intended area for the dive, the way back to the shore or the boat. The diver follows the shortest route. When searching, navigation prevents overlapping in the search pattern (or worse leaving parts of the search area out). For an autonomous diver, navigation is as basic as clearing a mask of water. Without navigation, other activities will not work at all (such as search and recovery) or will work with less efficiency (such as photography).

Explain the importance of navigation skills and name the two key types of navigation.

There are two types of navigation: navigation with use of references in the environment (natural navigation) and navigation with use of instruments, referred to as compass navigation. Both serve their own purpose and a diver should be able to use both methods. If you want more precision, you need to dedicate more of your time and attention. As navigation is in most cases just a tool and not the purpose of the dive, the required attention and time should be limited. This means that for navigation you always select a method that will serve the purpose, but allows you to dedicate a maximum of your time and attention to the real reason of the dive (observing underwater life, photography, etc.). Navigation can be as simple as taking a compass bearing back to the beach before starting to explore an area off that beach. Navigation can also be more complex. If you want to relocate a specific underwater feature, more precision will be required.

Natural navigation involves the use of clues with respect to your location and the direction you wish to go. Sound does not help much, as you cannot pinpoint the direction from where sound is coming. If there is a permanent source of sound at the shore line (surf or stones ticking against each other) the volume might give you a clue with

Describe natural navigation skills.

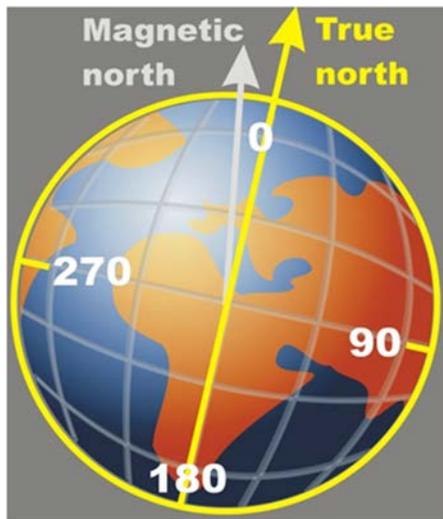
respect to the distance to the shore – if the sound gets louder you are swimming toward the shore, if the volume reduces, you are swimming away from the shore. Another clue would be the angle of the sunlight falling in the water. If your shadow stays in the same position to your right, you are probably swimming in a straight line.

Water movement can be a clue. On many dive locations currents and waves are movements that do not change direction in the duration of a dive. In shallow water, waves project darker and brighter lines on the bottom which run parallel to the coastline and in deeper water most diving locations allow enough visibility to look up and see in which direction the waves are moving. If you are shallow enough to feel the movement from the waves, you could even swim in a straight line from or to the cost with your eyes closed, just by feeling the direction of the water movement. You can also feel a current, or observe its direction by looking at the underwater life. Fish will mostly face the current, plants and soft corals will bend with the current, silt will move with the current, etc.

Sand ripples are caused by waves and are parallel to the shore. In some areas, waves can reach an enormous length and ripples can be expected at the depth corresponding to half the wave length. In these areas, ripples are still a clue at greater depth. In most locations sand ripples are only helpful in shallow water. If you intend to swim back the same way you have come, you look for locations that you would recognize on your way back. In this case you will have to look back after passing such a location, as it might look very different from the other side. On most dives, just paying attention to clues (natural navigation) will give you enough feeling for your direction and distance to navigate with sufficient precision. When more precision is needed, you should switch to compass navigation.

A compass has a needle that points to the magnetic north. The magnetic north is not the same as the geographical north – the line pointing north on a map. The error between the magnetic north and the geographical north is called magnetic declination or variation. How much of an error this is depends on where you are in the world. The error can range from 0 to far more than 10 degrees and as you approach to the North Pole, the variation

Describe the use of an underwater compass.



is so big that a compass becomes useless. Also related to your location on the earth is the magnetic inclination. A compass needle must be “balanced” for the location of where you are. If the needle points slightly upward or downward, it would touch the protective glass cover and due to friction it would then give the wrong direction. Bigger compasses can be “balanced”, but the small diving compasses cannot and need to be made for the location where they are used.

Variation is a factor that only plays a role when using a compass in combination with a map, which is normally not the case in diving. As a diver we can ignore variation. Inclination does not play a role either, but it explains why we cannot use a compass bought in Australia for diving in Austria. The biggest concern for us as a diver is compass deviation. Compass deviation is a local error – other local magnetic fields that influence the compass needle and hinder it to point to the magnetic north. Local magnetic fields can vary strongly from one location to the other and can prevent accurate navigation.

A wreck diver must swim away from a metal wreck before taking a compass bearing and any diver must be aware that a compass cannot be trusted close to large metal structures. Your own cylinder is well “protected” behind your back, but the cylinder of a body swimming at your side might influence the needle of the compass



– the diver using the compass must swim slightly ahead. A big influence on



the compass needle would be a torch used to illuminate it. For this reason compasses for underwater use should have luminous readings that glow for some time after the compass is illuminated with a torch.

Luminous readings are thus one feature of a diving compass. Other features include:

- A flat profile or the possibility to read the compass at the side (a window on the side through which the direction can be read). This is to allow a maximum distance between your eyes and the compass in the direction of movement. The further the compass points in the direction of movement, the more accurate your readings. A high compass that cannot be read from the side would force you to keep it low, which would reduce the distance from your eyes in the direction of movement.
- A ring that can be set for the return bearing. Nitrogen narcosis can cause you to forget simple things as a planned bearing. The ring helps in such a case. Often electronic compasses have a similar function.
- Filled with fluid. First of all the fluid in a compass makes it resistant to pressure, but the more important reason is a restriction on the movement of the needle. A needle in a gaseous space moves a lot and makes it difficult to read the compass. This does not apply to electronic compasses.
- 360° dial. Some compasses only indicate North, East, South and West or have a dial with other units, such as compasses used for artillery. If divers communicate the location of a good dive site, then the directions will be given based on a 360° compass dial and you would therefore want to have the same thing in order to be compatible.



When using a compass to swim in a straight line, you should hold the compass as far as possible in front of you in the direction you are swimming. A compass mounted in a console, or worn on the wrist is not ideal, because in both cases, the distance between the eye and the compass would be restricted. Many divers carry the compass attached to their BCD, to take it in their hand the moment they want to use it. Some even go a step further by mounting the compass on a slate, which allows them to hold the compass even further away.

You should not look at the compass all the time when navigating a straight line. The better way is to take a bearing to a point on the bottom you recognize, swim until you are there and then take a subsequent bearing to the next point. This way you are sure that you are not going off course due to a compass with a “stuck needle” and you are automatically compensating for current. You are navigating from fixed point to fixed point, rather than drifting with the current while swimming.

Having taken the precaution of preventing a stuck needle, compensated for current by swimming from point to point and avoided local magnetic fields, then you must put trust in your compass. You are not a homing pigeon (which means that your natural sense for navigation is probably not developed well enough to carry letters all over the world). Hence, if your feeling of the direction is in conflict with the compass, put trust in your compass.

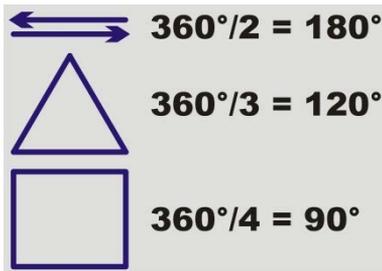
In most cases, compass navigation also requires you to keep track of distance. The most accurate method is obviously the use of a measuring tape or an electronic instrument for measuring distance. If no instruments are available (or if the use of instruments would take too much time and effort), then the next option would be arm spans. Place a finger on the bottom. Hold on to that point while you swim. Just before you have to let go of the point, you place a finger of the other hand on the next point and so on. When using arm spans, you have contact with the bottom, which means that you automatically compensate for current and a sloping bottom (the speed when swimming upward is probably not the same as swimming down a slope).

With other methods, there is no contact with the bottom, so any influences on your swimming speed automatically affect the precision of your measurement of distance. You can consider kick cycles, which are fairly accurate.

Elapsed time or air consumption is less accurate. When using kick cycles, it is helpful to know the average number of cycles you require for a certain distance. The way to find this out is to experiment by swimming along a measured line several times (in both directions). Note the average number of kick cycles required for that distance in your log book for future reference.

When swimming in a straight line, both direction and distance can be misconstrued. When looking for a specific location, such as a small reef, your error could consume more of your dive time than desired. You do not know if you ended up to the right or the left of the reef and if it is ahead of you or behind you. A preventive measure is not only to know the distance and bearing to a reef, but also the depth of the bottom around that reef. This way you can navigate with an “intentional error”. You do this by using the correct bearing, but to start several meters to the right (or left) of the point from which the bearing is taken. You then navigate until you find the depth at which the reef should be. If you don’t hit right on it when finding the depth, you know that the reef is likely to be to your left. You then find it by following the depth line (with your computer close to the bottom) in that direction.

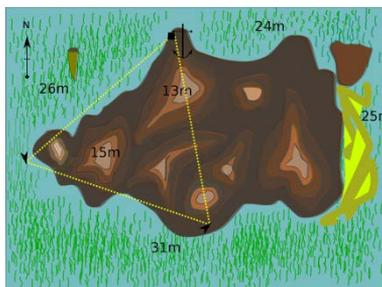
When you want to use your compass to swim a certain pattern, you need to change course one or more times. You do this by adding a certain number of degrees to the current bearing. Should the sum be more than 360 then you will need to deduct 360 to find your new direction. When you wish to swim the other way around, you will need to deduct a certain number of degrees from your current bearing. If in that case you find a negative result, you will need to add 360 to find the correct bearing.



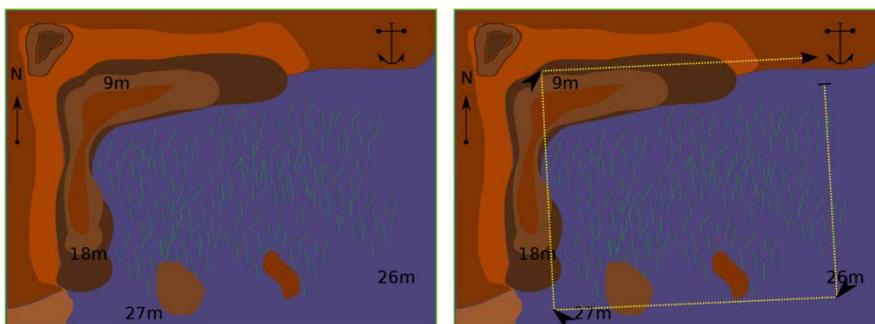
The number of degrees to be added (or deducted) is 360 divided by the number of lengths – going out and back to where you started is two lengths and thus requires you to turn 360° divided by 2 = 180° . A triangle has three lengths and thus requires you to make turns of 360° divided by 3 = 120° and so on.

Most briefings on dive sites include the presentation of a map. Such maps provide bottom contour and signal highlights on the site. It is common to provide a reference indicating which direction is north. Other features include depth lines and an indication where the dive is to start. If you want to take maximum benefit from a dive, you need to simplify the map. You do this by mentally projecting the course of your dive on the map. Imagine a triangle, square or rectangular pattern and see how it fits on the illustration on the map.

Describe how a diver integrates navigation skills with information received in a dive briefing.



The actual dive plan (which you can remember throughout the dive) then becomes something like: after descending the general pattern will be a square. Start at 160° until reaching a depth of 26 meters. Then follow that depth line in an approximate direction of 250° until meeting a steep drop-off. Enjoy some time at the drop-off, moving up to the reef top. Continue the dive from the reef top in a general direction of 340° until reaching a depth of 9 meters. Then turn back to the starting point at a bearing of approximately 70° . When arriving, ascend and do a safety-stop.

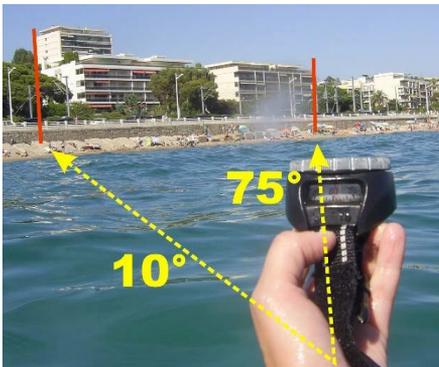


Although the pattern in the previous paragraph makes use of compass bearings, the compass would actually not be used much. The pattern is a square. Making a 90° turn is feasible without actually looking at the compass. For a

simple pattern like the one described here, the compass is used at the start to make sure the dive heads in the right direction. After that the compass serves to verify direction whenever there is a doubt. In the same way, you could project a triangle on the map of the dive site.

You can use a compass to mark the location. Ascend to the surface exactly above the object (this technique will not work on a location with current, but on such a location you do not navigate with a compass anyway).

Describe how to use a compass to fix a location with cross bearings.



At the surface you take a bearing to two locations of which you are sure you will recognize again. The name of this technique is “taking cross bearings”. The closer the angle between the two locations is to 90 degrees, the more accurately you will be able to relocate the object. A smaller or bigger angle between the two bearings will reduce accuracy. It is of benefit if one of the bearings is to the location where you enter and exit the

water. This will allow you to swim on your back to the object (at the surface) in one of the bearings, while verifying the second bearing from time to time – you use the bearing to the entry point to swim in the direction of the object via the shortest route and the second bearing to measure the distance you have to swim.

Deep Diving

The deeper you dive, the more complicating factors start playing a role. Suit compression changes thermal protection and buoyancy, narcotic properties of gases become noticeable, dive time becomes more restricted, lower temperatures influence both the diver and the equipment, and so on. In many cases, deeper dives also require you to ascend and descend directly without following the bottom contour. That implies a need for the ability to do all skills that were learned in the Open Water Scuba Diver course in mid-water. This deep diving theory chapter, combined with the three course dives, is meant to prepare you for the challenges of deeper dives.



At some point, depth becomes a complicating factor for a dive. Such complications can be related to a variation of aspects. Examples include: loss of ambient light due to poor visibility, lower temperatures, substantial suit compression (affecting heat loss and buoyancy), regulator and/or inflator performance, nitrogen narcosis, risk of decompression sickness, mental stress due to doubts about the ability to reach the surface in case of a problem, increased air consumption and other. With so many potential complicating factors, it is not possible to quantify “deep” in an actual depth. What is “deep” on one dive site may be a relaxed dive without any complications on another.

Describe the considerations to qualify a dive as a deep dive.

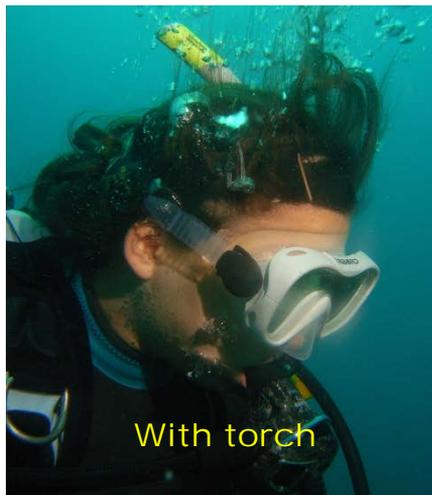
It is common to name any dive to depths greater than 20 meters deep dives, but that approach is a bit too simple. It can very well be that a dive to only 15 meters presents complications that require procedures related to deep diving. It can just as well be that a dive to 24 meters depth presents no complications at all. The dive could be done in a relaxed manner without any need for additional procedures or precautions. To justly qualify a dive as a deep dive, all complicating factors related to depth should be taken into account. If one or more such factors play a role, procedures and precautions should be put in place. That necessity is sufficient to qualify a dive as a deep dive.

Not all interesting dive sites offer good visibility. In some areas you can expect to lose visual contact with the surface at 5 meters depth (or even less) and have to depend on a torch to be able to see in the dark from 10 meters onward. Such lack of visibility can cause mental stress. When performing an emergency swimming ascent in an out of air situation, you have no (or hardly any) reference as to how much further you have to swim before reaching the surface. There is also little information (other than your instruments) to indicate that you are moving toward the surface at all. Such an event requires you to have confidence in your own ability.

Describe how visibility can become a complicating factor.

With limited visibility, you are swimming in a relatively small sphere. You cannot tell where the sphere is located in the broader setting of the dive site.

Any reference to a map of the dive site is not visible. To monitor direction and depth, you largely depend on your instruments. Procedures to maintain direction and to respect depth limits thus require altered procedures. Communication and maintaining contact with your buddy or the group require more frequent attention. Each diver needs to pay more attention to buoyancy adjustments. In poor visibility it is often not clear if you are moving up or down. Divers either depend on their instruments, or must “feel” if their buoyancy needs adjusting. In poor visibility a dive is “deeper” than in good visibility.



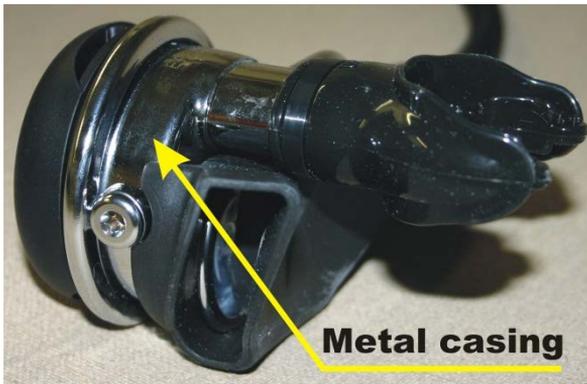
Not only because of “darker” conditions, but also because of loss of colour at depth, most deep divers carry an underwater light. Strong torches with a wide beam are popular for deep dives because they bring out the vivid colours of a larger portion of a reef. However, in bad visibility strong torches may be blinding to the diver. A phenomenon you may know from driving a car through fog in the evening. On sites with limited visibility it may be more appropriate to bring a torch with less light intensity and a narrower beam.

Cold water affects both the diver and the equipment. The diver needs better exposure protection, which in turn comes with more weights. Swimming

Describe how water temperature can become a complicating factor.

will cost more energy which results in a greater risk of overexertion. Regulator freezing becomes an issue. A frozen regulator will free-flow violently and necessitates aborting the dive. The risk of regulator freezing increases with lower temperatures and the higher the flow demanded from the regulator. Since divers breathe denser air at depth, flow increases with depth. The flow also increases when a diver is overexerted – a risk that is higher when wearing a thick suit and the associated additional weights.

To avoid the risk of freezing of the first stage of the regulator, it suffices to have the cylinder filled at a reputable source. Frequent changes of the filter on the compressor assure that the air in the cylinder is completely dry. As long as the air is dry, chances of a first stage freezing while underwater are very limited. Unfortunately this is not the case for the second stage. There is always moisture in a second stage. As a consequence, freezing can only be prevented by maintaining the temperature within the second stage above zero degrees Celsius.



As a gas expands, both pressure and temperature drop. With a high flow and big drop in pressure, the temperature could drop as much as 40° Celsius. A drop in pressure (and temperature) occurs in the first stage and in the second stage. Since there is no water inside the first stage, a

drop in temperature is not a problem. The water that is present in the second stage cannot be allowed to freeze. The water in which we dive will always have a temperature above zero. To maintain an above zero temperature within the second stage, we make use of the warmer surrounding water. This requires the second stage to have good heat conducting properties. Carbon and metal are ideal for that purpose. If plastic is used for making a second stage, it must be equipped with heat conducting features such as metal inserts.



Divers in temperate regions must always take the possibility of regulator freezing into account. A risk that becomes greater with lower temperatures, heavy breathing and increasing depth. As a precaution, many divers in such regions opt for two separate first stages rather than connecting both the primary second stage and the octopus to the same first stage. If a regulator freezes, the cylinder valve connect-

ed to the affected regulator can be closed, allowing the diver a relatively controlled ascent to the surface while breathing from the octopus. If a regulator free-flows and the valve cannot be closed separately, the flow will empty the cylinder in a very short time. During that time so much air is lost via the frozen second stage that the other will likely not function. The diver must make an emergency swimming ascent or use the octopus of another diver.

When descending, dive suits compress, resulting in a need to adjust buoyancy by adding air to the BCD. With thick suits, the loss of buoyancy can be substantial. A rather rapid change in buoyancy imposes requirements on the diver as well as on the equipment. The diver must remain alert and correct buoyancy changes early and often. If the diver fails to adjust buoyancy in time, the inflator mechanism must be quick enough to adjust substantial lack of buoyancy in very little time. Responding quickly to restore neutral buoyancy is particularly important when a dive site does not offer physical limitations to respect maximum depth.

Explain how suit compression can become a complicating factor.

If a diver fails to adjust buoyancy on a relatively shallow dive, the inattention goes unpunished. On a deep dive it is out of the question of delaying buoyancy adjustments until the moment where the diver arrives at the desired depth. The diver must adjust buoyancy every few meters while de-

scending. The frequency (every three meters or every six meters for example) depends on the thickness and type of exposure protection used. Dry suits require special attention. How buoyancy is adjusted depends on the type of dry suit. The correct procedures are part of a dry suit course.

Suit compression also affects thermal isolation. At 30 meters depth, even a 7mm wetsuit is very thin. The thermal protection provided by a wetsuit depends in part on a layer of warm water around the body. That layer stays intact. Loss of suit thickness does affect thermal isolation however. The speed of loss of body heat increases with increasing depth. Neoprene dry suits are affected by the same problem, but tri-laminate dry suits are not. The characteristics of different dry suits are covered in dry suit training.

The air in a cylinder only lasts half as long as at the surface when diving at 10 meters depth. At 30 meters only a quarter of the time (at the surface) is available. The increased air consumption has

Describe how increased air consumption can become a complicating factor.

different consequences. A need for procedures to prevent or deal with out of air situations is the first. For a deep dive an adequate cylinder size should be selected. The use of 12 or 15 litre cylinders is common. For any deeper dive a safety stop should be done. For the eventuality that a diver runs out of air before such a stop is completed, deep divers often place an additional cylinder at the descend line at 5 meters depth. That same cylinder also serves if a longer stop is needed because the no-decompression limit is accidentally exceeded. Some dive boats are equipped with regulators with long hoses that allow the positioning of second stages at 5 metres depth while the cylinder is on the boat. Since cylinders are lighter at the end of the dive, placing some weights at 5 meters may be helpful for a diver who misjudged the loss of weight resulting from emptying the cylinder.

The increased air consumption must also be taken into consideration when selecting a regulator. Both membrane and piston first stages in the “balanced” version offer enough flow to adequately supply air for the respiratory demands of a deep dive. Non-balanced first stages are not suitable for deep dives. The way in which non-balanced first stages are constructed imposes a compromise between breathing comfort and flow. Breathing comfort can only be improved at the cost of adequate flow. A reduced flow

(the diameter of the passages through which the air must pass) cannot supply the respiratory demands in all situation encountered during a deeper dive. Do not use non-balanced first stages for deep diving.

An increased nitrogen presence in the body disturbs the nervous system. Most educational materials indicate that nitrogen narcosis can become a problem starting from a depth of 30 meters, but there are opinions that advocate a shallower depth. Symptoms of narcosis include absent behaviour, difficulty to concentrate, impaired coordination, an inability to perform simple tasks and emotional changes such as euphoria or an increased stress level. The symptoms subside when ascending to a shallower depth where nitrogen narcosis was not previously a problem.

Describe how nitrogen narcosis can become a complicating factor.

The relative narcotic potency of all gases is compared to nitrogen which is represented as "1" (these constants are often quoted)

Neon	0.3 x
Hydrogen	0.6 x
Nitrogen	1 x
Oxygen	1.7 x
Argon	2.3 x
Krypton	7.1 x
Carbon dioxide	20 x

The problems related to nitrogen narcosis can be reduced by replacing some of the nitrogen in the breathing mix with another gas. For avoiding nitrogen narcosis, oxygen (as is done in Nitrox) is not suitable. In the periodic system of elements oxygen and nitrogen are very close to each other. They almost have the same narcotic properties. Oxygen is thus not an option to reduce narcosis. The complications presented by other gases that could be used to replace some of the nitrogen make them unsuitable for recreational diving (technical divers use such gases). Nitrogen narcosis must thus be dealt with, whether breathing air or Nitrox.

To deal with nitrogen narcosis, deep dives should have a simple (easy to remember) and strict dive plan. For both divers it must be clear that deep dives do not allow casual planning as would be acceptable for shallow exploration dives. Deep dives need a clear plan and clear parameters. If reserve cylinders are placed for a safety stop, the ascent must be done at the line. If such precautions were not taken, it must be clear for the buddies when and where the ascent will take place. During the dive, both divers

should pay attention to each other's reaction speed and comprehension of communication. When either one of the buddies has doubts about the effects of nitrogen narcosis an ascent to shallower depth should be initiated.

The deeper you dive, the shorter the allowed dive time will be. Deep dives are typically shorter than shallower exploration dives. The limitations in dive time require divers to check their

Describe how an increased risk of decompression sickness can become a complicating factor.



instruments at short intervals. Both tables and dive computers require adherence to additional rules that are to be respected in addition to the allowed depth/time combinations. Several of these rules are specifically meant for deep dives.

When engaging in deep diving, be sure to make the deepest dive of the day first and then progress to shallower depths in subsequent dives. Although it is not yet an issue at this level of certification, you should already be aware that repetitive dives are never to exceed a maximum depth of 30 metres. For deep dives it is always recommended to make a safety stop of 3 minutes at the depth of 5 metres. Dive computers may require additional stops at greater depths. If your computer indicates a need for such a deep stop, you should follow the instructions of the computer.

You always start a deep dive by first going to the deepest point of the dive. From there on, you progress to a shallower depth. Once you have reduced your depth, do not go back down. Dives in which a diver returns to greater depth, after having progressed to a shallower depth, are called yo-yo dives. Yo-yo dives are known for an increased risk of decompression sickness and should be avoided even if the computer does not provide an indication that you are not allowed to re-descend. Another step toward preventing decompression sickness is to control ascent speed. Slower ascents involve less risk.

In the previous sections, various complicating factors for deeper dives have been addressed. Divers must cope with these complications when participating

in deep dives. How well a diver can cope depends on various factors. Susceptibility to stress, diving experience, physical fitness, experience with local diving circumstances and so on. Such factors are personal. Because personal factors play a role, depth limits are not the same for all.

Explain what a personal depth limit is.

For Advanced Scuba Divers, a maximum depth of 30 metres is in place. That depth is not randomly selected. Beyond 30 meters, additional equipment requirements, increased narcosis and other factors, require more training than is offered in this course. Such training is offered in deep diver courses. The Advanced Scuba Diver program is not designed to prepare for deep dives under any circumstances. Diving environments present great variations and only diving in those circumstances can prepare you to deal with local challenges. The rule of always obtaining an introduction to local diving conditions remains in place at this level (and for all future levels).

Combining personal factors with local diving circumstances will result in a maximum depth at which you feel comfortable. This may not be the same as your buddies maximum and it will vary from one location to another. It is important to establish a maximum and not to participate in dives that go beyond your personal limit – the limit with which you feel comfortable.

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