NASE WORLDWIDE

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# Advanced Open Water Diver

# NASE Advanced Open Water Diver Manual

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# Introduction

Welcome to the NASE Advanced Open Water Diver course — an Advanced course unlike any other. In this program, we'll cover a number of topics, including:

- Core Skills Review and Assessment
- Advanced Dive Planning
- Underwater Navigation
- Deeper Diving

Throughout this course, you'll see us use the terms *Advanced Open Water course* and *Advanced course* interchangeably. It's important to keep in mind, however, that while this course can increase your overall level of training and experience, it won't necessarily make you an "advanced" diver. That comes from gaining significantly more experience, and from building on your base of knowledge and skills whenever possible. This course provides a good foundation and a great starting point, though.

# What Does This Course Entail?

The NASE Advanced Open Water Diver course involves two steps: knowledge development and in-water training.

- Knowledge development takes place through self study, using the NASE Advanced Open Water eLearning course. To complete this course, students must demonstrate mastery of more than 60 different learning objectives, covering the topics outlined previously.

- Skill development takes place through a series of instructor-supervised open-water training dives involving natural navigation, compass navigation and deeper diving. If time allows, the instructor may include one or more additional dives designed to provide an introduction to popular specialty diving activities, such as night diving and underwater imaging.

As with most NASE courses, there is no set number of required dives. What we require instead is that Advanced students log *at least* 150 minutes of Actual Bottom Time (ABT), under instructor supervision, while meeting the skill performance objectives for the Advanced course.

Prior to these dives, your instructor will most likely conduct a review and assessment of core diving skills, such as regulator recovering and clearing, mask clearing and no-mask breathing, and sharing air while stationary, traveling and ascending. Depending on circumstances, this may take place in confined water, such as a swimming pool, or on a shallow open-water dive, under controlled conditions.

Why is this?

- NASE standards require instructors to ensure that all students entering the Advanced Open Water Diver course possess the same level of ability as newly certified NASE Open Water Divers. Okay, does this mean we think NASE divers are better than divers of other agencies? Let's just say that, while we require that our beginning divers be able to perform largely the same skills as divers of other organizations, we do ask more of them.

Specifically, we require that our entry-level divers be able to perform all entry-level skills *while maintaining neutral buoyancy*. We also require that students log at least 100 minutes under instructor supervision before being certified as NASE Open Water Divers.

- Many students take the Advanced course as a means to get back into diving after a period of inactivity. For them, the skills review and assessment is essential.

While diver training has progressed over the past 60 years in areas such as eLearning and the use of dive computers, for most organizations, the way core skills are taught has not changed substantially since the 1950s. You'd think, after all this time, that someone would come up with a better way to do things. Well, we think we have.

Thus, the NASE Advanced Open Water Diver course provides us with a means to introduce students from other training organizations to our way of doing things. Okay, you might be thinking, *Who are these guys to think they can do it better than anyone else?* Well, we'll let you in on a little secret: *We actually dive.* Not only are we based in north Florida, where we can dive year-round in a variety of environments, we're also the only diver training organization that not only has its own training pool, but its own commercial diver training school and deep-water training site.

We discuss the core skills review and assessment in greater detail in the next section.

## It's Not the Advanced *Diver* Course, It's the Advanced *Open Water Diver* Course

We said at the beginning that this course would not necessarily make you an Advanced diver (even it provides an excellent starting point). Becoming a "real" advanced diver involves gaining additional experience and working to expand your base of knowledge and skills.

So why do we call it the Advanced course if it does not make you an advanced diver? Perhaps we can best explain it this way:

> What you are about to take is not an "advanced" diver course; it's an Advanced *Open Water Diver* course (as opposed to a Basic Open Water Diver course). Both are components of a two-part entry-level program. In other words, we have a basic entry-level program and an advanced entry-level program.

In an ideal world, no training agency would issue a permanent certification card until divers had completed both parts of their entry-level training. Unfortunately, that's not how the system evolved. We can better explain this by reviewing the limits of entry level diver training.

- The recommended depth limit for recreational diving is 30 m/100 ft; however, the Open Water Diver course (of any training agency) is only designed to prepare students to plan dives to 20 m/65 ft.
- If newly certified Open Water divers plan to make a dive under anything other than direct instructor or divemaster supervision, we encourage them to stay within conditions no more adverse than those in which they were trained.

In contrast, the Advanced Open Water Diver course helps prepare divers to go beyond those limits.

- Advanced Open Water Divers are trained to plan and make dives with similarly qualified buddies to the maximum recommended depth of 30 m/100 ft.
- Because Advanced Open Water students will be exposed to a greater assortment of dive sites and conditions than those they encountered during entry-level training, the range of conditions in which they can dive comfortably and safely will expend as well.

Still, there are limits to what the Advanced course prepares divers to do.

- While we encourage Open Water course graduates to make their initial dives under instructor or divemaster supervision, we encourage Advanced Open Water Divers to limit their dives to dive boats and popular dive sites where there are other, more experience divers on hand who can help in case of an emergency.
- Before you and your buddies plan and make dives at more remote sites, where there may not be other divers around, you would be wise to take the NASE Rescue Diver course. This way you'll be less likely to need others' assistance if a situation arises.

# Skills Review and Assessment

The first part of the NASE Advanced Open Water Diver course is a review and assessment of core skills from the basic Open Water course. Before you can take part in Advanced course navigation and deep dives, you need to demonstrate that you have at least the same level of competency as a newly certified NASE Open Water Diver.

If you are not yet familiar with NASE diver training, this may not sound as though we are asking a lot. However, once you discover what it is we expect of entry-level divers, you will realize this is actually quite an achievement.

This section is divided into six parts:

- Competency and Core Skills Defined
- Mask Clearing
- Regulator Recovery and Clearing
- Gas Sharing
- Alternate Air Source Configurations
- Buoyancy Control

The purpose of this section is two-fold:

- To let you know what to expect (and what will be expected of you).
- To provide you with tips and suggestions that will help you perform your best.

# Competency and Core Skills Defined

## Study Questions

As you go through this material, look for the answers to the following:

- *How does NASE define skill competency?*
- *In what skills should students entering the NASE Advanced Open Water Diver course be able to demonstrate competency?*
- *Why does NASE start the Advanced course with a review and assessment of core skills?*

To get started, we need to begin with some definitions. In this section, you learn:

- How NASE Defines Competency
- NASE Core Skills Defined
- Why the Emphasis on Core Skills at This Level?

## How NASE Defines Competency

In simplest terms, NASE simply asks more of students than most other training organizations. Blame our background in commercial, technical and — especially — cave diving. We're obsessed with excellence, particularly when it comes to buoyancy control.

We can tell you this, though: If you show up at a dive resort or charter operator who is familiar with what NASE asks of its divers, your abilities will never be questioned.

NASE training standards require that students be able to demonstrate competency in a variety of skills and abilities at various levels of training. But what do we mean by *competency?* As NASE defines it, competency is the ability to perform a given skill:

- On command.
- Repeatedly.
- Without significant error.
- Without undue stress.

What this means is that, should your instructor signal you to perform a particular skill, you are able to do it immediately, without having to psych yourself up or prepare yourself mentally or emotionally. And, should your instructor ask you to perform that skill again, you can do so without having to prepare mentally or emotionally as well.

It also means that, while your performance does not necessarily have to be letter perfect, you can't make any major mistakes. Just how perfect depends on the level of training.

- It would be unrealistic to expect a beginning student to recover and clear a regulator as quickly or as smoothly as we would, say, an instructor candidate.
- Still, students need to meet the stated performance objective. If that objective is to *completely* clear a mask of water, the student has to be able to get *all* the water out of the mask.

- Additionally, regardless of training level, the student can't just fumble his or her way through the exercise. A few stumbles might be okay; however, it can't take five minutes to complete a simple task, nor can it appear as though the student arrives at the result by accident.

The other condition for competency is *without undue stress*. In other words, a little stress is okay. It can't appear, however, that you are about to have heart failure at any moment.

The NASE Advanced Open Water Diver course has a number of performance objectives in which students must demonstrate competency. Before this can happen, however, students must first be able to demonstrate that they have developed and maintained competency in certain *core* skills.

# Core Skills Defined

Divers in NASE entry-level courses must be able to demonstrate competency in a variety of skills. Chief among these are:

- Mask removal, replacement and clearing, and no-mask breathing.
- Regulator recovery and clearing using both reach and sweep methods.
- Alternate air source use while stationary, ascending and traveling.
- All aspects of buoyancy control.

Prior to taking part in any Advanced Open Water Diver course navigation, deep or specialty dives, students must first demonstrate competency in these four areas. This can take place in a variety of ways. Here are some examples:

- If your Advanced Open Water instructor is the same one who certified you the weekend before, then he or she has presumably already seen you perform these core skills at an acceptable level within the preceding 30 days. No further assessment is necessary.

- Similarly, if you recently completed training with another instructor in the same dive operation as your Advanced instructor, he or she may simply elect to take your entry-level instructor's word as to your abilities.
- On the other hand, if it has been more than 30 days since your instructor — or another instructor whom he or she knows and trusts — has assessed your abilities, your Advanced instructor may insist on some sort of in-water review of core skills. The same may be true if you are a recent entry-level course graduate, but your NASE Advanced Open Water instructor knows little about the people who originally certified you.

If your instructor deems it necessary to get in the water for a core skills review, there are several ways this can take place. For example:

- Your instructor may conduct a core-skills review and practice session in a pool or other body of confined water.
- The instructor may designate the first open-water training dive in your Advanced course as a core skills review and practice dive. In this case, the dive is likely to take place in shallow water under very controlled conditions.
- If the instructor deems it necessary to conduct further review and practice of core skills, he or she may schedule a make-up core skills session, or may integrate this with other open-water training dives.

## Why the Emphasis on Core Skills at This Level?

You may wonder why the emphasis on core skills at this level of training. In other words, why beginning skills in an advanced course? It is actually for several reasons.

- To start, as we mentioned early on, it's not an *Advanced Diver* course; it's an Advanced *Open Water Diver* course (as opposed to a Basic Open Water Diver course). Both are components of a two-part entry-level program. In other words, we have a *basic* entry-level program and an *advanced* entry-level program.

- Many divers enroll in the Advanced Open Water course as a means to become active after a period of inactivity. In this case, the skills review is not only wise, but essential.
- Finally, NASE teaches a number of things in its entry-level programs that others do not. Many students who enroll in the NASE Advanced Open Water course completed their entry-level training with another organization. The skills review is a way for them to gain these additional abilities.

Most training agencies ostensibly require their instructors to conduct a basic skills review with unfamiliar students before participating in any continuing education course. In practice, this seldom happens.

NASE is the only training agency we're aware of that covers this skills review and assessment in its Advanced course materials. This helps ensure that this important part of Advanced Open Water training does not get left out.

The remainder of this section will focus on things we cover in the NASE Open Water Diver course that others generally do not. If you did your initial training with another organization, you may find this quite eye opening.

# Key Points to Remember

- NASE defines *competency* as the ability to perform a given skill on command, repeatedly, without significant error and without undue stress.
- Students in the NASE Advanced Open Water Diver course must demonstrate competency in mask clearing, no-mask breathing, regulator recovery and clearing, gas sharing and buoyancy control. These are skills you should have mastered during entry-level training.
- NASE starts the Advanced course with a review and assessment of core skills to ensure that every student enters the course with the same level of ability and is not lacking in any area that could affect safety.

# Mask Clearing

## Study Questions

As you go through this material, look for the answers to the following:

- *What is the primary reason some divers have difficulty with mask clearing and no-mask breathing?*
- *What is the best way to deal with difficulty clearing masks and no-mask breathing?*
- *What can you do if you managed to get certified* without *becoming truly comfortable with mask clearing and no-mask breathing?*

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No matter how much money you spent on your mask, no matter how well it fits, it's naive to think it will never flood (or at least get some water inside).

- Any mask can be knocked loose by a buddy's errant fin stroke or by turning suddenly and hitting your mask against a bulkhead or other piece of wreckage.
- Mask straps can always break or become unbuckled.

- In a worst-case scenario, you can always completely lose your mask under water.

Whatever the cause, these things happen. Every diver not only needs to be able to clear a mask, but to breathe without one long enough to make a slow ascent to the surface. As a NASE diver, you need to be able to do the following:

- Completely flood, then remove your mask.
- While continuing to breathe without a mask, swim a distance of no less than 10 m/35 ft (conditions permitting).
- At the end of the swim, replace and completely clear your mask of water.

The good news is, roughly three quarters of the people reading this can do this skill without difficulty. The other 25 percent may be thinking that they just signed up for the wrong course.

In that ideal world we always make reference to, no diver would ever get certified unless he or she could comfortably and repeatedly remove, replace and clear a mask of water. Unfortunately, far too many divers manage to get certified without ever truly mastering this skill.

> Your instructor may have thought he or she was doing you a favor by letting you slide on this one. In fact, that instructor was doing you the worst disservice imaginable.

The good news is, there is a reason why one in four new students has difficulty with mask clearing. Once you understand why, you can take steps to correct the problem.

If you are among the fortunate 75 percent, this section may be largely academic. Bear with us; you may learn something that will enable you to help the unfortunate 25 percent who still struggle with this skill.

Here is what we will look at in this section:

- Why Johnny Can't Clear
- Preventing the Problem
- Solving the Problem After the Fact

## Why Johnny Can't Clear

To better understand why some divers have difficulty with mask clearing, you first need to understand why most divers do not. It has to do with the ability to separate nose breathing from mouth breathing.

- When your mask floods, the *last* thing you want to do is inhale through your nose because, if you do, you will inhale water.
- Yet, at the same time you *are not* inhaling through your nose, you have to be able to inhale through your mouth to get the air from your regulator you'll need to clear the mask.
- When it comes time to exhale, you need to be able to do so through your nose, so that the air goes into your mask and not out your regulator exhaust tee.

Most divers can do this without thinking. A small percentage, though, either lack the innate ability to separate nose and mouth breathing, or never learned to do so in childhood. Here is what happens to these people when they try to follow the advice traditionally given for mask clearing:

- Some of these people will simply panic the minute their mask fills with water, as they immediately start inhaling water through their noses. In a few cases, this marks an immediate end to their diver training.
- Those who don't succumb to immediate panic will attempt to follow the instructions to "look up and exhale through your nose." What happens when they do, however, is that most of their exhalation goes out through their mouths and does little to expel water from their masks.
- Now, when these divers go to inhale, their lungs attempt to draw air in simultaneously through their noses and mouths. As they are already looking up, this inevitably causes water to go right up their noses.

The result? Instant panic and very little progress in learning to actually clear a mask.

## Preventing the Problem

NASE Instructors are taught to help students prevent mask clearing problems *before* their beginning course even starts by showing them how to identify whether or not they can easily separate nose and mouth breathing. If students discover they cannot, there are exercises the instructor can give them to help overcome this problem before in-water training begins.


Additionally, we tell instructors to first have students become comfortable with breathing with their face in the water *without* the added stress of having to clear a mask. Once students are comfortable with no-mask breathing, mask clearing is comparatively easy.

Now all of this is great if you are just learning to dive. What do you do, however, if you are already certified but aren't comfortable with mask clearing? The good news is, there are tricks you can use to help deal with this problem.

## Solving the Problem After the Fact

Let's say you are a certified diver whom, for whatever reason, still isn't comfortable with mask clearing. You know you may have to do a 10 m/35 ft no-mask swim before you can take part in other Advanced course activities. More importantly, however, is the fact that you cannot safely participate in diving without being comfortable with mask clearing and no-mask breathing. What do you do? *Relax*. We have some tricks that can help.

To start, you need to be able to separate nose and mouth breathing. Try this:

- Start by holding the palm of your hand centered over you nose and mouth and almost touching your face. This will allow you to feel when you are exhaling through your nose and when you are doing so through your mouth.

- Hold your mouth slightly open and exhale. You should feel and hear most of your breath come out of your mouth.
- Now repeat the exercise with your mouth closed. You should feel and hear most of your breath come out of your nose.

Now that you can tell the difference, try this.

- While holding your mouth slightly open, move your tongue toward the back of your throat with the tip of your tongue just touching the roof of your mouth.
- While holding your tongue in this position, inhale and exhale several times.

With any luck, you'll discover that, with your tongue in this position, you'll inhale and exhale only through your nose — despite the fact your mouth is open. Now do this:

- Run a bathtub full of warm water (bubbles are optional).
- Hop in the tub with just your snorkel.
- Put your snorkel in your mouth and your face in the water.
- Try breathing in and out through your snorkel with your nose exposed to water.

- If you are successful with what is, essentially, no-mask breathing, try breathing in through your snorkel and out your nose, as you would when clearing a mask.

This is what we have instructors whose students think they will have difficulty with mask clearing do prior to the beginning course. It can work *after* the beginning course as well.

Now let's say you are still having difficulty with mask clearing. Here are some additional tricks you can try:

- If you can't prevent exhaled air from coming out your regulator by moving your tongue, try simply sticking the tip of your tongue into your regulator mouthpiece to block the air flow.

- If you can't seem to prevent water from coming up your nose, try pinching off your nose each time you inhale.
- *Don't look up* — at least not initially. If you are unsuccessful in getting all of the water out of your mask on a single breath, looking up all but guarantees you will inhale water on your next breath. Instead, look forward and slightly down as you inhale and exhale. You only need to look up as the last of the water leaves your mask, so that the bottom of the mask skirt becomes the lowest point and you get the last of the water out.

These are the same tricks NASE Instructors use with beginning students who are having difficulty with mask clearing. They can work for you, too.

## Key Points to Remember

- The primary reason some divers have difficulty with mask clearing and no-mask breathing is that they lack the ability to separate nose breathing from mouth breathing.
- The best way to deal with difficulty clearing masks and no-mask breathing is to *prevent it from becoming a problem in the first place.*

- If you are still not truly comfortable with mask clearing and no-mask breathing, there are several things you can do prior to the Advanced course that may help.

# Regulator Recovery and Clearing

## Study Questions

As you go through this material, look for the answers to the following:

- *What is the primary reason divers learn regulator recovery and clearing in entry-level courses? How does this relate to how they might need this skill in real life?*
- *What will most likely happen to a missing second stage if you are* diving like a fish?
- *What aspect of primary second stage loss is generally* not *covered in most entry-level scuba courses?*
- *What is the first thing you should do if you lose your primary second stage under water?*

Regulator recovery and clearing are such fundamental skills they are often the very first skill new divers learn. As a NASE Advanced Open Water student, you need to be able to recover and clear a regulator second stage that has fallen behind you, using either the reach or sweep method.

We most likely needn't elaborate on exactly *how* you recover and clear a regulator. Instead, we'd like to focus on a few things that typically *aren't* part of how these skills are traditionally taught. Here is what we will discuss:

- The "Why" Behind These Skills
- What Happens When You "Dive Like a Fish"
- What Often *Isn't* Covered in Entry-Level Training
- The First and Best Response to a Lost Regulator

## The "Why" Behind These Skills

When your entry-level instructor first introduced regulator recovery, he or she may have justified it by saying something like, "In the unlikely event someone knocks a regulator out of your mouth…" Does this happen in real-life diving? *Yes* — but only very rarely.

The primary reason entry-level divers learn this skill is that there are a number of exercises in beginning diver training, such as gas sharing, that require students to take a regulator out of their mouth and drop it. At the conclusion of the exercise, students need to be able to find that second stage and resume breathing. It would, in fact, be difficult to teach a beginning scuba class if students did not develop this ability early on.

What's worth noting is that, when you learned this skill, you most likely did it under conditions that were very *untypical* of real-life diving. Specifically, you most likely did it while kneeling upright on the bottom — something you almost *never* do when diving in the real world. What this means is that how you learned this skill may not be very helpful if you have to use it in real life.

## What Happens When You "Dive Like a Fish"

One of NASE's tenants is *Dive like a fish, not like an ape*. It refers to the fact you never see fish standing, sitting or walking upright on their tails. Fish are almost always horizontal — and divers should be, too.

To start, when you are maintaining proper body position, you *can't* get a regulator second stage to simply drop behind your shoulder. A conventional second stage will simply drape itself out in front of you, where you can easily look down and see it.

> An exception exists in the case of the more modern, "tech style" regulator system configuration, where the primary second stage is attached to a one-meter/40-inch or longer hose that comes under the right arm and ends in a 90- or 120-degree swivel.

If one of these second stages gets away from you, the hose will initially run down your back — but then the second stage itself will dangle from beneath your arm pit. If you can't recover this type of second stage by simply reaching for it with your left hand, you can easily do so by either the reach or sweep method.

The only time divers should ever be vertical is when descending, ascending or resting on the surface. In fact, about the only time a conventional second stage would ever get behind you is when you are vertical on the surface. For this reason, any meaningful practice of regulator recovery should include recovering the second stage while floating on the surface with your BC partially inflated.

> As the best way to recover a second stage is to *never* let it get away from you in the first place, you need to get in the habit of always keeping a conventional primary second stage draped across your shoulder when at the surface. If you are using the newer, under-the-arm type of second stage, it's important to have a stainless snap on the second stage and clip it to a right-shoulder D-ring whenever it is not in your mouth — just as we do in tech and cave diving.

You'll read more about this new type of regulator system configuration in the section on gas sharing.

## What Often *Isn't* Covered in Entry-Level Training

Among the most likely causes of a lost primary second stage is what happens when the five-cent cable tie that keeps the rubber mouthpiece attached to the second stage breaks. You most likely won't even notice the second stage get away from you. What you *will* notice is when you take that next breath and get a mouth full of water through the now-empty mouthpiece instead of air.

In this case, simply recovering the second stage won't be enough, as you are going to end up with a second stage with no mouthpiece.

- If you are sufficiently adept, you may be able to wrestle the mouthpiece back on the second stage. The catch is, you may already be out of air and need to take a breath before you can get the mouthpiece back in place.

- If you do succeed in getting the mouthpiece back on, you are still left with a second stage whose mouthpiece has no cable tie to hold it. This means you can just as easily lose it again.

The bottom line is that you should never use a second stage whose mouthpiece is not held securely in place by a cable tie or other suitable device. To do so is to invite catastrophe.

Which brings us to our next point…

## The First and Best Response to a Lost Regulator

You most likely remember practicing regulator recovery in your basic Open Water course. After cavalierly tossing the second stage over your right shoulder, you dutifully began exhaling tiny bubbles while you hunted for the missing second stage. And hunted. And hunted — as a sense of panic grew from the feeling that you might not find it before running out of air.

The irony is, while you hunted, your regulator system offered you a perfectly functional second stage in the form of your alternate air source — which you were blithely ignoring. Remember also, from our previous discussion, that if you succeeded in finding the missing second stage, odds are that in real life, it would be missing a mouthpiece.

What this underscores is the fact that, when a regulator second stage suddenly goes missing, your first response *should not* be to begin hunting for it. Instead, you should locate and begin breathing from your alternate. Do that and you will have all the time in the world to deal with the missing second stage (which may be unusable anyway). Any meaningful practice of second stage recovery needs to include this important first step.

If you are using an integrated alternate-air-source inflator or the newer, "tech style" regulator configuration (in which the alternate is stowed in an elastic necklace just a hand's width from your mouth), you should be able to find and begin breathing from your alternate almost instantly. If you are using the older, more traditional "octopus" configuration, you may need to hunt for your alternate — especially if you failed to stow it in a reliable retainer.

# Key Points to Remember

- Regulator recovery in entry-level classes is taught primarily to facilitate the teaching of other skills. It's important to practice this skill, however, in a way that is more typical of what might happen in real life.
- If you are maintaining a horizontal body position, an over-the-shoulder second stage will tend to simply hang down in front of you as opposed to getting lost behind you.
- One situation seldom covered in entry-level scuba courses is what to do if the mouthpiece comes off your primary second stage.
- If you lose your primary second stage under water, the first thing you should do is begin breathing from the alternate. Do this *before* wasting time looking for the missing second stage.

# Gas Sharing

## Study Questions

As you go through this material, look for the answers to the following:

- *What possible scenarios should you be prepared for in an out-of-air situation?*
- *What is the best way to quickly get gas to an out-of-air diver?*
- *Why might divers want to use an alternate air source for traveling as opposed to ascending?*

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What is the best way to share gas with another diver? This is a question divers have posed since the invention of the alternate air source in the late 1960s. In this section we'll look at:

- Possible Gas Sharing Scenarios.
- The Best Way to Share Gas.
- When Gas Sharing is a Matter of Convenience.

By the way, throughout this section — and the course in general — we tend to use the terms *gas sharing* and *air sharing* interchangeably. When we do, we mean the same thing. So "share air" can also mean sharing Nitrox or even mixed gas.

# Possible Gas Sharing Scenarios

Assuming, for a moment, that the potential donor is equipped with a conventional alternate-air-source second stage, there are four possible ways an air-sharing situation can play out:

- The out-of-air diver could simply swim up, take the donor's alternate air source second stage and begin breathing from it. This would be nice — but, while it is something that theoretically *could* happen, the odds of it actually happening are slim.

- The out-of-air diver could also swim up, signal *I'm out of air/give me air!* and wait for the donor to pass the alternate-air-source second stage. We'd hope that this takes place very quickly, as the out-of-air diver very likely needs breathing gas *right now*.

- The third alternative is for the out-of-air diver to signal *I'm out of air/give me air!* At this point, the donor passes his primary second stage and, thus, does not force the out-of-air diver to wait while he locates his alternate-air-source second stage, gets it out of its holder and turns it around so that the receiver can actually breathe from it.
- The final scenario is that the out-of-air diver is so desperate for air that he swims up and literally rips the primary second stage out of the donor's mouth. This does not happen anywhere near as often as divers sometimes claim it does — but it *does* happen.

# The Best Way to Share Gas

Which of these four scenarios just outlined is the one NASE recommends? *Do we really need to ask?*

> Just in case this is still not as readily apparent as it should be, NASE recommends passing the primary second stage in an out-of-air emergency.

There are really only two drawbacks to this approach:

- It means the donor will be momentarily without air. *Big deal.* He is not the one in a state of near panic. The couple of seconds it will take him to switch to his alternate won't be anywhere near as stressful as asking the out-of-air diver to wait five to ten seconds or more while the donor fumbles for his alternate.
- If you are using a traditionally configured regulator system, the receiver won't get the benefit of the four extra inches of sec-

ond stage hose that the donor's alternate generally has. But, you know what? As long as both divers end up with a working second stage, does it really matter?

On the flip side, passing the primary second stage offers numerous benefits.

- *It's fast:* There is, in fact, no faster way to get gas to an out-of-air diver. It's the difference between sharing air in less than a second and having to wait up to ten or more seconds to find and pass a conventional octopus. This is time an out-of-air diver may not have.
- *It works with any gear configuration:* If you are equipped with an alternate-air-source inflator, this is the only method you can use. But it works equally well with conventional alternate-air-source second stages — or any combination of the two.

- *It reduces the likelihood of upside-down second stages:* The natural wrist motion associated with turning a primary second stage around to face an out-of-air diver will keep it right side up. In contrast, the wrist motion associated with passing a conventional octopus often turns the second stage upside down. This can result in an already panicky diver breathing water after every exhalation.
- *In the unlikely event a panicky diver does rip a second stage out of your mouth, you'll be ready:* All you will have to do is pick up and begin breathing from your alternate-air-source second stage.

Passing the primary second stage has been a standard part of cave and technical diver training for more than 20 years. These environments are unforgiving. A delay in passing gas under these conditions can be fatal — just as it can be in recreational diving.

**Passing a Second Stage:** When you pass a second stage to an out-of-air diver, there are certain things it's important to remember.

- *Keep the second stage right-side up:* Fortunately, if you are passing your primary second stage, your natural wrist motion as you turn the second stage to face the out-of-air diver will tend to ensure this.

- *Don't block the purge button:* If the out-of-air diver gets the second stage in his or her mouth before you can let go of it, you want this person to be able to purge it. Holding the second stage by the hose, close to the second stage body, tends to work better than holding on to the second stage itself.

- *Don't force the second stage into the other diver's mouth:* This might only serve to heighten the distressed diver's state of panic. Instead, hold the second stage directly in front of the receiver's eyes, so that he or she can clearly see it. Let the receiver take the second stage and guide it into his or her own mouth.

## When Gas Sharing is a Matter of Convenience

*C'mon!* Since when is air sharing not a matter of life and death? Well, consider the following:

> Divers *A* and *B* are making a shallow reef dive from a boat. Their plan is to follow the reef line until the first diver reaches 140 bar/2,000 psi, then turn the dive and return the way they came. Several minutes into the dive, Diver *A* notices he has 165 bar/2,400 psi remaining. He asks Diver *B* how he is doing on air. Diver *B* discovers, much to his horror, that he only has 90 bar/1,300 psi left — less than he theoretically needs to get back to the boat.

What are they to do?

- One option would be to ascend immediately, then swim back to the boat on the surface. Doing so would expose the divers to rougher seas, stronger currents and boat traffic — plus the fact swimming at the surface is almost always more exhausting than swimming under water. *Not* a great idea.
- Another option would be to attempt to make it back to the boat on Diver *B*'s remaining air. If they do, however, it's unlikely Diver *B* will have sufficient gas to make it all the way and, the

closer Diver *B* gets to actually running out of air, the greater the risk in this approach.

- The third option is for Diver *B* to start breathing from Diver A's alternate air source second stage, while they both start heading back for the boat under water. Now it doesn't take a math genius to figure out that, even with 165 bar/2,400 psi remaining, Diver *A* may not have sufficient gas to get them both back all the way. *That's okay*. He doesn't have to.

All Diver *A* really needs to do is get Diver *B* sufficiently close to the boat that Diver *B* will have no difficulty making it the rest of the way on the 90 bar/1,300 psi he has left.

> Long surface swims are not only not a lot of fun, they are also not all that safe. After all, *the surface is where most diving accidents happen*. So long as divers have sufficient gas to breathe, swimming under water is almost always more desirable, and anything divers can do to facilitate staying under water is generally a good idea.

Traditional diver training paints sharing air as a life-or-death situation requiring an immediate ascent. As you can see, however, that is not always the case.

# Key Points to Remember

- An out-of-air diver may wait for you to pass him or her a functioning second stage — or he may simply grab your alternate or the one in your mouth.
- Passing an out-of-air diver your primary second stage can get air to the diver faster than hunting for an alternate, and helps minimize the risk of upside-down second stages.
- Alternate air sources are not just for out-of-air ascents. They can help get a low-on-air diver close enough to an exit point that he or she can make it the rest of the way on their remaining air.

# Alternate Air Source Configurations

## Study Questions

As you go through this material, look for the answers to the following:

- *What is the chief benefit of the traditional regulator configuration?*
- *What are the benefits of alternate-air-source inflators?*
- *Where did the modified tech configuration come from? What is its chief benefit?*
- *What should sidemount divers never need to do but always be able to do? Is this more or less complex than with other configurations?*

At this point in your diving career, you may be:

- Considering the purchase of your first regulator system.
- Considering the replacement of your current regulator.
- Contemplating the reconfiguration of your current regulator for greater safety and ease of use.

Whatever the case, it helps to be aware of all the options available to you. We've included this information because how you configure your regulator system directly impacts how you share air. In this section, we'll look at four such configurations:

- Traditional Regulator Configuration
- Alternate Air Source Inflator
- Modified Tech Configuration
- Sidemount

For each configuration, we'll look at both the benefits and drawbacks and leave you to draw your own conclusions.

## Traditional Regulator Configuration

This is the configuration you most often see. It consists of:

- A first stage.
- A primary second stage on a standard-length hose.
- A color-coded alternate-air-source second stage on a slightly longer hose.
- A low-pressure BC inflator hose.
- An SPG or instrument console.

It's important to understand that this configuration *was not* the result of a meeting between diving's top safety and educational experts as to what constituted the ideal regulator system. It simply evolved and, as such, may have more potential drawbacks than any other approach.

Benefits of this configuration include:

- It's familiar. Everyone knows what it is and how it works.
- The alternate-air-source second stage generally has a slightly longer hose than a standard second stage. This helps facilitate gas sharing.

Drawbacks of this configuration include:

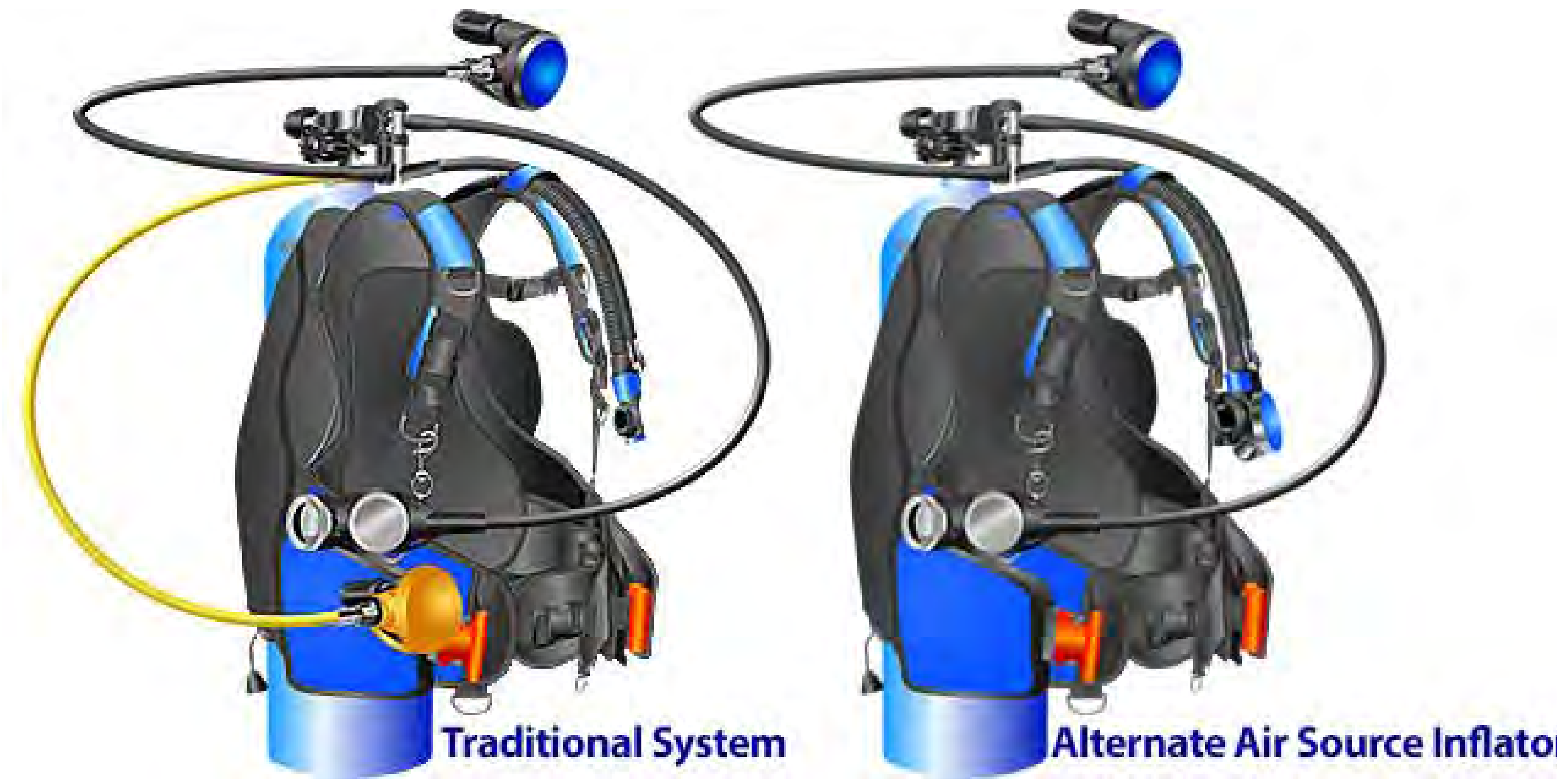
- There are a lot of hoses and they tend to stick out in all directions.
- It does not facilitate passing the primary second stage to an out-of-air diver.

- Depending on design, it may be very easy for an out-of-air diver to end up putting the alternate in his or her mouth upside down. This can cause the diver to inhale water and panic.

The only way to minimize the risk posed by the last point is to use a *side-exhaust* alternate-air-source second stage. This has no *up* or *down*, and thus cannot be put in a diver's mouth upside down, causing him or her to inhale water.

## Alternate Air Source Inflator

As you should remember from your beginning course, this combines the functions of an alternate-air-source second stage and a BC power inflator into a single unit. Unlike the traditional regulator configuration, this can only work by passing an out-of-air diver the primary second stage, while the donor picks up and begins breathing from the inflator.




Benefits of this configuration include:

- It's simpler and cleaner, having one less hose than the traditional regulator configuration.
- By its very nature, it facilitates passing the primary second stage.
- Because this configuration *only* works by passing the primary second stage, it minimizes the risk of an out-of-air diver getting a second stage in his or her mouth upside down.
- After passing the primary, the donor is less likely to have to hunt for the remaining second stage, as it is in a familiar location he or she accesses all the time.

Drawbacks of this configuration include:

- Alternate-air-source second stages tend to dangle a bit more than conventional equipment.
- You lose the option for an out-of-air diver to simply swim up, take the alternate, and begin breathing on his own. However, as we mentioned in the last section, this seldom happens in real life — and, when it does, it carries with it the risk of upside-down second stages.
- If the primary second stage is equipped with a standard length (i.e., shorter) hose, this may interfere somewhat with gas sharing.

You can mitigate this last point by equipping the primary second stage with a one-meter/40-inch or longer hose, making it, in essence, a variation on the modified tech configuration discussed next.

## Modified Tech Configuration

The modified tech configuration is a single-first-stage adaptation of the same hose configuration used by back-mounting technical and cave divers.

- The primary second-stage hose is at least one meter/40 inches long. If this length is used, the hose is routed under the right arm and connects to the second stage with a 90- or 120-degree swivel. Longer hoses are routed under the arm and once around the head, in the exact same manner as tech and cave divers do. This is the hose that goes to an out-of-air diver.

- The alternate-air-source second stage is on a shorter-than-standard-length hose and is suspended from a breakaway elastic necklace, putting it within a hand span of the wearer's mouth. This is what the donor uses after passing the primary. (An alternate-air-source inflator may be used in place of this.)

- The low-pressure inflator and high-pressure hose are typically shorter than those found on traditionally-configured systems.

Benefits of this configuration include:

- It facilitates passing the primary second stage to an out-of-air diver.
- Unlike a conventional configuration, there is no hunting for the alternate once the primary is passed.
- The hose length and routing help ensure that the overall configuration is extremely streamlined, with no hoses sticking out or dangling unnecessarily.

Drawbacks of this configuration? There are very few, and include:

- If setting up this configuration for the first time, or re-configuring an existing system, you will likely have to invest in additional hoses and hardware, as those required for this configuration are not likely to come standard.
- As with an alternate-air-source inflator, you may need to explain your system's operation to new buddies.

# Sidemount

Once the sole domain of advanced cave divers, sidemounting has suddenly taken off as the configuration of choice among many serious divers. Like everything else, sidemounting has both benefits and drawbacks — especially when it comes to gas sharing.

> As the name implies, sidemounting involves carrying two separate tanks and regulators, mounted along the wearer's sides. To keep the volume of gas inside each bottle even throughout the dive, sidemounters regularly switch back and forth between regulators.

Among the benefits of sidemounting is that, if everyone on a team is using sidemount, no team member should ever have to share air with another. However, when sidemount divers dive with non-sidemounters, or when diving at a site where they may come across an out-of-air diver from another team, sidemount divers need to be able to share gas.

> All sidemounters should equip at least one regulator with a longer hose. However, as sidemounters shift back and forth between bottles and regulators, they will not always be breathing from that longer hose.

If approached by an out-of-air diver, a sidemount diver will need to remember which regulator he or she is using, and donate the one with the long hose, regardless of whether or not it is the one in the donor's mouth.

In summary, the benefits of this configuration include:

- Sidemount divers should never need to share gas with one another, as they carry both the equipment and the gas needed to manage their own out-of-air emergency.

- If approached by another diver who needs gas, a sidemounter will likely have more than sufficient gas to do so.
- Depending on the situation and configuration, a sidemounter may even be able to pass an out-of-air diver a complete independent cylinder with its own regulator and pressure gauge.

Drawbacks of this configuration include:

- Just as overall gas management with sidemount is more complex, so is managing an out-of-air emergency.
- Sidemounters must be able to remember which of their two bottles has the long hose and donate it — not just whatever regulator they happen to be breathing from at the moment.

You can mitigate some of the gas-sharing problems associated with sidemount simply by equipping *both* regulators with a long hose. Then, no matter which regulator you are using, you just donate the one in your mouth.

# Key Points to Remember

- The traditional regulator configuration's chief benefit is its popularity; everyone knows how it works. It carries the risks, however, of divers breathing from upside-down second stages and second stages that are hard for the donor to locate.

- Regulators equipped with alternate-air-source inflators can be simpler and cleaner than traditional regulator systems, and can facilitate passing a primary second stage to others (as that is the only way they work).
- The modified tech configuration is an adaptation of the same hose configuration used by back-mounting technical and cave divers. It is among the best possible configurations to have if you need to donate gas to others.
- While sidemount divers should never need to get gas from another diver, they should nevertheless be prepared to give gas to others. Doing this can be more complicated than with other configurations.

# Buoyancy Control

## Study Questions

As you go through this material, look for the answers to the following:

- *What two pieces of equipment greatly facilitate maintaining good body position under water?*
- *What is the foundation and most important component of the Buoyancy Control Pyramid?*
- *What is meant by* diving like a fish?
- *What is meant by the three* As *of buoyancy control?*

The number one complaint among dive operators is that new divers can't control buoyancy. And no wonder! The typical scuba student spends *up to 90 percent* of his time in the water standing, sitting or kneeling on the bottom. How can he or she ever learn buoyancy control doing that?

One thing NASE prides itself on is that our students learn to control buoyancy from the first minute they get in the water. For us, neutral buoyancy is not a "skill" — something to be demonstrated on command while, the rest of the time, students sit like rocks on the bottom.

If you did not have the benefit of such training, it's understandable you might have some concerns about your own buoyancy control skills — especially considering that you'll be expected to demonstrate all of the required core skills while maintaining neutral buoyancy. *Don't worry*. There are things you can do that can dramatically improve your buoyancy control abilities with just a modest amount of practice. Topics we'll cover in this section include:

- Start With the Right Equipment
- Dive the Buoyancy Control Pyramid
- Dive Like a Fish
- Practicing the Three *A*s

Mastering buoyancy control requires practice. Still, you need to know what you are doing during that practice. After all, practice *does not* make perfect. Only *perfect practice* makes perfect.

## Start With the Right Equipment

NASE encourages divers to wear full-length exposure protection, all the time. To start, it helps keep divers warmer. Full-length suits also provide full-length exposure and abrasion protection above and below water.

> Equally important, though, by providing additional buoyancy in the legs, full-length wet suits help divers maintain a near-horizontal body position. (It's tough to control buoyancy if your feet are perpetually sinking.)

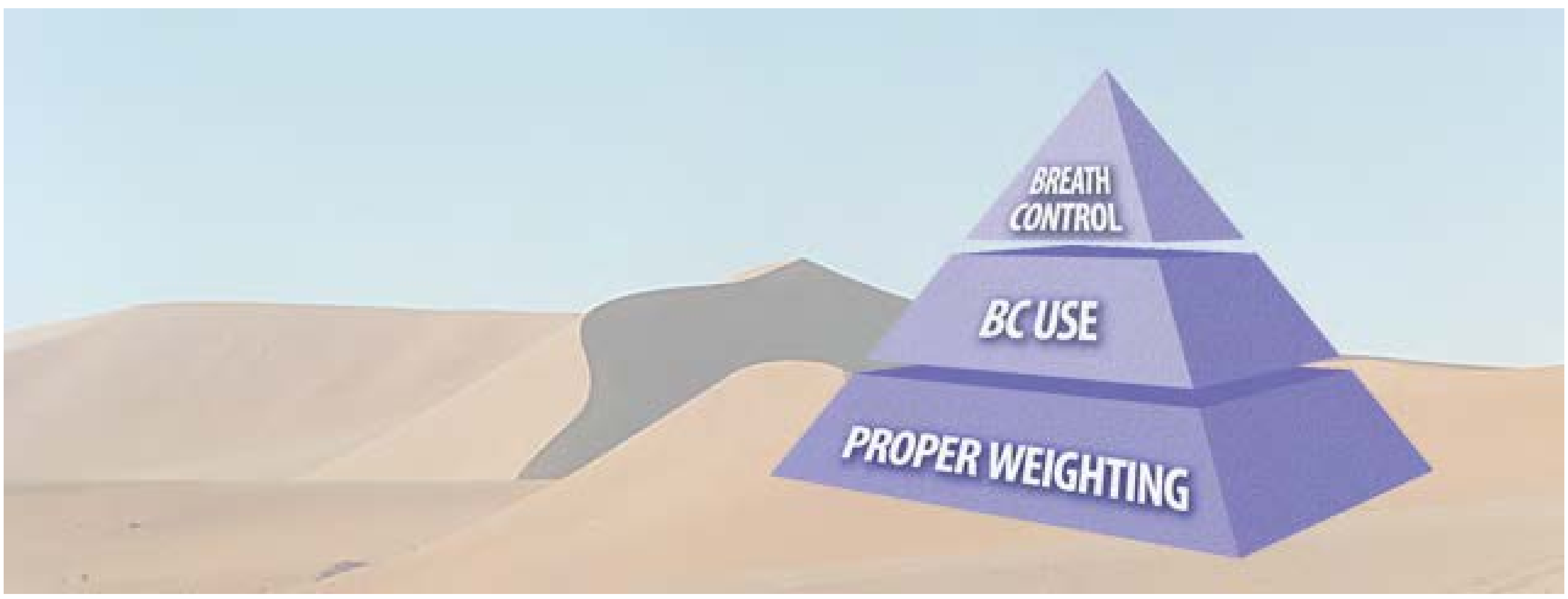
As far as weight-integrated BCs go, not only are they more comfortable and more convenient to wear, but by concentrating ballast at a point more in line with most divers' natural balance point, they make maintaining proper body position easier.

Unfortunately, even though over 95 percent of BCs sold in the past two decades have been weight-integrated, the majority of rental BCs are not. This means it's going to be tough to control buoyancy if you keep relying solely on rental gear. (It's also difficult to control buoyancy if you need to learn a new BC configuration each time you dive.)


Purchase a good-quality, weight-integrated BC. Become familiar with it and learn to use it effectively. Not only will doing so provide you with years of service, you'll also do a vastly better job of keeping your buoyancy under control.

# Dive the Buoyancy Control Pyramid

There's an illustration called the *Buoyancy Control Pyramid* that shows the relationship between the three key elements of buoyancy control: *proper weighting, BC use* and *breath control*.




Proper weighting is not only the foundation of the Buoyancy Control Pyramid, it is, by "volume," more important than the other two elements combined.

**Properly Weighted Divers Don't Always Float at Eye Level:** You may have been told that a properly weighted diver will float at eye level. *Bull pucky*.

Exactly where a properly weighted diver will float at the beginning of a dive is dependent on far too many variables to make a blanket statement like that. Factors ranging from the type and thickness of the exposure suit worn to the amount of breathing gas likely to be consumed during the dive will all impact where a diver floats at the beginning.

Regardless of the equipment used, every diver's goal should be the same — that is, to wear the least weight possible. Using the least weight possible (without risking uncontrolled ascents) helps achieve several goals:

- It keeps divers safer. Properly weighted divers are the ones least likely to have difficulty maintaining positive buoyancy at the surface.
- It makes controlling buoyancy easier under water, as divers only have to compensate for exposure suit compression, and not the compression of an unnecessary air bubble in their BCs that is there solely to offset the unneeded weight.
- It helps divers maintain better body position under water.

So what is the best way to determine how much weight a diver needs?

- In open water, you generally need only enough weight to be able to initiate a feet-first descent by exhaling fully. This won't be your final weight check, but it's a good start.

- The ultimate weight check will come at the end of each dive, at safety stop depth, when you have between 35-70 bar/500-1,000 psi remaining. This is the point during the dive at which you will be the most buoyant and, consequently, need the most weight.

During your end-of-dive safety stop, you should be able to hover motionless with no air in your BC. If you can't do this at the end of the first dive, keep adjusting your weight with each subsequent dive until you can.

## Dive Like a Fish

After a lifetime of standing, walking and sitting erect, you will have a natural tendency to want to stand, kneel or sit on the bottom. Get over it.

> You need to get in the habit of doing everything under water while maintaining a perpetual state of neutral buoyancy.

Among other things, this means that:

- When you descend, you don't plummet to the bottom like a rock, but rather add air to your BC as needed during the descent so that you arrive at the bottom neutral (in fact, you should never even come in contact with the bottom).

- Conversely, when you ascend, vent air as needed so that you never come up faster than 10 m/30 ft per minute.
- Develop the ability to perform all critical scuba skills — including emergency procedures — while neutrally buoyant.

*Let's face it:* If you suddenly find yourself needing to clear a mask or share air, there may be nothing below you but fragile coral, deep mud or, in the case of a wall dive, nothing at all. If you can't perform these important skills without a solid surface to rest on, you're screwed.

*Remember:* You're a fish, not an ape. Dive like it.

## Practicing the Three *A*s

You can facilitate the process of practicing buoyancy control by following the three *A*s: *Awareness, Anticipation* and *Action*.

**Awareness:** As a diver, you need to be perpetually *aware* of not only your current depth, but also any changes in depth you make. (Changes in depth may require you to add or remove air from your BC.)

The best way to do this is to maintain a visual reference in the form of an ascent/descent line, the bottom below you, or a wall or slope on either side of you. Lacking a visual reference, you will need to keep your eyes glued to your computer or depth gauge until a visual reference comes back into view.

**Anticipation:** When you become aware of a change in depth, you should anticipate the possible need for a buoyancy adjustment by locating and holding on to your BC's inflation/deflation mechanism. Once you begin rising or sinking out of control, it may be too late to begin hunting for it. *Anticipate* this need ahead of time by locating the inflator mechanism preemptively.

**Action:** If you do find yourself rising or sinking, take *action* by adding or venting air from your BC as needed.

> Be aware that kicking often masks the need for buoyancy adjustments. For example, if you kick with your fins at a slightly downward angle, their thrust can generate lift to help keep you off the bottom. Unfortunately, this is not very streamlined and the thrust from your fins can stir up silt or damage fragile plant and animal life.

One of the best things you can do when learning to control buoyancy is to stop frequently. If your buoyancy is under control, every time you stop you should simply hover. If you find yourself having to kick to maintain depth, you need to vent or add air as needed.

# Key Points to Remember

- Among the keys to buoyancy control is wearing the right equipment. This usually means full-length exposure suits and weight-integrated BCs.
- Proper weighting is not only the foundation of the Buoyancy Control Pyramid, by "volume," it is more important than the other two elements combined.
- *Diving like a fish* means overcoming your natural tendency to stand, kneel or sit on the bottom. Like fish, divers should strive to be neutrally buoyant and horizontal at all times.
- You can facilitate the process of practicing buoyancy control by following the three *A*s of: *Awareness, Anticipation* and *Action*.

# Advanced Dive Planning

As the diving you do becomes more advanced, so must the process of dive planning. Advanced diving can involve managing risks and hazards that go beyond those encountered in most entry-level dives.

Topics we will discuss in this section include:

- The NASE Dive Planning Checklist
- Advanced Gas Management
- Team Diving: Dive Planning in Action

Bear in mind that, even though the risks you encounter at this level may increase, so too may the rewards.

# The NASE Dive Planning Checklist

## Study Questions

As you go through this material, look for the answers to the following:

- *What are the things you need to do before leaving home?*
- *When would you need to conduct on on-site assessment and what should it include?*
- *What key things will you want to check before suiting up?*
- *What components need to be part of your final dive plan review?*
- *What does the pre-dive check acronym* ABC *stand for?*

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While going through this next section, you'll need to be able to refer to the NASE Pre-Dive Checklist. This is available from several places:

- When taking the NASE Advanced Open Water eLearning course, it's among the items you download at the beginning of the course.
- It appears in the Appendix of the *Advanced Open Water* eBook.

- You can also download it from *www.ScubaNASE.com*. Find it in the *Student Forms* section, under *Advanced Open Water.*

While we normally encourage students to save paper whenever possible, this is one document you will want to print out and keep in front of you for the remainder of this section.


Pre-Dive Checklist

Before You Leave Home

Tasks

- ☐ Regulator and BC serviced/inspected in the last year?
- ☐ Dive computer battery changed in the last year?
- ☐ Camera system, dive light and other batteries charged?
- ☐ If diving locally, did you check the weather?
- ☐ Any rental gear picked up, tanks filled and analyzed?
- ☐ All necessary reservations/bookings made?
- ☐ Tell someone else where you are going and when you should return

Packing List

Depending on whether or not you are diving locally, or from a beach or boat, not all items may be necessary

- ☐ Mask, fins, wetsuit boots
- ☐ Exposure suit/undergarments
- ☐ Hood and gloves for cold?
- ☐ Weight system or weight belt

On Site Assessment

This list is for shore dives; on boats, listen to and follow the crew briefing

- ☐ Conditions okay for diving?
- ☐ Safest entry/exit point?
- ☐ Easiest and safest entry/exit technique?
- ☐ Note current, waves, etc.
- ☐ Restrooms, other facilities?
- ☐ How do you summon EMS?
- ☐ Phone number for DAN: (919) 684-9111 (use another number?)
- ☐ Nearest dive group or facility you can go to for help?

Final Gear Check Before Suiting Up

- ☐ Scuba unit fully assembled?
- ☐ Weight pockets installed (or ready to install)?
- ☐ Air turned all the way on and pressure checked?
- ☐ All other equipment present and ready to go?

Dive Plan Review

- ☐ Where are you going? Who is primarily in charge of navigation?
- ☐ Planned depth and time?
- ☐ Maximum depth and time?
- ☐ Minimum Gas Reserve (MGR)?
- ☐ Is remaining gas half usable or all usable?

Final Equipment and Buddy Check

The checklist is divided into five sections:

- Before You Leave Home
- On-Site Assessment
- Final Gear Check Before Suiting Up
- Dive Plan Review
- Final Equipment and Buddy Check

Most of what appears on the checklist is fairly self explanatory. Much of it may have been covered in your beginning course.

In this section, we'll elaborate on some of the checklist items, discussing things that may not have been covered in your entry-level course, or differentiating between dive planning for vacation boat dives and local shore dives closer to home.

## Before You Leave Home

Dive planning starts before you ever leave the house. There are tasks you will need to perform, and items you will want to be sure to pack.

**Tasks:** This portion of the checklist is fairly straightforward. A few things to note:

- Many dive trips have been compromised because equipment maintenance *was not* up to date, computer batteries were on the verge of dying or a dive light simply was not re-charged. Don't let this happen to you.
- Imagine driving an hour or more to your local dive site only to discover conditions *were not* conducive to diving. Be smart. Check the weather before you go and, if there is a website that reports local dive conditions, check it as well.
- What if, after a weekend of diving (or a week-long dive vacation), you failed to show up for work on Monday morning?

Would anyone know where you'd gone? Would they even know where to begin looking? Always tell someone other than your dive buddy where you are going and when you should be back — and check in with this person when you get back.

**Packing List:** In terms of course and accessory equipment, there should be no surprises here. Obviously, you'll need less in the way of exposure protection on a tropical vacation trip, nor will you need to worry about things like tanks and weights.

> Given the current airline restrictions on number of checked bags and their size and weight — and the fact that, for the first time in memory, the airlines are actually charging to check even one bag, it may be tempting to leave items such as BCs and regs at home. *Don't do it*.

Even at those resort dive operations where the management is good about purchasing quality rental gear, and about making sure that equipment is properly maintained, there is not guarantee that:

- The rental BC and reg you pick up hasn't been used by several dozen strangers — just in the preceding couple of weeks.
- One of those strangers encountered any problems with the equipment's behavior that he somehow failed to report to the dive operator.

Rest assured that if you report the problem to most dive operators, they will act promptly to make things right. Unfortunately, that may come after the defective gear has ruined a dive — or worse.

The bottom line is, you are always best off bringing and using equipment you know and trust. Doing so doesn't even have to cost you a fortune in excess baggage fees. Many manufacturers now make ultra-compact, ultralight BCs, regulators and other equipment that you can fit in your carry-on bags.

**Emergency and Survival Items:** We want to spend some time discussing the items listed under *Emergency Kit*, as this is often not covered in entry-level courses.

- *First Aid Kit:* It's a fact that, in life, *feces occur.* You'd best be prepared. You can expect that most dive operations will have some sort of first-aid kit on hand. Still, it's a good idea to have your own — especially if you and a buddy may some day be off diving by yourselves. Diving requires special first-aid supplies. Fortunately, you can get diver-specific and affordable first-aid kits from organizations such as Divers Alert Network (DAN).

- *Emergency Oxygen:* Among the most serious of diving-related injuries is Arterial Gas Embolism (AGE) and decompression sickness (DCS). The best possible first aid for both of these injuries is to have the affected diver breathe pure oxygen. Positive-pressure resuscitation with pure oxygen is also the best possible way to revive a drowning victim. Oxygen administration requires specialized training and it is a good idea to take this training in conjunction with your Rescue Diver course. After you receive this training, it is a good idea to make sure there is always emergency $O_2$ on site — even if that means bringing your own.


- *Visible Surface Signal:* There are two distinct types of visible surface signals: safety tubes and signal mirrors. Depending on circumstances, you may want to have both. Inflatable safety tubes are a great way to make sure your dive boat and others can see you, even in rough seas. Signal mirrors can help gain the attention of people in search aircraft, and rescue and dive vessels

- *Audible Surface Signal:* Visible signals are great when someone is looking for you or looking right at you. How do you gains the attention of someone who *is not* looking your way — or when line-of-site is obscured by fog, high seas or other factors?

This is why you need an audible surface signal. Whistles are the most common. Some divers also like to use a horn-style signal powered by air from their BC low-pressure inflator hose. Just remember that if you are out of air, you can't signal with one of these, so carry a whistle as a backup.

- *Folding Snorkel:* Modern jacket-style and back-inflation BCs rendered snorkels largely redundant in the early 1980s. If you absolutely *must* swim at the surface, you are best off just breathing from your regulator. If air conservation is an issue, try swimming on your back while breathing through your nose and mouth (and maintaining verbal contact with your buddy). Unless diving from a beach and having to navigate through shallow water to a distant kelp bed, it's best to avoid surface swims altogether.

Having a snorkel that you *won't* need attached to your mask can cause problems. Still, many argue that it's better to have a snorkel and not need it than to need it and not have it. We agree; however, our recommendation is to consider carrying a small folding snorkel in your emergency kit pocket, rather than go around with a bulbous monstrosity you never use attached to your mask.


- *Pocket Mask™:* For years Rescue Divers have been taught a method for in-water resuscitation that involves direct mouth-to-mouth contact. If this is a good idea, why does so much of modern CPR training focus on the use of barriers? Worse, the blow-on-the-cheek method used to teach this technique isn't remotely close to what you would actually have to do to effectively ventilate a diver on the surface.

*Reality check:* Direct-contact mouth-to-mouth resuscitation in the water *doesn't* work. The only way to effectively ventilate a drowning victim on the surface is with an oral/nasal mask, which has the added benefit of providing better protection against communicable diseases. Use of oral/nasal masks is covered in the Rescue Diver course.

# On-Site Assessment

When diving from boats, you'll generally get an assessment of dive site features and conditions from the crew. When you and a buddy are diving from shore, however, this is something you will need to do yourselves.

The checklist contains seven items to check. Most of these are fairly self-explanatory. Some items you will want to pay particularly close attention to include:

- *Conditions okay for diving?* Don't just assume conditions will be safe and enjoyable, even if you checked ahead of time. See for yourself. Sometimes, the best decision you can make is to choose an alternate location or to simply turn around and dive another day.

- *Summoning help:* To start, don't just assume your cell phone will get reception; check for bars before you get in the water. No service? Where is the nearest alternate phone? Make sure you know the local EMS number and who will respond. You'll also need to know the number for DAN or the equivalent local diving emergency medical number; they are the second number to call after activating EMS. Also, look around. Are there other dive groups you could go to for help if needed? If not, where is the closest home, business or government facility you could go to for assistance?

## Final Gear Check Before Suiting Up

Few things are worse than suiting up, only to discover you have a problem that could have been solved had you only done a final gear check. This is another area where the checklist is fairly self-explanatory. Some things worth noting:

- You will generally want to assemble your scuba unit and other equipment *before* donning your wet suit or dry suit. In warm weather, donning your exposure suit prematurely risks heat exhaustion or heat stroke. An exception exists in cooler weather, when your suit is dry and the air is cold. In these circumstances, it may be more comfortable to don your suit first, and let it help keep you warm.


- Depending on your gear configuration and the amount of lead used, you may want to install the weight pockets in your BC before putting it on, or wait and do it after donning the BC. Common sense and prior experience will likely dictate which is best. Just remember that, once the weight pockets are installed, your scuba unit will be considerably less stable when you try to hold it upright.

- Depending on how close you are to entering, this may be the point at which you will want to turn your air all the way on. *Do not* give in to the persistent myth that, unless you turn the knob back a partial turn, you will somehow damage the valve.

So long as you don't force the turnwheel in either direction, there is little danger of valve damage. What *has* happened, however, is divers accidentally turning their air all the way *off*, then opening the valve a partial turn. This may allow the regulator to breathe adequately at the surface, but leave the diver starved for air at depth. Better to gently turn the valve all the way on or all the way off. This way there is less chance for error.

## Dive Plan Review

Your final dive plan review needs to include:

- Where you are going (and who will be in charge of navigation).
- Planned and maximum depth and time.
- Minimum Gas Reserve (MGR).
- Whether the remaining gas is *half usable* or *all usable*.

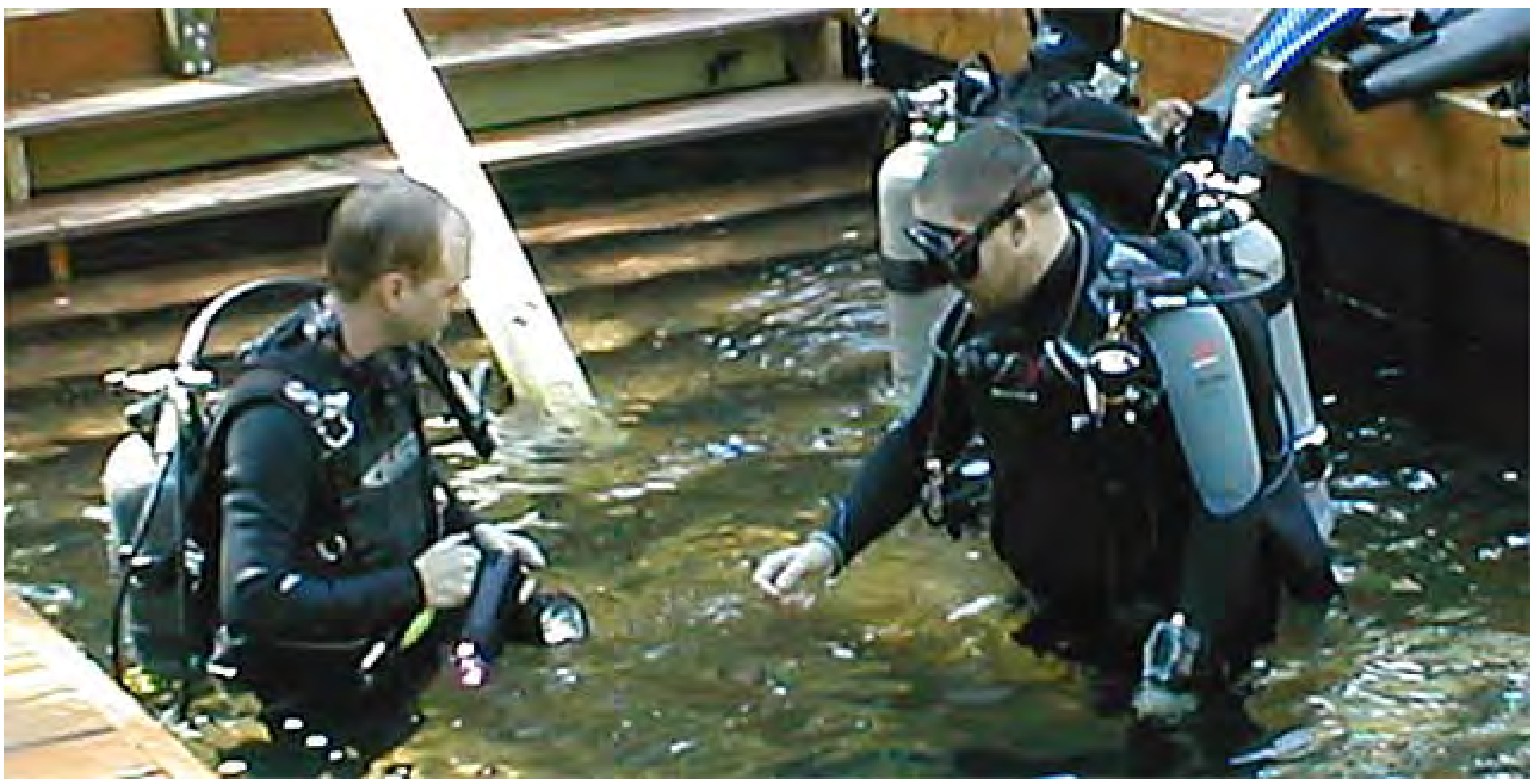
We'll discuss advanced gas management in greater detail in the next section.

You will likely discuss these things at some length prior to the dive. You will want to review them again, however, just prior to entering the water or descending.

## Final Equipment and Buddy Check

Conditions and circumstances will dictate where you do your final check. On a shore dive with calm conditions and little or no current, you may be able to do this in waist-deep water or while floating on the surface. On dive boats or in rough seas or breaking surf, you'll need to do it before entering. No matter where it's best to do your final check, don't start your dive without confirming that you, your equipment and your buddy are, in fact, ready to descend.

Various diving texts recommend different procedures you and your buddy can follow when doing this final check. Unfortunately, many of these checklists don't reflect modern dive equipment. Additionally, while it would be theoretically ideal for you and a partner to do a detailed systems check of each other before each dive, this is not something real human beings seem willing to do.



The best pre-dive checklist we've seen is one that is not only incredibly easy to remember (unless, for some reason, you never learned your *ABCs*), it's something you can easily do with a buddy or by yourself. Here are the components:

- *A:* The *A* stands for air. This is the single most important thing to check. Is your air turned all the way on? You can have a buddy check this for you but, remember, buddies can as easily turn your air *off* accidentally as they can turn it on. The best thing you can do is take several deep breaths from your regulator while watching your pressure gauge. If the pressure doesn't fluctuate, and the regulator continues to breathe easily, you're most likely good to go. If the pressure bounces or drops, you or your buddy may have accidentally turned the air *off*. Remember, while there are many problems you can encounter in and under the water, the only real emergency is being without air. Having air to breathe gives you the time you need to solve anything else.


- *B:* The *B* stands for *BC*. There are two things to check here. First, are all BC controls connected and functioning? (In other words, does the BC actually inflate when you push the button?) Second, is your BC inflated to the proper level? This is generally half-full; however, in some circumstances, such as drift dives from boats, you may need to be able to immediately descend upon entering, in which case you need to enter the water with a totally deflated BC.

- *C:* The *C* stands for *Computer*. The first thing you want to do here is activate the computer and check it for function. It's been a while since any manufacturer made a computer that did not self-activate on descent. Still, you don't want to be a meter or more under water when you discover your computer simply isn't working. Second, if diving Nitrox, you need to confirm that your computer is set to the correct *Fraction of Oxygen* ($FO_2$). If it is set to the wrong $FO_2$ value, or if it has defaulted since last being set, you may risk either DCS or oxygen toxicity.

Finally, it's a good idea to ask your buddy to give you a visual once-over, looking for items such as twisted straps, hoses or accessory items caught under straps and so on. When your buddy says you're good to go (and confirms that he or she is ready, too), it's time to dive.

# Key Points to Remember

- Things you need to do before leaving home include: making sure equipment maintenance is up to date; checking conditions; letting someone know where you are going and when you will be back; and, reviewing your equipment checklist. Remember that emergency/survival items such as audible and visible surface signals may be vital.
- When diving from shore, you are the one responsible for site assessment. This includes items such as making sure conditions are conducive to safe diving and knowing how to summon help.
- In all but cold weather, you will want to assemble your scuba unit and other equipment *before* donning your wet suit or dry suit. Depending on how close you are to entering, this may be the point at which you will want to turn your air *all the way on*.
- Your final dive plan review needs to include: where are you going (and who will be in charge of navigation); planned and maximum depth and time; Minimum Gas Reserve (MGR); and, whether the remaining gas is *half usable* or *all usable*.
- The pre-dive check acronym *ABC* stands for *Air, BC* and *Computer.*

# Advanced Gas Management

## Study Questions

As you go through this material, look for the answers to the following:

- *What must your Minimum Gas Reserve (MGR) provide sufficient gas to cover?*
- *How do you determine MGR for any particular dive?*
- *What is* Usable Gas? *What is the difference between* all usable *and* half usable?

In your entry-level course, discussion of gas management may have been limited to statements such as *Don't let your pressure gauge go below 50 bar/750 psi* or, *Keep the pressure gauge needle out of the red zone*. For the shallower depths that beginning divers are *supposed* to be limiting themselves to, this may be adequate.

Now, however, you are in the Advanced course. You are learning to plan and make deeper dives, and dives in more challenging environments. Such a simplistic approach to gas management isn't going to cut it any more.

In this section, we discuss the kind of gas management skills that more advanced divers need. Topics we will be covering include:

- Minimum Gas Reserve (MGR)
- Usable Gas

Good gas management practices go beyond simply having enough gas to deal with emergencies. Their real focus is on *preventing those situations from happening in the first place*.


## Minimum Gas Reserve (MGR)

Having an alternate air source is of little value unless you keep enough gas in reserve to get you and an out-of-air diver safely to the surface. Doing so means keeping sufficient air set aside to allow for two divers to breathe continuously while:

- Taking a moment at the bottom for the out-of-air diver to resume breathing at a normal or near-normal rate, to establish clear communication between divers and, possibly, to deal with entanglement, entrapment or other problems.
- Ascending at a rate of no more than 10 m/30 ft per minute.
- Making a three-minute safety stop at 3-6 m/10-20 ft.

Additionally, you have to account for the fact that, even if you allow a minute for the distressed diver to get his or her breathing back under control, both divers are still likely to consume gas faster than they would under less stressful conditions.

## Finding Minimum Gas Reserve

The calculations needed to precisely determine Minimum Gas Reserve (MGR) requirements are covered in the Deep Diver course. If you would like to get a head start on this, however, you will find more in-depth discussions of both Surface Air Consumption (SAC) rates and MGR calculations in the Appendix of the NASE *Advanced Open Water Diver* digital eBook. You can also download this Appendix and the NASE SAC and MGR Calculators from *www.ScubaNASE.com*. Look in the *Student Forms* section under *Advanced Open Water Diver course*.

For now, you may be able to use the MGR values that appear on the NASE Pre-Dive Checklist.

| Depth | Minimum Gas Reserve |
|---|---|
| 10 m/35 ft | 45 bar/700 psi |
| 20 m/65 ft | 60 bar/900 psi |
| 30 m/100 ft | 90 bar/1300 psi |
| 40 m/130 ft | 120 bar/1700 psi |

These values are based on the following assumptions:

- Both divers have an "under stress" Surface Air Consumption (SAC) rate of no more than 30 liters/1.0 cubic feet per minute.
- Both divers are using cylinders no smaller than the popular 11 liter/80 cubic foot size.

One thing you should notice immediately is that, as depths approach 20 m/65 ft, the amount of reserve gas you learned was acceptable in your beginning course may be nowhere near adequate. Also bear in mind that, if you have reason to believe you have a higher-than-average gas-consumption rate, even the values listed on the Pre-Dive Checklist may not be sufficient.

If this is the case, you should go ahead and read the in-depth SAC and MGR information, and use the SAC and MGR Calculators to determine Minimum Gas Reserve values that are more appropriate for you.

## Usable Gas

As the name implies, *Usable Gas* is the amount of gas you have available to use after you deduct your Minimum Gas Reserve from your actual starting pressure. Depending on circumstances, this gas may be *all usable* or *half usable*.

- If, at any point during the dive, you and your teammates can make a direct ascent to the surface and not be faced with a long surface swim, your gas is *all usable*. This means you don't have to begin ascending until you hit your MGR.
- If, on the other hand, you need to ensure you can return to your starting point under water, in order to avoid a long surface swim, your gas is *half usable*. This means that as soon as you have consumed half your usable gas, you need to turn around and head back to your starting point on the remaining half.

Here are some examples that may better illustrate these points.

- Let's say you plan a dive on a small- to medium-sized wreck in 30 m/100 ft of water. It's normal on deeper dives to *not* stray too far from the descent/ascent line. In this case, because you are always within a minute of the anchor line, you can consider your remaining gas *all usable*. In other words, as long as you are back at the anchor line and beginning your ascent before you hit your MGR, you're fine.


- Now let's say you and your teammates plan to follow a shallow reef line away from the boat. Given the shallow depth, your air is likely to last quite a while, and you could conceivably end up

300 m/1,000 ft or more away from the boat. Given factors such as waves, current and boat traffic, the last thing you want to risk is having to swim back to the boat on the surface. This means your remaining gas is *half usable*. Thus, if your MGR is 45 bar/600 psi, and your starting pressure is 200 bar/3.000 psi, you have 155 bar/2,400 psi in usable gas. Deduct half of this from your starting pressure and you will see that you will need to turn around when the first team member hits 125 bar/1,800 psi.

Divers are forever arguing over which alternate-air-source configuration or which ascent method is the "best" way of dealing with an out-of-air emergency. In so doing, they overlook the obvious: *The best way of dealing with an out-of-air emergency is to never let it happen in the first place*. The concepts of Minimum Gas Reserve and Usable Gas help you and your buddies do just that.

# Key Points to Remember

- Your Minimum Gas Reserve (MGR) must provide sufficient gas to make a slow ascent and safety stop while sharing air with another diver. You must also make allowances for spending up to a minute on the bottom before ascending, and for both divers consuming gas at a higher-than-normal rate.
- Generally recommended MGRs can be found on the NASE Minimum Gas Reserve table. More precise MGR values can be determined using the NASE Surface Air Consumption (SAC) rate and MGR Calculators.
- *Usable Gas* is the amount of gas you have available to use after you deduct your Minimum Gas Reserve from your actual starting pressure. If you can safely surface at any point during the dive, this difference is *all usable*. If it is important that you be able to return to your starting point before surfacing, this difference may only be *half usable*.

# Team Diving: Dive Planning in Action

## Study Questions

As you go through this material, look for the answers to the following:

- *What benefits does team diving offer?*
- *How does solo diving differ from diving in teams?*
- *How many members constitute the ideal dive team?*
- *What goals must team members agree upon ahead of time?*
- *What is the best position for team members to maintain, relative to one another?*

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Why do experts always encourage diving in teams of two or three? What constitutes the ideal team? How can you work effectively as team members under water? In this section we look at:

- Team Diving Benefits
- Solo Diving: The Team of One
- The Ideal Team
- Team Goals
- Team Positioning

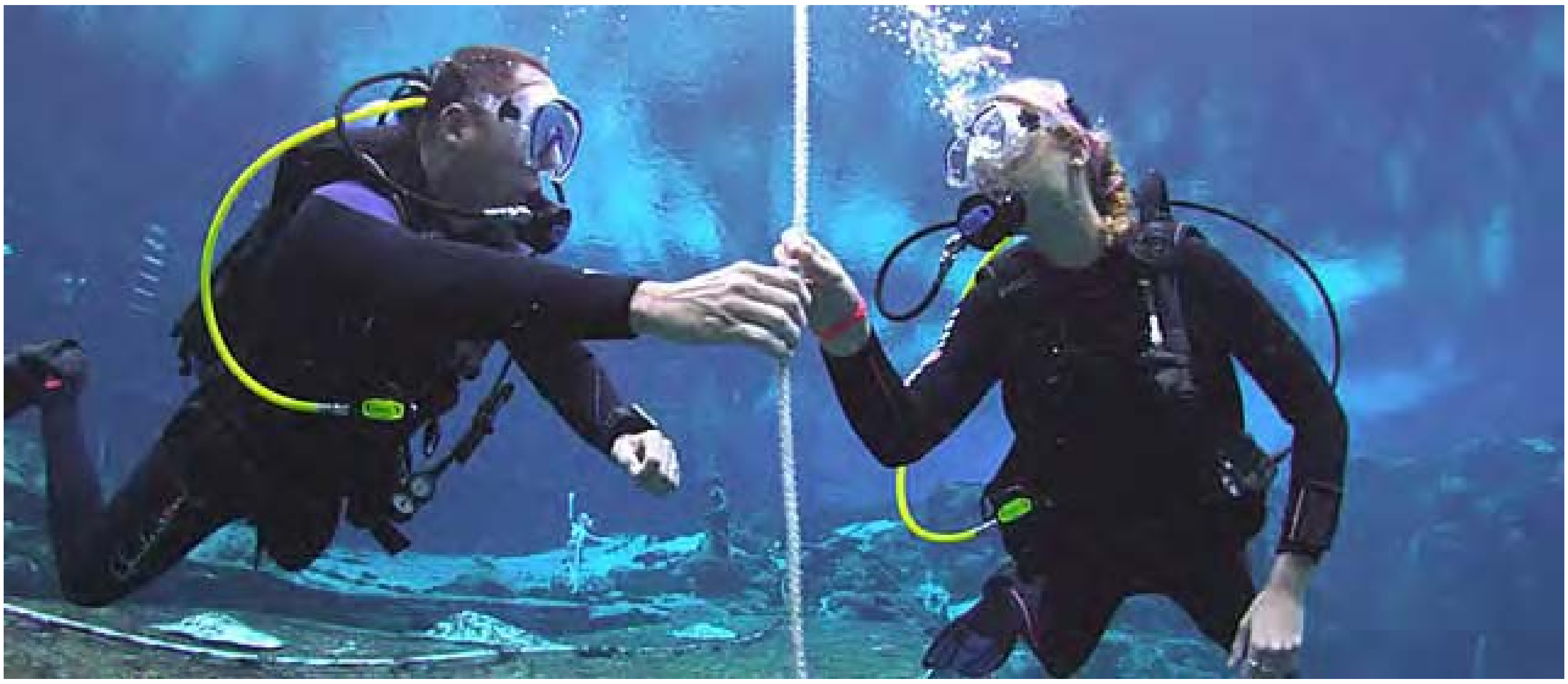
Simply being with other divers doesn't make you a team. Real teamwork requires planning and discipline.

## Team Diving Benefits

Every diver training organization and nearly every diving expert recommends and encourages divers to dive in teams of two or more. There is a reason for this: team diving offers benefits in the areas of safety, enjoyment and efficiency that solo diving generally does not. These benefits include:

- *Safety:* This is, arguably, the single greatest benefit of team diving. Unless you are carrying some sort of independent alternate air supply, such as a pony or sidemount cylinder, a buddy with an alternate air source will likely be your only option if you want to make a slow ascent and safety stop while continuing to breathe normally. However, increased safety goes beyond just this. If you are incapacitated or lose consciousness under water, no amount of self-rescue training will save you. A competent buddy, however, may well be able to.
- *Enjoyment:* Man is a social creature. Most of us find that activities are a lot more enjoyable when we get to do them with others. That's not to say you can't have fun on your own —

just that you are likely to have *more* fun when you dive with others.



- *Efficiency:* Two or three divers can almost always accomplish more than one diver can. Before the dive, two or more divers can split the planning, logistics and heavy lifting. During the dive, two or more sets of eyes will almost always see more than one pair does. Additionally, as each diver has individual strengths and weaknesses, you can assign tasks according to each diver's abilities and simply get more done.

Despite these benefits, team diving is not without its drawbacks. These chiefly have to do with what happens when one diver's safety and enjoyment are compromised by the inexperience, inability, poor attitude or poor judgment of another. Some people argue that, in such a situation, the competent diver might simply be better off on his or her own. Which leads us to…

## Solo Diving: The Team of One

Depending on who you talk to, solo diving is either a crime against humanity, whose evil is only eclipsed by dope dealers and terrorists, or a misunderstood activity whose benefits may, at least at times, outweigh those of team diving. Which point of view is correct? It really depends on circumstances.

- A competent, self-reliant diver could, conceivably be safer than two incompetent buddies, or a competent diver whose safety is compromised by an egregiously bad partner.

- There is no question, however, that two or three competent and self-reliant divers, diving together as a coordinated team, are far safer than one diver diving alone, no matter how competent.

NASE recognizes that some divers will elect to dive by themselves, whether doing so is wise or not. Ultimately, the decision to solo dive is one each diver has to make for himself (assuming a dive operator even allows solo diving from their boats or premises).

Before one even considers solo diving, common sense dictates there are certain conditions that must be met, including:

- *Experience:* Solo diving requires an overall level of experience and ability well beyond that of someone with just a few hundred dives under his or her belt.

- *Training:* Diving independently of a buddy requires specialized training in the techniques of buddy-independent diving. Some organizations offer specific courses in this. All training agencies offer certifications that, while not intended to qualify someone for solo diving, nevertheless effectively do. We'll discuss this last point in greater depth shortly.
- *Equipment:* Solo diving requires specialized equipment — chiefly in the area of redundant gas supply. With no buddy

around to help you solve an out-of-air situation, you effectively have to carry your "buddy" with you, in the form of an additional bottle, such as a pony bottle or sidemount cylinder.

Even with sufficient training, experience and equipment, there are some risks these precautions simply can't mitigate, including:

- *Sudden Incapacitation:* A severe injury or the sudden onset of an illness can incapacitate a diver beyond the ability for him to care for himself.
- *Loss of Consciousness:* If you lose consciousness while diving in a team, your teammates may well be able to get you to the surface and resuscitate you. That can't happen when you are by yourself.
- *Severe Entrapment or Entanglement:* We know, from first-hand experience, of good divers who nevertheless perished in situations where a buddy could have gotten them unentangled or unstuck. Unfortunately, no buddy was around to do so.

A number of organizations and individuals simply condemn solo diving under all circumstances. However, there is a certain hypocrisy in doing so. Consider the case of an instructor, assistant instructor or divemaster who is teaching, assisting with training or guiding less experienced divers.

- Where a solo diver's attention might be focused almost entirely on his own safety and survival, the dive leader's attention is generally focused outward to those for whom he is responsible.
- While the instructor, assistant instructor or divemaster is busy looking out for the safety and well being of their students, who is looking out for them? You might be tempted to say, "Well, isn't the divemaster the instructor's buddy — and vice versa?" *No*, they are not. They are neither looking out for one another or likely even close to each other.

- In a teaching situation, a dive leader who suddenly finds himself without air can always pick up on one of his divers' alternate air sources. But what if he suddenly becomes incapacitated or unconscious? Are his students or divers anywhere near qualified to respond?

NASE Worldwide neither encourages nor condemns solo diving. The decision to do so is one each diver has to make — although divers would be wise to consider *all* of the risks in doing so.

NASE *does not* offer a specialized Solo Diver certification. We do, however, offer Divemaster, Assistant Instructor and Instructor training and certification and, as you have seen, some of the risks involved in teaching and guiding divers go beyond those of solo diving.

One thing we can tell you, however, is that solo diving is an activity well beyond the limits of someone at your current level of training. That should pretty much table further discussion for the time being.

## The Ideal Team

How many members constitute the ideal dive team? Depending on circumstances, two or three.

- Two divers is, of course, the minimum — and what we generally think of when we hear someone refer to a *buddy team*.

- A team can also be comprised of three divers. This is common when the overall dive group has an uneven number of members. In cave diving, three divers is considered the ideal team, as you have two people to help in the event of an out-of-air emergency, instead of just one. The same thing can be true in recreational diving — or you can have a situation in which the three-person team degrades into one buddy pair and a solo diver. *That's not good.*

- With the exception of a class or dive group being lead or guided by a designated divemaster or leader, teams of four or more divers generally *don't* work. They quickly break up into individual buddy pairs and, sometimes, the occasional solo diver. Better to stick with two- or three-person buddy teams.

## Team Goals

Among the surest ways to guarantee failure is for a dive team to get in the water with no clear idea of where they are going, who is responsible for getting them there and back, and what they will do along the way or when they get there. Before you and your teammates even get in the water, there are things you need to discuss and agree upon, including:

- *Where do you want to go?* Do you have a specific destination in mind, such as a reef or wreck, or do you just want to do a scenic tour of the bottom.
- *How do you plan to get there?* Is there a specific compass heading you need to follow or (more likely) a natural-navigation route that will take you where you want to go?
- *Who will be primarily responsible for navigation?* Even though all team members need to agree on where you are going and how you will get there, you need to designate one person as being primarily responsible for navigation. If you don't, you risk having the team split up and go in different directions.

- *What special activities do you plan to engage in?* Is it just a sight-seeing dive — or do you plan to shoot photos or video? Bear in mind that, unless all team members are engaged in the same activity, things are likely to *not* work out too well.

You also need to agree on the parameters of planned and maximum depth and time, as well as Minimum Gas Reserve (MGR) and whether or not your remaining gas is half usable or all usable.

## Team Positioning

Even though you've designated a team "leader" who will be primarily responsible for navigation, you'll want to avoid swimming single-file. A single buddy pair is best off swimming side-by-side. Depending on circumstances, a three-person team may be better off swimming three-abreast, or having the lead diver swimming just slightly in front (but where he can still turn and maintain eye contact with fellow team members).

There are several reasons why side-by-side positioning is better for recreational divers.

- It minimizes the risk of a diver being left behind.
- It allows divers to keep their buddies in sight at all time and maintain direct eye contact simply by turning their heads.
- Divers can gain their buddies' attention and signal one another instantly.
- If there is an out-of-air or other emergency, divers are in the best possible position to respond.

When descending or ascending along a line, divers should face one another, try to remain within arm's reach and maintain eye contact.

# Key Points to Remember

- Team diving offers benefits in the areas of safety, enjoyment and efficiency that solo diving generally does not.
- Solo diving requires special training and equipment, and a level of overall experience that is well beyond what most recreational divers possess. Even then, there are risks that no amount of training and equipment can manage that simply aren't present when divers dive in teams.
- The ideal dive team is two or three divers. Any more than this tends to break down into separate buddy pairs and, possibly, one or more solo divers.
- As part of the planning process, team members need to agree on where they are going, how they will get there and what they plan to do along the way or at their destination. They also need to agree on parameters such as depth, time and Minimum Gas Reserve.
- Team members are best off swimming side by side. Doing so helps avoid buddy separation and allows divers to quickly communicate with one another and respond quickly to any problems.

# Underwater Navigation

Why worry about navigation? Compasses are complex and no one can remember all of those terms like *bearing* and *azimuth* — or even what they mean…right? What makes it worth the time to learn?

As it turns out, the ability to navigate under water is among the most valuable of all scuba skills. Among its many benefits:

- You no longer need to blindly follow a divemaster, instructor or more capable buddy. As a navigator, you can be the one who leads the way.
- By learning to navigate, you use time and breathing gas more effectively, wasting little or no time wondering where the heck you are.
- As being lost can put you some distance from the security of the boat or shore, or in hazardous environmental conditions, being able to navigate is also safer.

Nevertheless, many divers find the thought of having to do so daunting. Unfamiliar terms such as *azimuth, bearing, heading* and *reciprocal* make the process sound intimidating, as does the notion that you need graduate-level trigonometry to navigate successfully.

> The good news is, the vast majority of the time, all you need under water is what we call *natural navigation*. This is merely an extension of how you find your way around on land. In fact, if you've made even one dive in which you did not blindly follow someone else, you've already used natural navigation — possibly without realizing it.

On rare occasions, you also need to be able to use an underwater compass. Forget the bewildering terms and complex mathematics, though. We're going to make this idiot-simple.

Let's get started.

# Natural Navigation

## Study Questions

As you go through this material, look for the answers to the following:

- *What are several examples of underwater "roads" divers can follow when navigating without a compass?*
- *How do underwater signs and landmarks affect your ability to navigate without a compass?*
- *How can divers combine the elements of natural navigation to find their way under water?*
- *What is the most important factor in natural navigation?*

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If you have made even one dive during which you were not blindly following someone else, you've already made use of natural navigation — possibly without even realizing it. Natural navigation under water is merely an extension of how we get around on land. Consider how you get home from work at night:

- You follow roads.
- You turn at intersections.
- You are further guided by signs and landmarks.

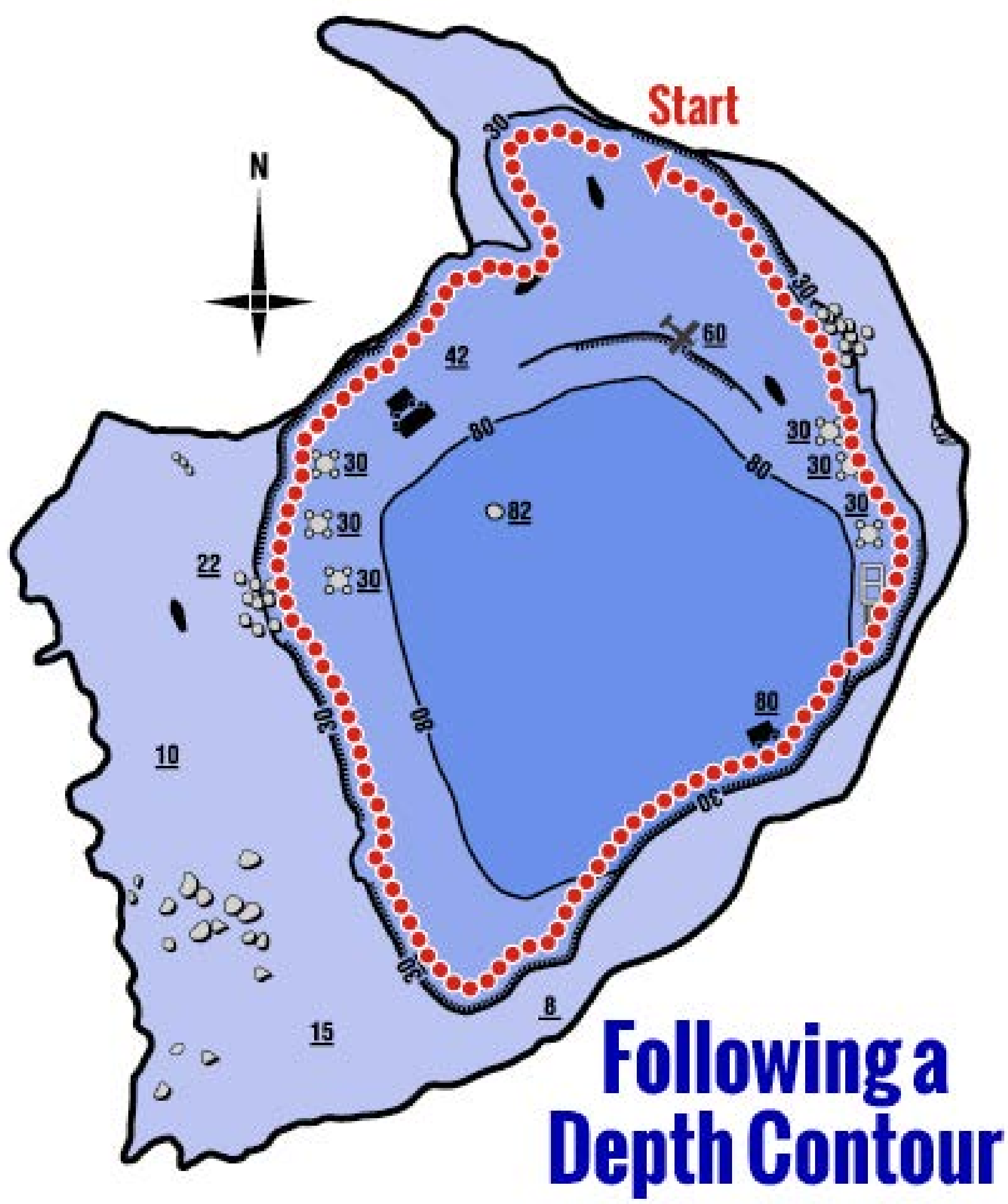

You do much the same under water.

## Underwater Roads

The "roads" we follow under water are seldom paved and generally not man-made. Nevertheless, they can point the way as surely as if they were. Examples of underwater "roads" that divers frequently follow include:

- *Reef Lines and Sand Channels:* Coral reefs often array themselves in lines with edges that are easy to follow for long distances. Coral reefs will also frequently lie parallel to one another, forming easily followed sand channels between them.
- *Walls and Slopes:* Walls are vertical; slopes are angled. Navigating them, however, is much the same. You can, for example, swim

along the base of a wall or slope. Alternately, you can swim along the drop off where the wall or slope begins. You can also swim part way down a wall or slope by following a *depth contour*. Do this by using your computer to maintain a constant depth while keeping the wall or slope on your right or left (you can return to your starting point by maintaining the same depth and keeping the wall or slope on the opposite side).



- *Man-Made "Roads:"* Occasionally, you actually follow a man-made road under water, such as one that existed before a quarry was flooded or a lake was dammed. More common examples of man-made "roads" include the sides of a shipwreck or guidelines installed by divers to help others find their way around a popular dive site.

Where any of these "roads" intersect, you have the opportunity to change direction. Examples might include:

- Two intersecting reef lines.
- A wreck lying perpendicular to a drop off.
- A permanent guideline intersecting a wall or canyon.

## Signs and Landmarks

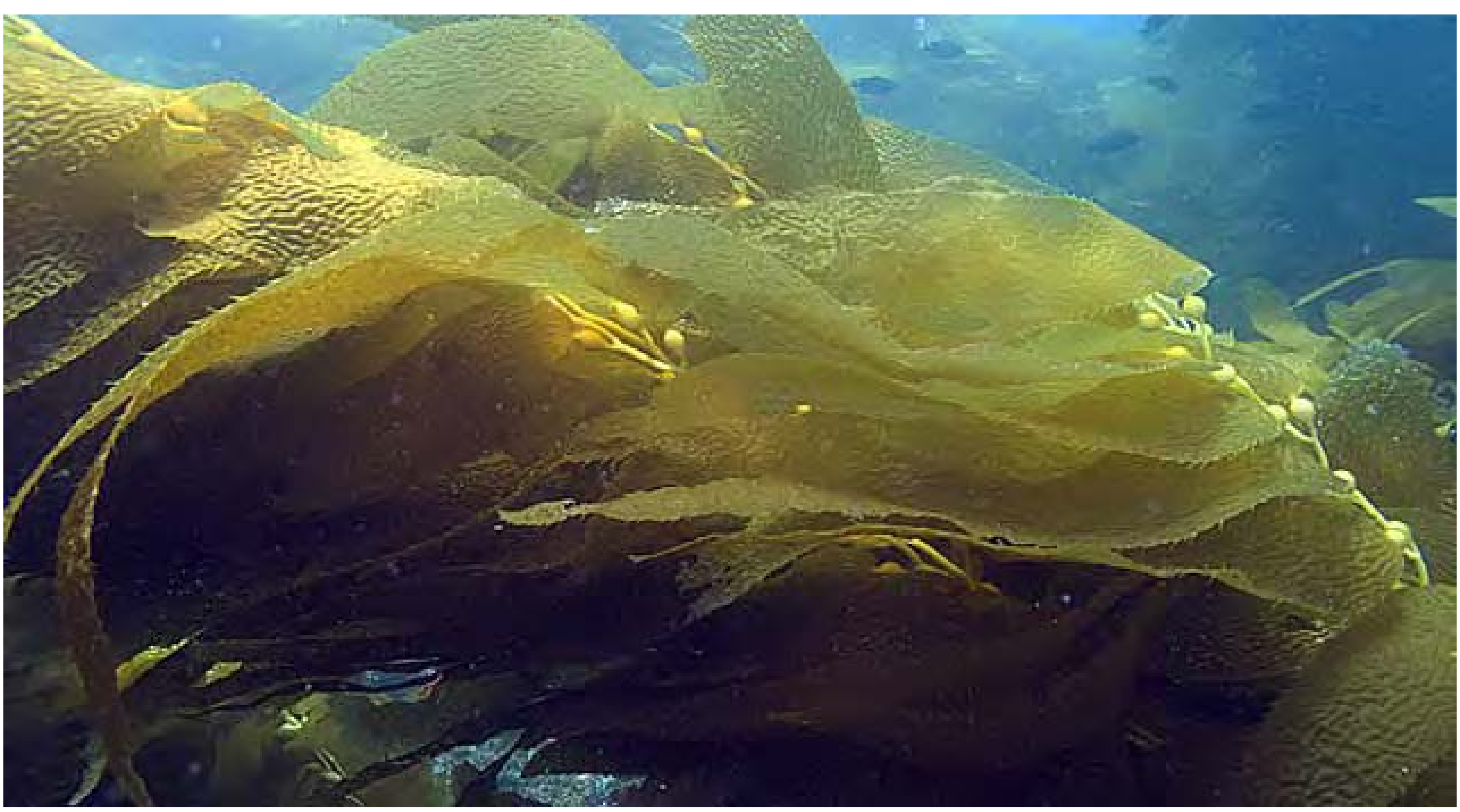
Underwater signs and landmarks can serve as confirmation that you are, in fact, headed in the right direction. They can also mark a point at which you will want to change direction. Given sufficient visibility, you can even navigate by swimming across a featureless bottom from one landmark to the next. Examples of underwater signs and landmarks include:

- *Sunlight:* Students in orienteering courses on land learn to use the sun as a navigational reference. It is possible to do so under water as well — although the fact water quickly diffuses sunlight limits this ability. While you are not likely to see sunlight cast any distinct shadows under water, in shallow water you may notice that the side of a wreck, reef or rock formation that is opposite the sun is darker. For the most part, increases or decreases in the overall levels of sunlight and color provide confirmation of changes in depth, often warning you of such changes before you can consult your dive computer.

- *Depth:* As a generalization, the shallower the depth, the closer you are to shore. There are exceptions, however, such as when ascending the side of an isolated pinnacle.

- *Sand Ripples:* Sand ripples, if present, will generally run parallel to shore. You can confirm this simply by noting the direction of incoming waves prior to entering. If you are swimming perpendicular to the sand ripples, and the depth is getting progressively shallower, odds are you are approaching the beach.

- *Current and Surge:* At times, detecting the presence of current or surf is easy — such as when it is dragging you along the bottom.

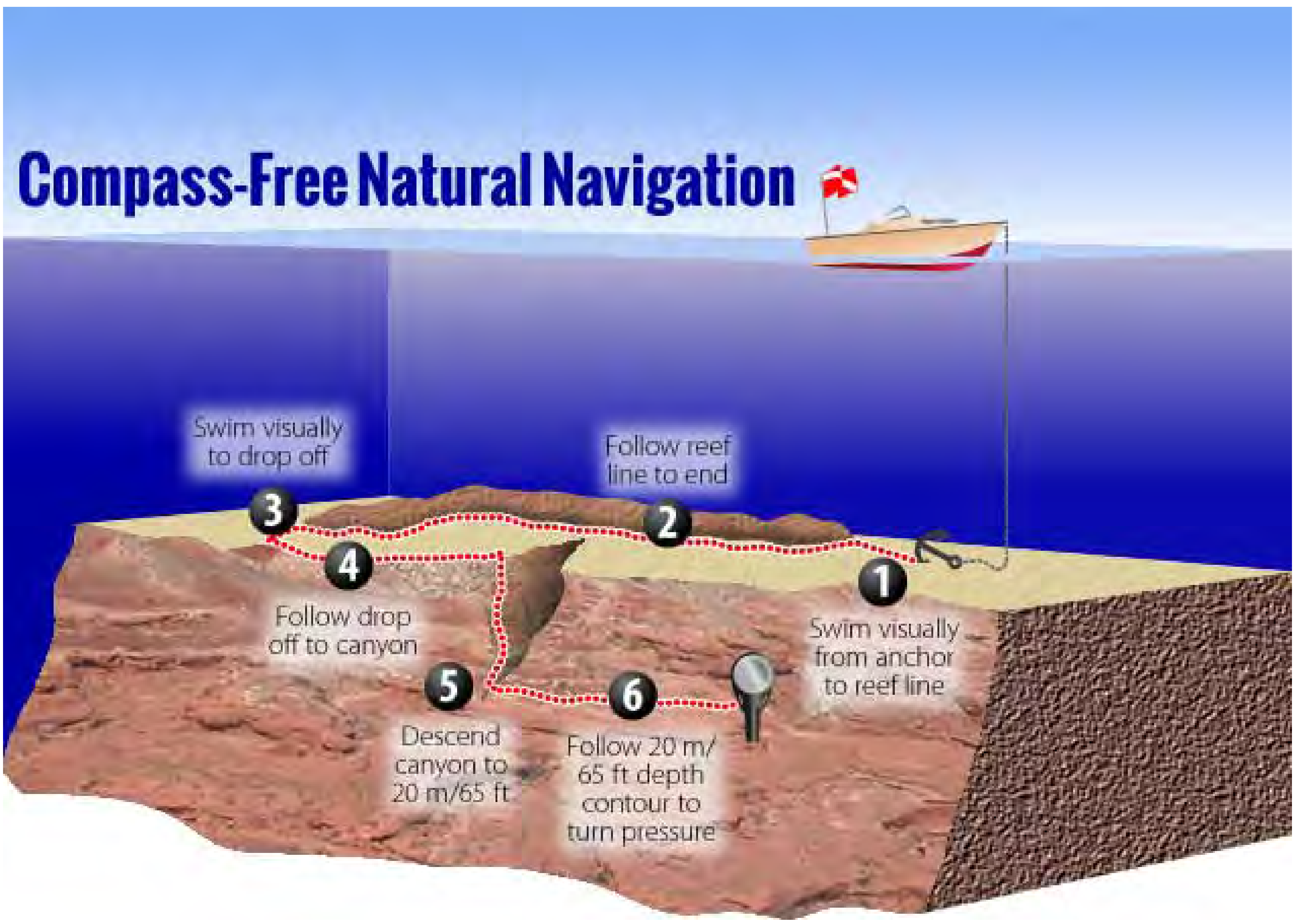


In general, however, the signs are more subtle, such as kelp or vegetation leaning in one direction, or the back-and-forth motion of soft corals as waves pass overhead. For this information to be useful, however, you have to know certain things going in, such as the direction of longshore currents, or which direction the waves are moving above you. This further underscores the importance of a careful site assessment before entering the water.

- *Distinct Coral or Rock Formations:* Unusually large coral or rock formations make great landmarks — particularly if you have seen them before, or have gotten a detailed description of them from other divers. These items share the virtue of seldom being identical. Therefore, if you find yourself "a might bewildered" and then stumble across a familiar landmark, you will at least know where you are.
- *Wrecks and Other Man-Made Artifacts:* Coming across a familiar wreck or artifact provides the same sort of confirmation of where you are as coming across a familiar rock or coral formation. Additionally, unless very broken up, large wrecks generally make it easy to find your way around — much more so than trying to follow a series of random coral heads.

# Putting it All Together

The following illustration shows how you can use these various factors in combination with one another to make a rather lengthy dive without ever consulting a compass.




In this example, divers are able to follow a reef line, a drop off, an underwater canyon and a depth contour for several hundred meters or yards before reaching their gas turnaround point.

# Limiting Factors

Nothing in life is perfect and, even though natural navigation is all you need most of the time, it does have its limitations.

- A flat, featureless bottom may provide little in the way of reference points for effective navigation. Fortunately, unless you become lost, the odds of finding yourself in such a situation are slim. After all, if there is nothing to see, there is little reason to go there.
- *The biggest single limitation in natural navigation is visibility*. Trying to find your way under water in poor visibility is like trying to drive in dense fog. When you can no longer see familiar landmarks, knowing where you are or where to turn is difficult.

When you have no apparent underwater "road" to follow, or can't see your way from one way point to the next, natural navigation can become next to impossible. A similar problem can exist in good visibility if the distances between landmarks is still greater than the eye can see. This is why, even though we seldom use it, compass navigation is a skill every diver needs.

# Key Points to Remember

- Underwater "roads" can include reef lines and sand channels, walls and slopes, and man-made "roads."
- Underwater "signs" and landmarks can serve as confirmation that you are, in fact, headed in the right direction. They can also mark a point at which you will want to change direction.
- Just as when navigating on land, divers can combine "roads" and landmarks to find their way under water.
- Underwater visibility generally is the most important factor in natural navigation. It's tough to navigate using visual references when you can't see.

# Compass Navigation

## Study Questions

As you go through this material, look for the answers to the following:

- *What are the four critical parts of an underwater compass?*

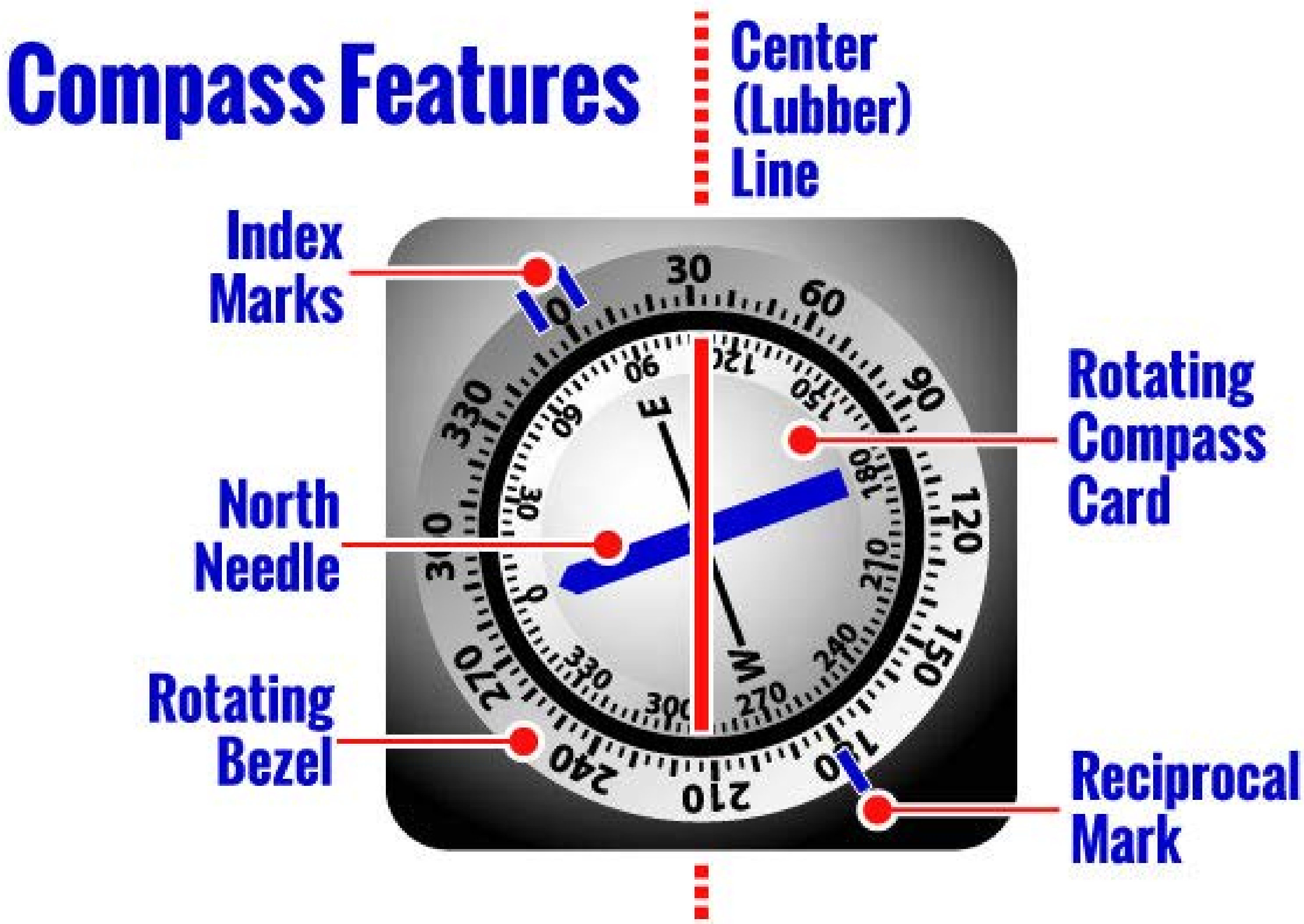
Many divers go months — or even years — without needing to use a compass. Depending on where they dive, some divers *never* need to use a compass. Nevertheless, in those comparatively rare instances where you do need a compass, there is no substitute for having one — and for knowing how to use it effectively.

In this section, we will discuss:

- Compass Features
- Using an Underwater Compass
- Understanding the Limitations of Compass Use
- Measuring Distance Under Water

## Compass Features

Before you can use a compass, you need to understand its features and what they do. Underwater compasses fall into two broad categories: *mechanical* and *digital*.




**Mechanical Compass Features:** Let's look at these first. They include:

- *North Needle:* The one thing that all compasses have in common is a needle or indicator that points to magnetic north. On underwater compasses, this is generally incorporated into a *compass card*, a rotating disc that may also have the other *cardinal points* of the compass (*East, South* and *West*), as well as degree numbers and markings. It's important to understand that, in order to work properly, the compass card or north needle needs to be able to turn freely — and, to do that, you must be holding the compass *perfectly level* when using it.

- *Center Line:* Technically known as a *lubber line*, this is generally a brightly colored line that runs down the center of the compass. It's helpful to think of it as the compass's center line, as one of the keys to effective compass use is to keep the center line of the compass perfectly aligned with the center line of your body.
- *Index Marks:* These are generally incorporated into a rotating *bezel*, also with degree markings. (On some compasses just the index marks rotate; the bezel is fixed.) The index marks are used to mark where the north needle should be pointing when the compass is aimed in the desired direction of travel.
- *Reciprocal Mark:* This is a mark on the side of the bezel directly opposite the index marks. You use this mark when running a *reciprocal* compass course — which is basically just returning to your original starting point.


Compass with Side Window

- *Side Window:* Most better-quality compasses also incorporate a side window. Similar to "bubble" compasses found on boats and airplanes, the side window allows you to take a direct reading of your direction of travel, measured in degrees. Some divers prefer using the side window over the markings on the top of the compass.


Dive Computer with Compass

**Digital Compass Features:** A relatively new development in underwater compasses, digital compasses are most often incorporated into better-quality dive computers (although it's rare for a new dive computer to be introduced that *does not* have this feature). Exactly how these compasses work can vary widely by make and model. As a generalization, most work in a manner very similar to side-window compasses. You will need to read the owner's manual for your particular computer, however, to see exactly how yours works.


**Compass Mounting Options:** There are at least four different ways you can mount an underwater compass:

- *Console Mounting:* This is by far the most popular way of carrying and using a compass. It not only keeps all of your instruments together, it also makes using the compass easier than using a wrist-mounted compass. Depending on the make, the compass may be mounted on the top, side or back of the console. Ideally, the compass should be on the same side of the console as your computer or depth gauge, so that you can monitor depth while following the compass.
- *Retractor Mounting:* Some divers don't like the bulk associated with big consoles, preferring instead to use wrist-mounted dive computers and other instruments. For reasons we'll discuss shortly, there are some limitations to using wrist-mounted compasses. An alternative is to mount the compass on a retractor. This way, you can pull it out when needed, and leave it clipped off (or back in your dive bag) when it is not.
- *Wrist-Mounting:* The most basic compasses come with a wrist strap. If you find yourself in possession of such a compass, our advice is to look for an alternative means of mounting ASAP.
- *Slate Mounting:* It's unusual to see recreational divers use slate-mounted compasses. These are more common among research divers, such as underwater archaeologists, and Special Operations divers, such as SEALs, who have very high-tech

*compass boards* for traveling long distances to enemy beaches. Compass boards also come in handy for underwater map making and, due to their extended center line, are among the most accurate ways to use a compass under water.

# Key Points to Remember

- The four critical parts of an underwater compass are the bezel, center or *lubber* line, index marks and degree markings.

# Using an Underwater Compass

## Study Questions

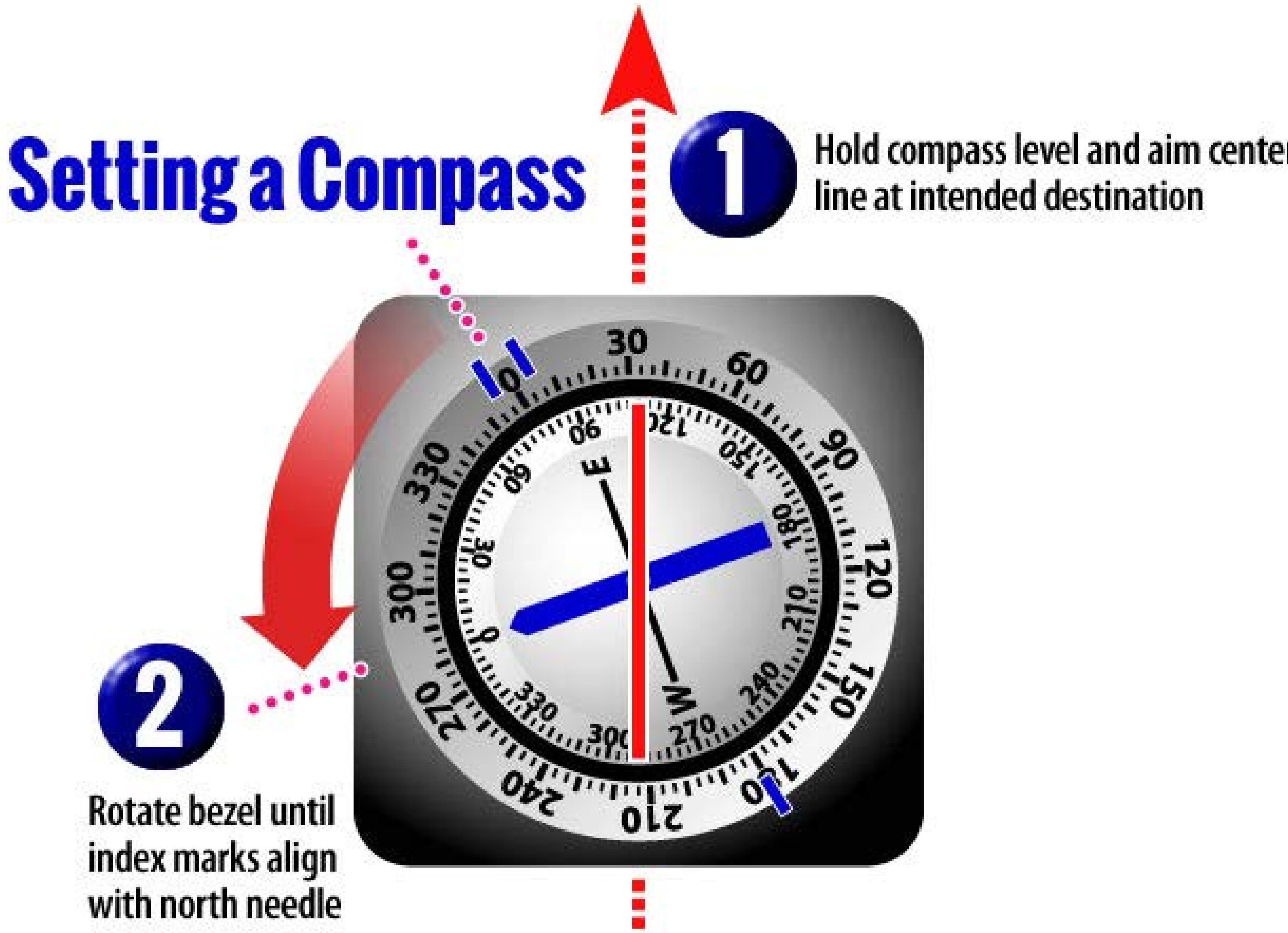
As you go through this material, look for the answers to the following:

- *What factors affect how you set an underwater compass?*
- *What is the greatest limitation on the accuracy of underwater compass use?*

There are two aspects to using an underwater compass:

- Setting the compass prior to use, and…
- …following the compass under water.

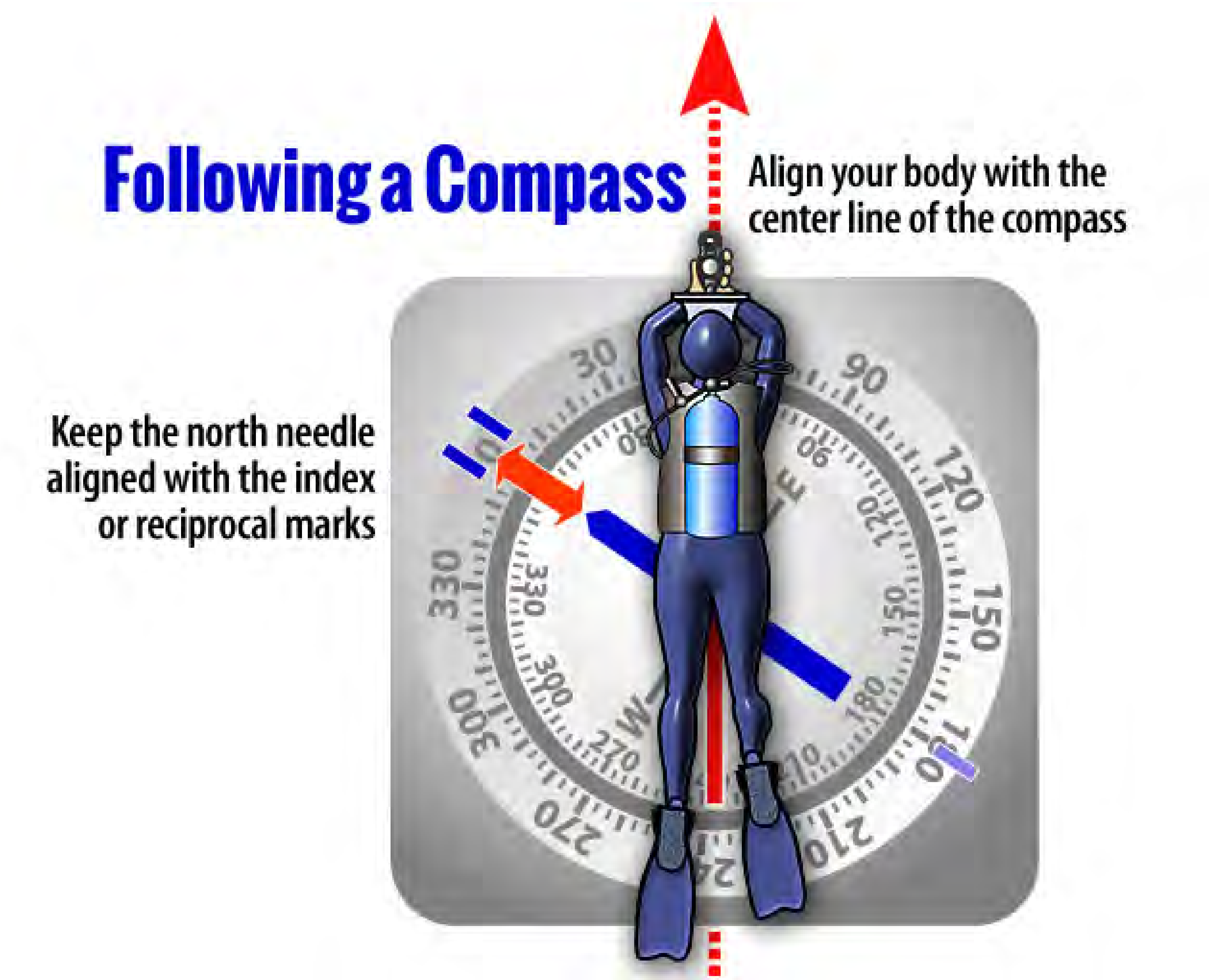
**Setting a Compass:** Before you can use your compass under water, you need to *set* it for your intended destination. This means either establishing a degree heading for that destination or marking where the north needle should point when the compass's center line is aligned in the right direction. This is also known as taking a *heading*.




- *Setting a Top-Reading Mechanical Compass:* This is pretty easy. Start by holding the compass perfectly level. Aim the center line at your desired destination. Allow several seconds for the north needle to stabilize. Rotate the index marks so that they are aligned with the north needle.
- *"Setting" a Side-Reading Compass:* You don't actually "set" a side-reading compass as you do a top-reading one. What you do, instead, is aim the compass at your desired destination, al-

low several seconds for the compass card to settle, then make a mental note of the degree heading you see in the side window when it does.

Most digital compasses will work in largely the same manner as a side-reading mechanical compass (although some may also provide a means to lock in a digital heading). Consult your owners manual for specific instructions.



By the way, when talking about compass use, you will also hear the terms *bearing* and *azimuth* in addition to *heading*. For all intents and purposes, they mean the same thing.

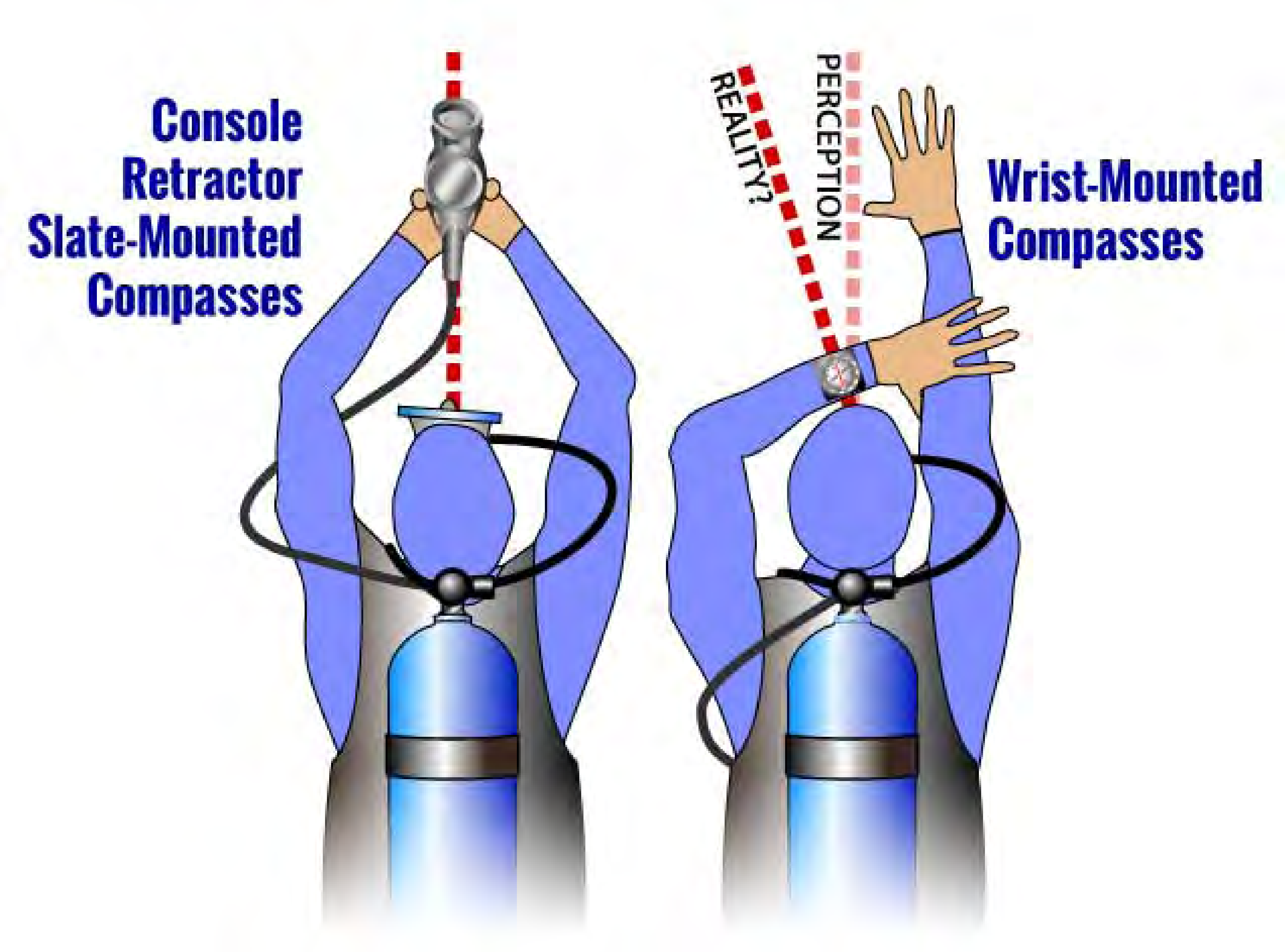
Once your compass is set, you are ready to go underwater and follow it.

**Following a Compass:** Just as you set top- and side-reading compasses differently above water, you use them differently under water.

- *Following a Top-Reading Compass:* As always, start by holding the compass perfectly level. Align the center line of the compass with the center line of your body. Now turn your body until the north needle is centered inside the index marks. Swim in the direction the center line points while keeping the north needle inside the marks.
- *Following a Side-Reading Compass:* Again, keep the compass level. Hold the compass in front of you so that the center line of the compass aligns with the axis of your body. Turn your body until the degree heading you noted on the surface is centered in the side window. Swim in the direction the center line points while keeping the correct degree heading centered in the window. It may take a while to get used to the fact the

compass card *is not* moving; you and the rest of the compass are rotating around it.

As we mentioned before, following a digital compass will be largely the same as following a side-reading mechanical compass. See your owner's manual for specifics.




**Holding a Compass:** If using a console-, retractor- or slate-mounted compass, just hold the compass in front of you while keeping the center line aligned with the axis of your body.

If need be, you can continue to hold onto the compass with one hand while making a buoyancy adjustment with the other.

But what if you have a wrist-mounted compass? Many diving textbooks show a position in which the diver holds one arm straight out in front of him, while bringing the arm with compass across so that the compass is directly in front of the diver's eyes. This works great…in theory (and a few divers can actually pull it off). What usually happens, though, is that while you may *think* the compass is correctly aligned with your body's axis, it is actually off by several degrees. Also, you now have both hands tied up, making buoyancy adjustments more of a challenge.

This is what we alluded to earlier when we said that wrist mounting a compass was a less-than-desirable option. Bear in mind, too, that many of the computers that have built-in digital compasses are wrist-mounted models. If you find yourself with such a compass, what can you do?

- If you anticipate doing a lot of compass following, you may want to consider moving your compass or your computer to a retractor.
- As an alternative, you can also take your compass or computer off your wrist and simply hold it in your hands while running a compass course (just don't drop it).

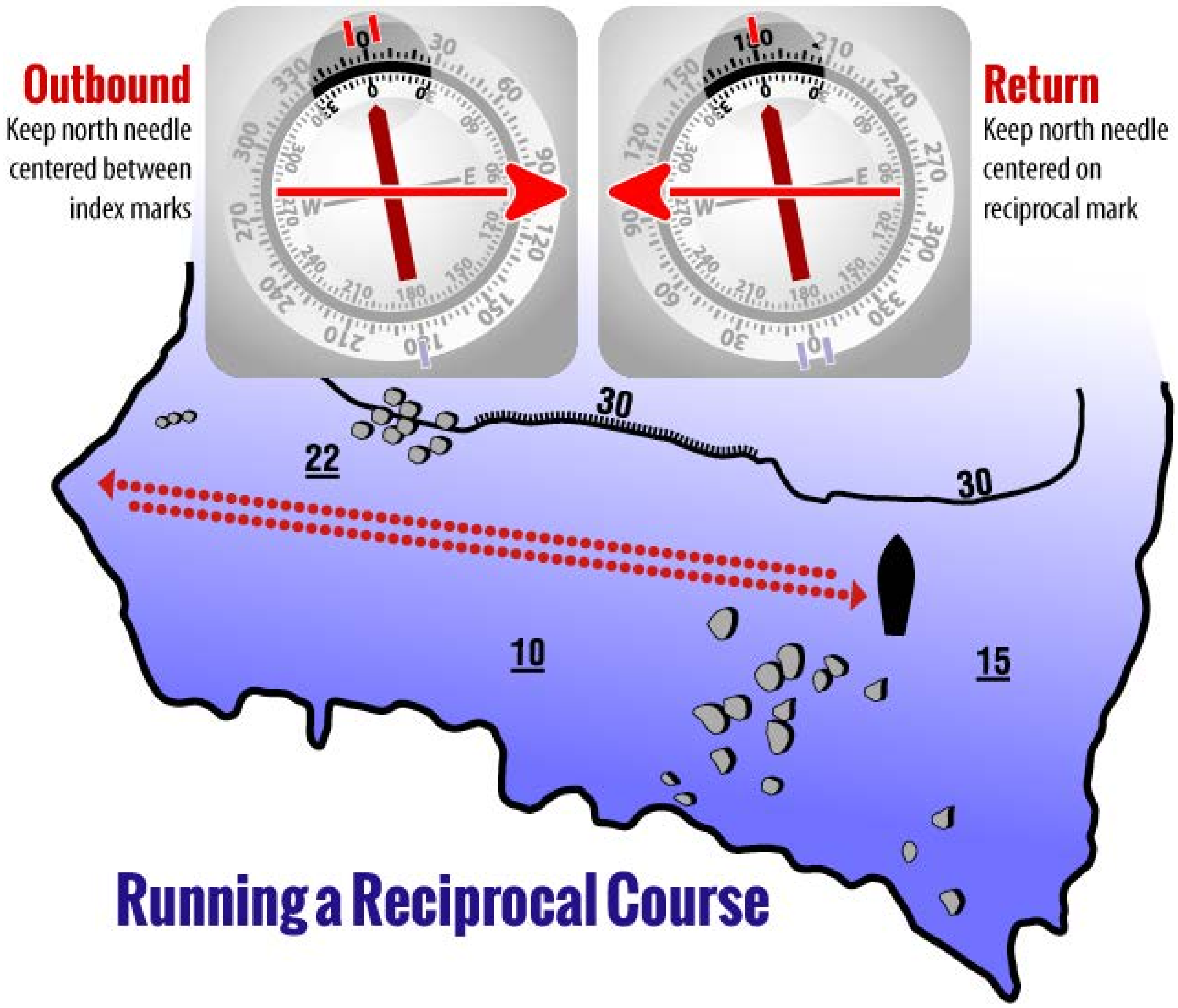
**Running a Reciprocal Course:** Sometimes using a compass entails making a one-way trip. For example:

- When diving in very shallow water (10 m/30 ft or less), it's common to travel farther from the boat or shore than you would on deeper dives.
- This being the case, there is also a greater likelihood that you may have difficulty finding your way back to your starting point using natural navigation alone.
- If this happens, you could simply ascend and hoof it back to the boat or shore on the surface. However, this can be exhausting and puts you at greater risk from boat traffic.
- The better alternative is to surface, take a heading on the boat or shore, then descend and swim to your exit point under water, following your compass heading.

Of course, for this to work, you'll need to estimate the distance to your exit point and then swim only that far under water. If the boat does not appear over head (or you don't run into the beach), surface and take a new heading. We will discuss how to measure the distance covered under water shortly.

Most of the time, however, you will be relying on your compass to get you out to your intended destination and back again. The return trip is what is known as running a *reciprocal* course.

Here is how you do it:




- *Running a Reciprocal Course Using a Top-Reading Compass:* If your compass is equipped with a reciprocal mark, there is no need to re-set the bezel. Simply align the compass so that the north needle points directly at the reciprocal mark. If your compass lacks a reciprocal mark, simply turn it so that the *south* end of the north needle aligns with the index marks.

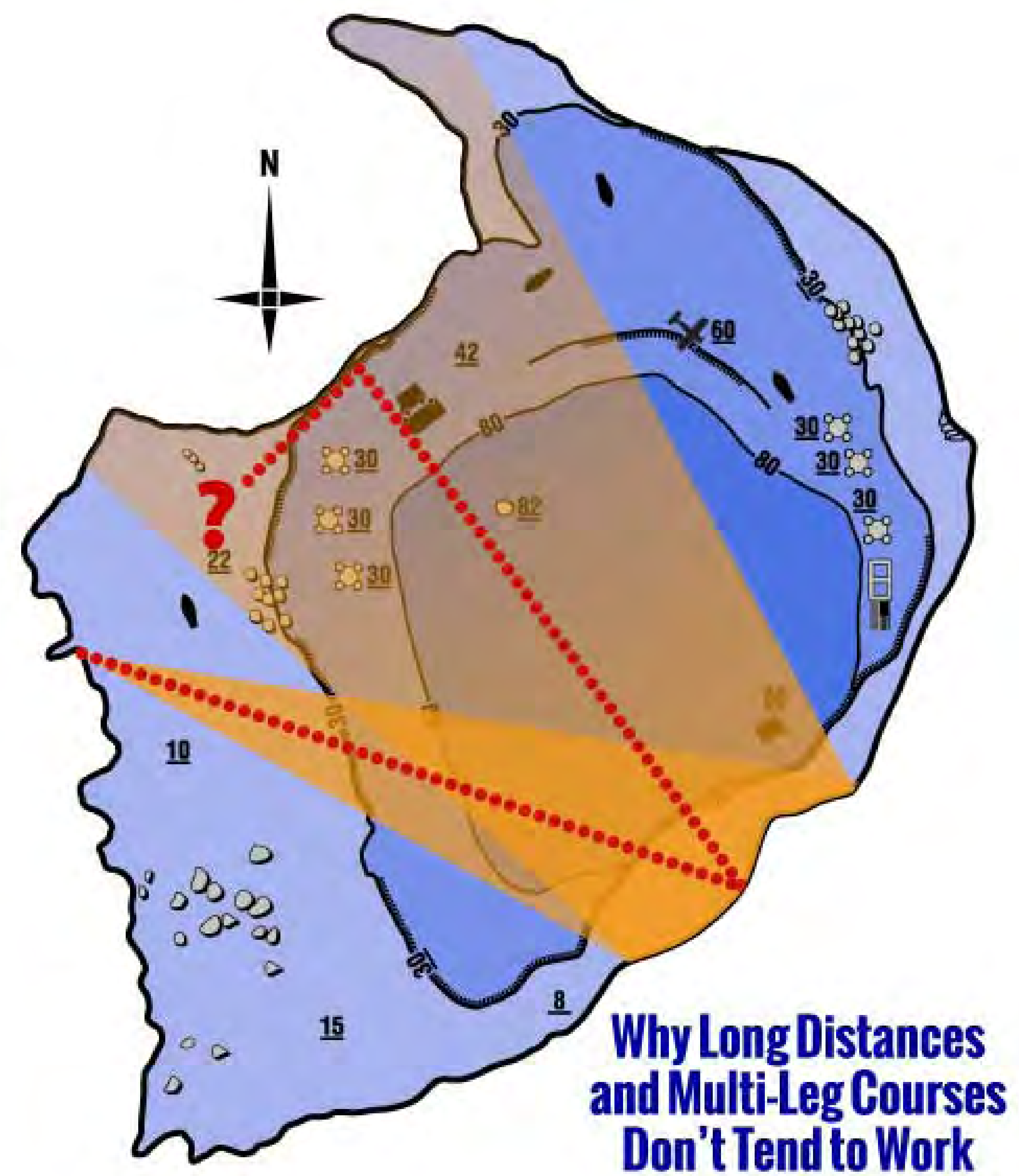
- *Running a Reciprocal Course Using a Side-Reading or Digital Compass:* If your original heading was *less* than 180 degrees, *add* 180 degrees to it. If it was *more* than 180 degrees, *subtract* 180 degrees. The new number is your reciprocal course.

## Limitations of Compass Use

Using an underwater compass is not like using your car or truck GPS. Even on your best days, you are going to miss your intended destination by as much as 10 to 15 degrees. If the distance you are trying to cover is short, this is no big deal. You'll likely see your destination, even if you don't hit it head on.

If you try to go a greater distance, this 10- to 15-degree "cone of error" increases the further you go. The problem is compounded if you try to run multiple-leg courses.

The following illustration brings the point home:




Dive instructors frequently have students run a small triangular or rectangular compass course as a means of gaining familiarity with compass use. With the exception of one situation we will cover later on, such complex courses have no practical application.

Something else you should be aware of is the dangers associated with running compass courses in deeper water. When using a compass, it's best if you keep the bottom in sight. Doing so makes it easier to maintain depth. When you lack this visual reference, it's easy to become focused on the compass and lose track of depth. You could, in fact, be changing depth and not realize it.

> Ending up on the surface rather than at your intended destination is, at best, embarrassing. At worst, if you did not realize your were rising, you risk coming up at a dangerous rate of ascent. Even worse than this is plunging into dangerously deep water without realizing it.

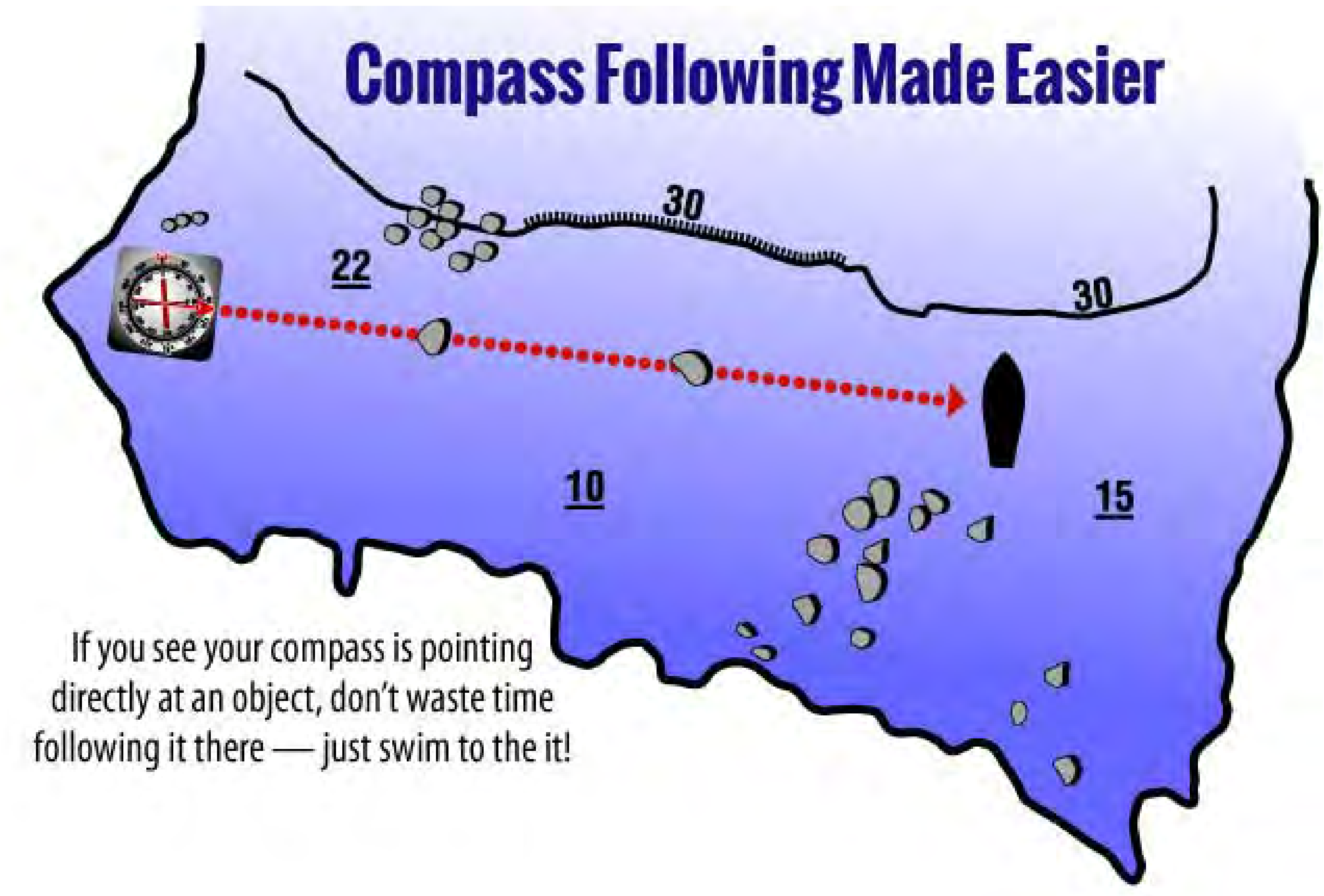
Some textbooks recommend having one buddy monitor the compass while the other monitors depth, alerting the compass user to any changes. *That doesn't work*. Trust us.

If you absolutely must run a compass course in water with no visual references, *both* buddies need to monitor depth. This is why it is helpful to have your compass in a console with your dive computer. Doing so makes it easier to monitor depth while following your compass.

Here is a trick that can greatly improve the accuracy of your compass courses:

- Before swimming blindly with your eyes glued to the compass, see whether the compass is pointing to a rock, coral formation or artifact in the distance.
- If it is, ignore the compass; *just swim to the object*. (Doing so will help you avoid that 10- to 15-degree error often associated with simply following the compass.)
- When you reach the object, use the compass to see if there is yet another object you can swim to along the same line of travel. Repeat this as often as you can until you reach your destination.

Doing this will significantly increase the accuracy of your compass courses.




To re-cap, to stay within the limitations of your compass:

- Keep the distances covered as short as possible. Avoid long-distance navigation and multi-leg courses.
- When using a compass, keep the bottom in sight. Avoid compass courses with no visual reference as to depth.
- Don't follow your compass blindly if you see there are one or more objects you can simply swim to in your line of travel. Doing this increases accuracy and helps you remain on course.

# Key Points to Remember

- The procedure for setting an underwater compass will vary depending on whether it is a top-reading, side-reading or digital model.
- Distance is the greatest limitation on the accuracy of underwater compass use. The longer the compass course, the greater the margin for error.

# Measuring Distance

## Study Questions

As you go through this material, look for the answers to the following:

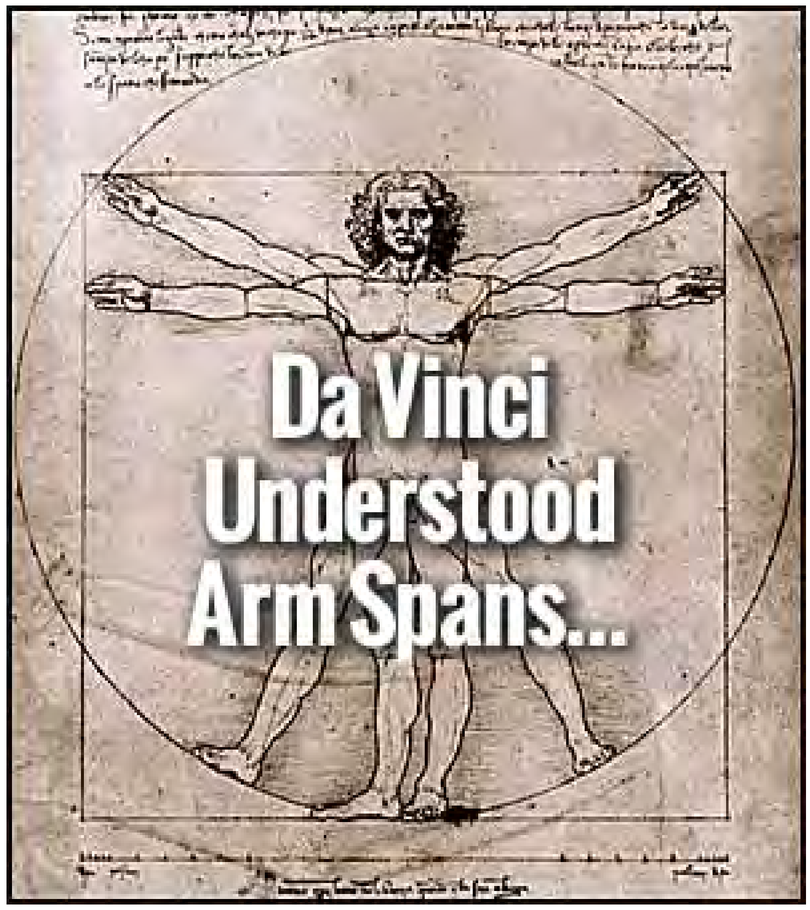
- *What is the most accurate (although not commonly used) means of measuring distances under water?*
- *What commonly used method of measuring distance under water is considered to be the most accurate?*
- *What is generally considered to be the most common method of measuring distance under water?*
- *What is a common alternative to measuring longer distances with kick cycles?*

When setting your compass on the surface, it's important to estimate the distance to your intended destination as well. Why? Given the inherent inaccuracy of underwater compass use, you can easily miss the object you are swimming to. *If you don't pay attention to the distance you have covered, you could end up overshooting your intended destination by a considerable amount.*

# Tape Measure

By far the most accurate means of measuring distances under water is to use a fiberglass tape measure, similar to those found on construction sites. These are frequently used by underwater archaeologists and other scientists. Cave divers use these tape measures and knotted guidelines when making maps. Unfortunately, it would not be very practical for recreational divers to carry and use such a big, bulky item.

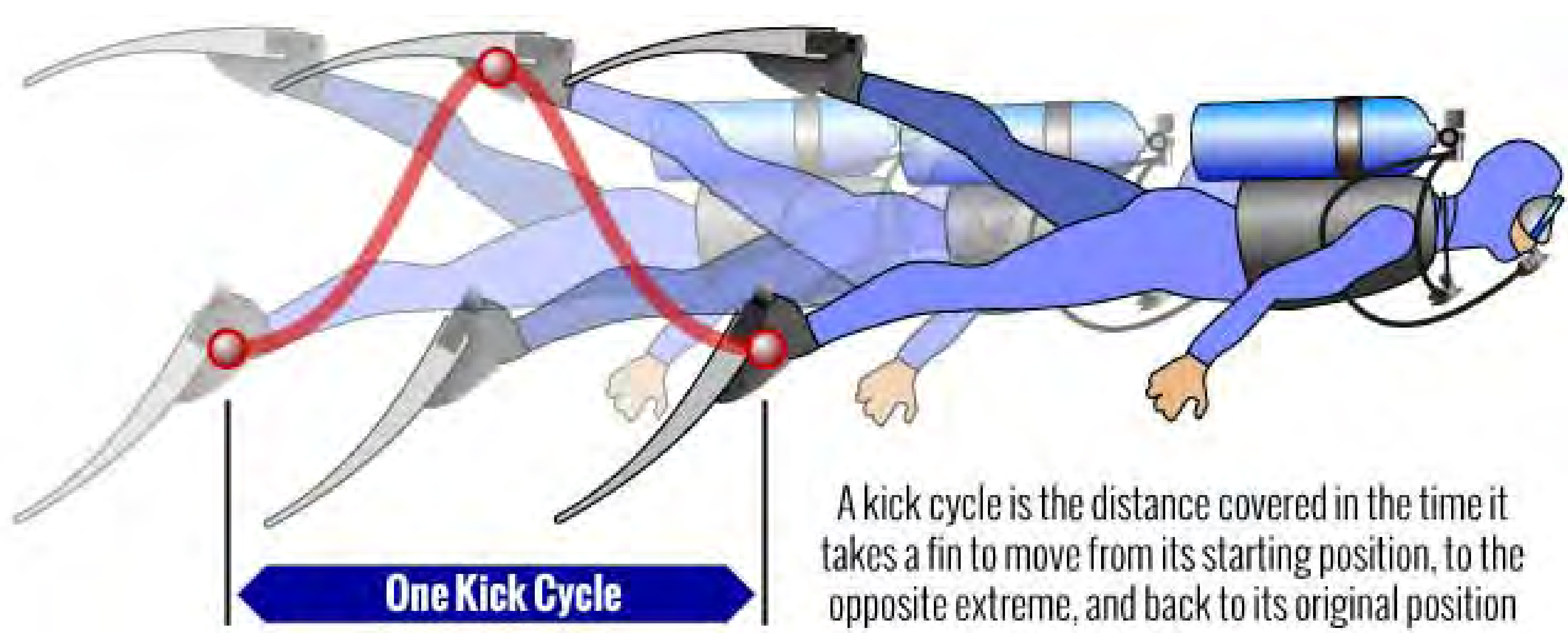
# Arm Spans




The most accurate way to measure distances underwater, using just what you have with you, is arm spans. Of course, to do so, you will need to measure what your arm span is ahead of time. Measuring with arm spans is practical when the distance to be measured is less than, say, a dozen or so arm spans. (For example, doing a survey of a small wreck.) For longer distances, though, using arm spans is impractical.

# Kick Cycles

The most common means of measuring distance under water is to use *kick cycles*. A kick cycle is the distance you cover in the time it takes one fin to move from its starting position, to the opposite extreme, and back to its starting position. To use kick cycles, you will need to do a baseline measurement, seeing how many kick cycles it takes to cover a measured distance of, say 100 meters or yards. Kick cycles have the further benefit of not requiring you to retrieve a reel or measuring tape afterward.



# Timed Swim

A final way you can measure distance under water is to establish a baseline for how many seconds it takes you to swim a fixed distance. If you know that, at a normal pace, you cover 50 meters or yards in a minute, and you are swimming to a wreck that is 100 meters or yards offshore, you should expect to hit the wreck after around two minutes of swimming. If you don't, it may be time to surface and check your bearings.

> It's important to understand that, short of using a fiberglass tape measure, measuring distance under water *will not* be perfectly accurate. You can easily be off by 20 percent or more. Additionally, no matter how accurate you are under water, you are comparing the distance covered against a visual estimate of distance you made at the surface. This could easily be *very* inaccurate.

All of this underscores why you should limit compass navigation to relatively short distances. The less territory you try to cover, the less the inherent inaccuracy of compass navigation will matter.

Remember the KISS principle: *Keep It Simple, Stupid*.

# Key Points to Remember

- By far the most accurate means of measuring distances under water is to use a fiberglass tape measure, similar to those found on construction sites.
- Among commonly used methods of measuring distance under water, *arm spans* are considered to be the most accurate. Only a fiberglass measuring tape is more accurate, and its use isn't commonplace.
- Kick cycles are generally considered to be the most common method of measuring distance under water.
- An alternative to measuring longer distances with kick cycles is to establish a baseline as to how many meters or feet you cover in a fixed number of seconds.

# Navigating Around an Obstacle

## Study Questions

As you go through this material, look for the answers to the following:

- *What can you do if you find your compass course blocked by an obstacle?*

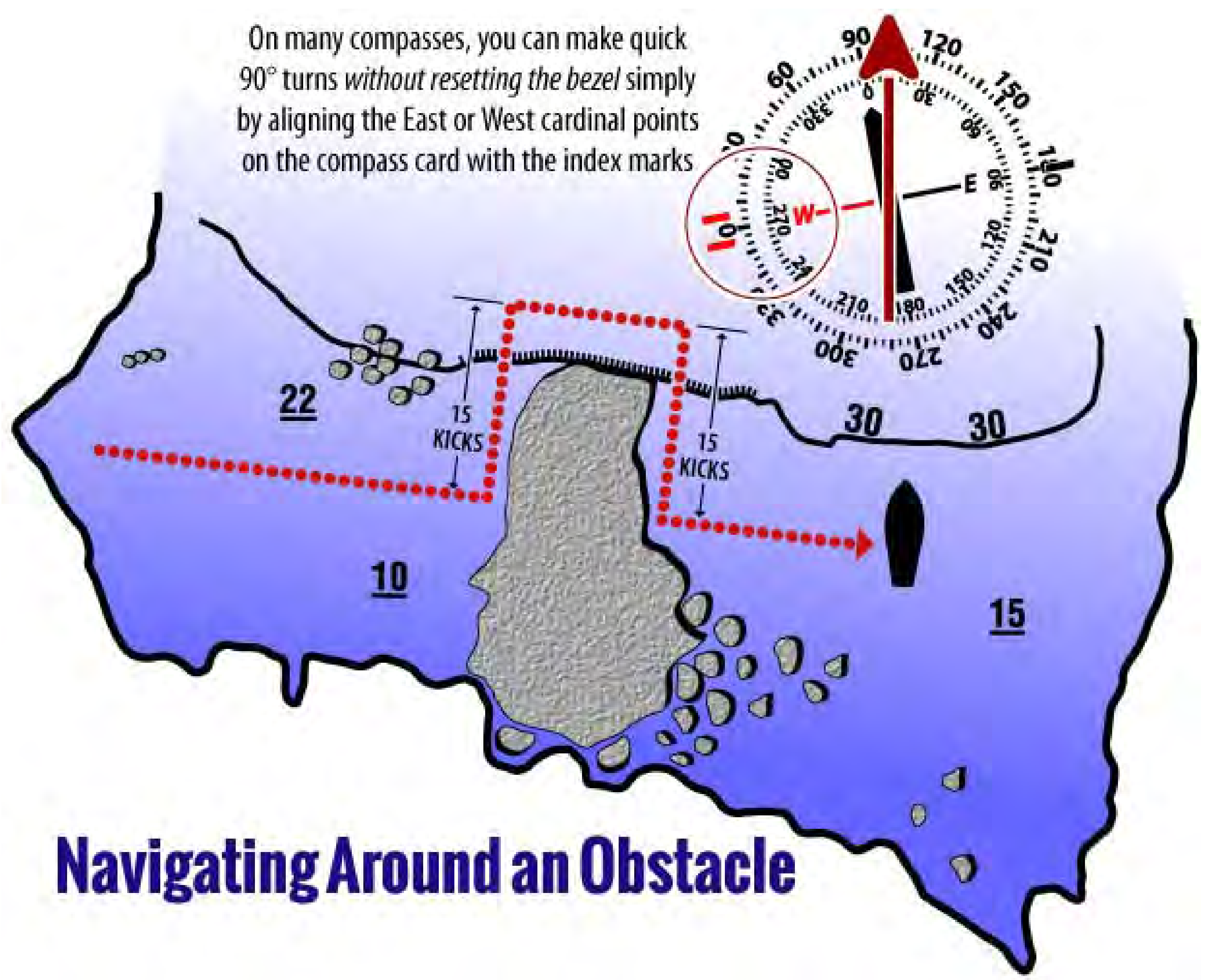
Earlier we told you that, with one exception, you should avoid multi-leg compass courses. This is that exception.

> Let's say you take a heading on a buoy marking an off-shore wreck. While following your compass to the wreck, you run into a huge rock outcropping rising from the bottom all the way to the surface. You can't go over it. You can't go through it.

What do you do?

- Start by turning 90 degrees in the direction most likely to take you around the object. If your compass card has *East* and *West* cardinal points, there is no need to re-set the bezel. Just center the appropriate cardinal point between the index marks.
- As you swim, count kick cycles.

- Once you clear the obstruction, note the number of kick cycles it took to get to this point and return to your original heading.
- Once you are completely past the obstacle, turn 90 degrees back toward your original route. Begin counting kick cycles.
- Once you have traveled the same number of kick cycles as you did to clear the obstruction, turn 90 degrees back to your original heading.



It is now as though you were able to pass right through the obstacle. Remember you will need to repeat this process when running the reciprocal course back to shore.

# Key Points to Remember

- If you find your compass course blocked by an obstacle, you can navigate around it using a series of 90-degree turns, and then returning to your original heading.

# Deeper Diving

Deeper diving is a large part of the Advanced course. Any dive past a depth of 20 m/65 ft is considered a deep dive by recreational standards. In this section we will be discussing for aspects of deeper diving:

- Deeper Diving: What and Why?
- Deep Diving Risks and Hazards
- Equipment for Deeper Diving
- Planning and Making Deep Dives

# Deeper Diving: What and Why?

## Study Questions

As you go through this material, look for the answers to the following:

- *What depth ranges are considered within the realm of recreational deep diving?*
- *Why might recreational divers want to plan and make deeper dives?*

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*What?* and *Why?* are the first two questions you should ask about any specialized diving activity. In this section, the two questions we will answer are:

- What is Deeper Diving?
- Why Dive Deep?

## What is Deeper Diving?

When it comes to recreational diving, most experts consider any dive past 20 m/65 ft to be a deep dive. Your entry-level training did not prepare you to dive past this depth — even though the recommended depth limit for recreational diving is 30 m/100 ft (with an absolute limit of 40 m/130 ft for divers with specialized Deep Diver training).

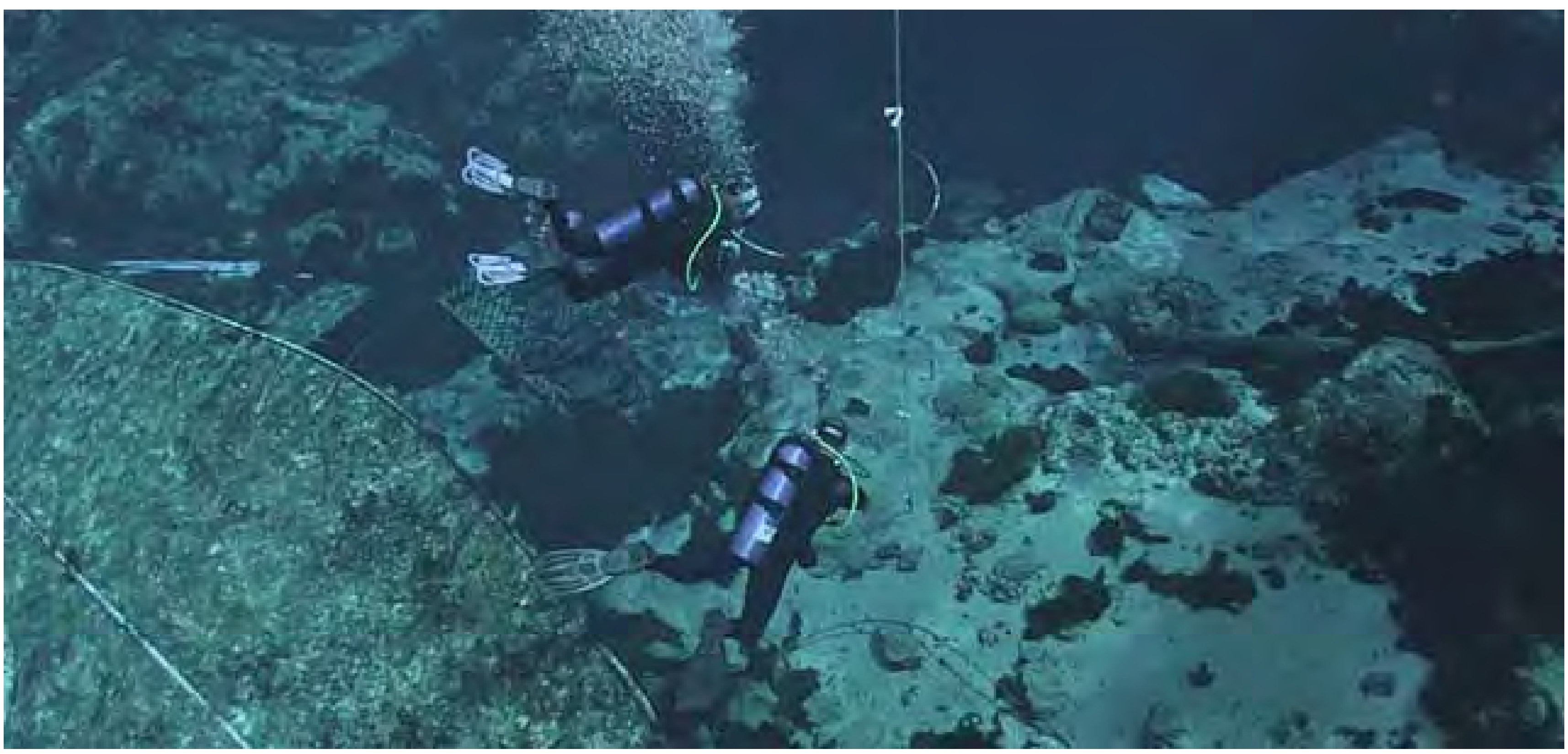
> Dives past 20 m/65 ft expose divers to greater risks than shallow dives do. We will discuss these risks in greater detail in the next section.

The ability to safely make dives past the 20 m/65 ft limit is among the most common reasons divers enroll in advanced training. To do that, however, there are some things you need to know first — which is what we cover in this chapter.

# Why Dive Deep?

The answer to this question is fairly straightforward: *To see more and do more.* Here are some examples.

- The ability to safely plan and execute deeper dives provides access to a greater range of dive sites, including many wrecks and wall dives.



- Most diveable wrecks lie at depths greater than 20 m/65 ft (shallower wrecks tend to be broken up as hazards to navigation). Thus, if you want to see and experience these wrecks, you need to be able to safely manage these greater depths.
- Most tropical wall dives start at depths between 24 m/80 ft and 30 m/100 ft. While you are not likely to be venturing any distance down these walls as a recreational diver, your deep

diving qualification will at least enable you to get out over the edge and look down.

The plain truth is that if you want to see and experience all there is to see and do as a recreational diver, you need to be able to safely exceed the 20 m/65 ft limit.

# Key Points to Remember

- The depth range for recreational deep diving is between 20 m/65 ft and 30 m/100 ft with 40 m/130 ft feet as the maximum depth for recreational diving.
- The ability to safely plan and execute deeper dives provides access to a greater range of dive sites, including many wrecks and wall dives.

# Deep Diving Risks and Hazards

## Study Questions

As you go through this material, look for the answers to the following:

- *How does increased gas consumption at depth affect the planning and execution of deeper dives?*
- *How does deeper diving impact the risk of decompression sickness? How can divers manage this risk?*
- *Can deep divers manage the effects of nitrogen narcosis? Is there a way to help prevent narcosis? How should deep divers respond to narcosis symptoms?*
- *How does loss of ambient light affect deep divers? What steps can they take to manage this loss?*
- *Why is some sort of physical reference such as a wall, slope or down line essential to deeper diving? What can deep divers do to prevent or manage their loss?*
- *Why is buddy separation a greater problem at depth? What steps can deep divers take to avoid this?*

Before undertaking any specialized dive activity, you must first identify the risks and hazards associated with it and how you are going to manage or overcome those risks. Specific risks that we will be discussing in this section include:

- Increased Gas Consumption
- Limited No-Decompression Time
- Nitrogen Narcosis
- Diminished Ambient Light
- Loss of Descent/Ascent Line
- Buddy Separation

We will discuss each risk factor in greater depth and explain how, as an Advanced diver, you can deal with it.

## Increased Gas Consumption

You remember from your beginning class that gas consumption increases in direct proportion to depth.

> For example, a cylinder that lasts 60 minutes at the surface will only last 15 minutes at a depth of 30 m/100 ft.

As a result, Advanced divers must not only plan for increased gas consumption (i.e., allow for a greater Minimum Gas Reserve), but also monitor pressure more frequently. In deeper water, you should be checking your pressure gauge at least once every two minutes at the beginning of the dive, and every minute as you approach your MGR.

Because the risks and consequences of a sudden gas loss are greater, you and your teammates also need to be in agreement as to the best way to share air, and make sure your equipment is up to the task.

## Limited No-Decompression Time

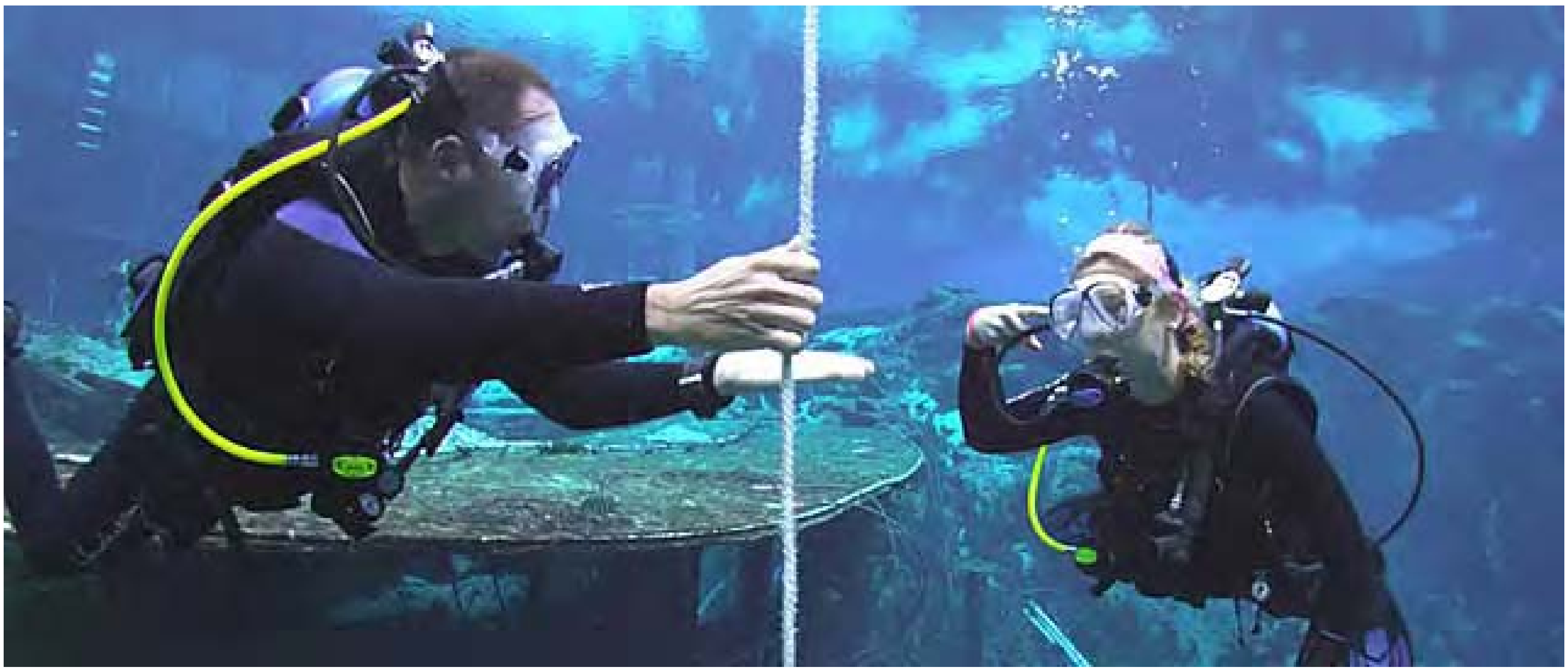
You may have heard other divers say that, as long as you limit yourself to a single tank, you can't exceed the no-decompression limits. That's not necessarily true of repetitive dives and it is certainly not true of dives past 20 m/65 ft.

What you will discover as an Advanced diver is that, the deeper you go, the greater the likelihood you could exceed the no-deco limits on a single dive — even if it is your only dive of the day.

This is why deep divers need to monitor their computers more frequently and avoid repetitive dives to deeper depths. You may have learned in your beginning class that divers should always make repetitive dives to the same or shallower depths than previous dives. Doing so affords maximum allowable bottom time for each dive and, thus, helps prevent the risk of accidentally exceeding the no-decompression limits.

## Nitrogen Narcosis

In your beginning class, you learned about the hazards and risks associated with nitrogen narcosis. However, as your diving was limited in depth to 20 m/65 ft, this discussion was largely abstract. Now that you will be diving to depths approaching 30 m/100 ft, these risks become very real.



> It's important to remember that the effects of nitrogen narcosis can vary from diver to diver and day to day. Although the effects of narcosis increase in direct proportion to depth, *awareness* of narcosis becomes more pronounced as depths approach 30 m/100 ft. It other words, the deeper you go, the more impaired you are — whether you realize it or not. It's only the realization of your level of impairment that may come on suddenly.

For most of us, the threshold of severe narcosis impairment is 30 m/100 ft. This is one reason why this depth is the recommended limit for recreational diving. Keep in mind, however, that there is no guarantee that, on any given day, you won't get "narced" at shallower depths.

> Despite what some divers claim, there is no way to "manage" narcosis, other than lessening its severity by keeping your carbon dioxide levels low by avoiding exertion at depth. When you suspect impaired thought or action, you and your ream mates need to ascend immediately.

The good news is, simply moving to a shallower depth may be all that is needed to reduce the symptoms of narcosis. This may be an option if diving a slope or wall. If there is no shallow water available, your only option may be to ascend slowly, make your safety stop and then call it a day.

## Diminished Ambient Light

Even in clear water, ambient light levels decrease significantly at depth, as does apparent color. The presence of silt and sediment can make matters worse — in fact, given sufficient sedimentation, it can be as black as night at 20 m/65 feet, even at noon on a bright, sunny day.

This is why dive lights are an important deep diving tool, even in daylight. Dive lights can:

- Enable you to see more (especially in corners, cracks and crevices).
- Help restore the natural appearance of colors under water.
- Make it easier for buddies to keep track of one another.

## Loss of Descent/Ascent Line

Unless diving a wall or slope, a physical or visual reference, such as anchor or “down” lines, is essential to safer deep diving. Without such a reference, you risk getting lost or disoriented, and may end up surfacing a considerable distance from the boat or shore.

Obviously, you should prevent this from happening; however, you also need to have a backup plan in case it does.

- Some recreational divers will do as technical divers do, and carry a surface marker buoy and safety reel to deploy it. Deploying a surface marker at depth does carry with it the risk of entanglement and requires special training. You can get this in the NASE Tek Basics course.
- If you do manage to surface some distance from the boat or shore, having the audible and visible surface signals discussed earlier can be a literal lifesaver.

# Buddy Separation

Buddy separation is a serious problem under any conditions, but is even more so on deeper dives due to reduced gas supply and available bottom time.


Finding a lost buddy can take several minutes. If you can't locate the missing diver after one minute, you can always follow standard procedure, make a slow ascent and safety stop, then meet up at the surface. At this point, however, the dive is over.

To avoid this, deep divers need to remain closer together and establish eye contact frequently. This is one case where preventing a problem clearly is the best solution.

# Key Points to Remember

- Gas consumption Increases in direct proportion to depth. A cylinder that lasts 60 minutes at the surface, for example, will only last 15 minutes at a depth of 30 m/100 ft. As a result, deep divers must not only plan for increased gas consumption (i.e., larger Minimum Gas Reserve volumes), but monitor pressure more frequently.
- The deeper the dive, the greater the possibility divers can exceed the no-decompression limits on a single tank. Deep divers need to monitor their computers more frequently and avoid repetitive dives to deeper depths.
- The effects of nitrogen narcosis can vary from diver to diver and day to day. Although the effects of narcosis increase in direct proportion to depth, *awareness* of narcosis becomes more pronounced as depths approach 30 m/100 ft. There is no way to "manage" narcosis; when you suspect impaired thought or action, ascend immediately. Keeping $CO_2$ levels low, however, can mitigate the onset of narcosis symptoms.

- Even in clear water, ambient light levels decrease significantly at depth, as does apparent color. The presence of silt and sediment can make matters worse. Dive lights are an important deep diving tool, even in daylight.
- Unless diving a wall or slope, anchor or "down" lines are essential to safer deep diving. Take steps to avoid their loss, but have a backup plan in case it happens.
- Buddy separation is a serious problem under any conditions, but even more so on deeper dives due to reduced gas supply and available bottom time. To avoid this, deep divers need to remain closer together and establish eye contact frequently.

# Equipment for Deeper Diving

## Study Questions

As you go through this material, look for the answers to the following:

- *How does deeper diving affect the selection and maintenance of your regulator system?*
- *What options are available to deeper divers in terms of redundant gas supplies?*
- *What role can dive lights play in deeper diving?*
- *Why are dive computers all but essential for deeper diving?*

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So long as you stay within the recommended recreational depth limit of 30 m/100 ft, deep diving should not require much more in the way of equipment than shallower dives — especially if you purchase the right equipment up front. Still, there are a few points worth discussing, including:

- Regulator Systems for Deeper Diving
- Redundant Gas Supplies
- Dive Lights
- Dive Computers and Deeper Diving

# Regulator Systems for Deeper Diving

It would be foolish to own separate regulator systems for shallow and deep diving. If you purchase the right regulator system going in, the same regulator should be more than adequate for both. So what makes a good deep-diving regulator?

Bear in mind that any regulator used for deeper diving must be capable of supplying gas for *two* divers breathing at higher-than-normal rates. At 30 m/100 feet, the gas passing through your first stage is significantly denser than at the surface; two divers will at least double this task load, even if they are not breathing hard.

Now you might wonder, *Why would any manufacturer make a regulator that was not adequate for all recreational diving depths?* Good question.

> As it turns out, there is a legitimate market for low-end regulators that will only be used in shallow water. These unbalanced piston regulators are popular as rental regs; tech divers use them on their 6 m/20 ft deco bottles.

Unfortunately, some divers are attracted by the low price of such regs and purchase them for general use as well — only to discover — sometimes at the worst possible time — that they just aren't up to the task. Avoid spending money foolishly; invest in a medium to top-of-the line regulator from a major manufacturer.

Also bear in mind that regular, professional maintenance, while essential for any regulator, is especially important for those used for deeper diving. Ultimately, it is the maintenance that will have the greatest long-term effect on regulator performance.

# Redundant Gas Supplies

Some divers like to have the added security of the type of redundant gas supply used by technical divers.

- For example, many deep divers carry a separate backup gas supply in the form of a pony bottle or self-contained ascent bottle.
- If you choose to go this route, keep in mind that this gas supply must equal your single-diver Minimum Gas Reserve (MGR).

Among the benefits of sidemounting is that this configuration is inherently redundant.

## Dive Lights

As we discussed earlier in this section, dive lights help make up for the loss of ambient light at depth, restore natural colors and help divers keep track of one another.

Unlike night diving, where it is important to have both primary and backup lights, as well as a tank marking light, deep divers can generally get away with just one hand-held light.

## Dive Computers and Deeper Diving

While dive computers are nice to have on shallower dives, their ability to more precisely account for exposure to elevated partial pressures of nitrogen make them essential on deeper dives.

> To use earlier examples, if your find yourself needing to move into shallower water to reduce narcosis, or to stay within an acceptable MGR, your computer's ability to adjust no-decompression limits accordingly will be extremely helpful — and something you can't do with dive tables.


As deeper diving often segues into learning technical diving, consider investing in a multi-gas computer you won't need to replace later on.

# Key Points to Remember

- Any regulator used for deeper diving must be capable of supplying gas for *two* divers breathing at higher-than-normal rates. Regular, professional maintenance is essential for any regulator used for deeper diving.
- Many deep divers carry a separate backup gas supply in the form of a pony bottle or self-contained ascent bottle. Among the benefits of sidemounting is that this configuration is inherently redundant.
- Dive lights help make up for the loss of ambient light at depth. They can also restore the appearance of natural color and help divers keep track of one another.
- While dive computers are nice to have on shallower dives, their ability to more precisely account for exposure to elevated partial pressures of nitrogen make them all but essential on deeper dives. As deeper diving often segues into learning technical diving, consider investing in a multi-gas computer you won't need to replace later one.

# Planning and Making Deep Dives

## Study Questions

As you go through this material, look for the answers to the following:

- *What environmental conditions should deep divers avoid and why?*
- *How does deeper diving affect the distance traveled under water?*
- *What impact could surface swimming have on deep divers?*

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Planning and making deep dives isn't all that different from making shallower dives. All the normal dive-planning rules apply — as well as the need to establish and stay within a safe Minimum Gas Reserve. There are also some things you will want to do when diving deeper. These include:

- Avoid Adverse Conditions
- Limit Travel Distances
- Avoid Surface Swims

# Avoid Adverse Conditions

As previously discussed, advanced divers need to avoid conditions that might increase gas consumption, the risk of DCS or the possibility of buddy separation or loss of your down line. These include:

- Strong currents, as these can increase exertion, resulting in elevated $CO_2$ levels and a higher risk of DCS.

- Poor visibility, as this can reduce ambient light to near blackness and increase the risk of buddy separation and loss of a physical or visual reference for descents and ascents.

# Limit Travel Distances

Deep divers are best off limiting the distance they travel from their descent/ascent lines.

- With limited time, divers can't risk getting lost and, in the process, risking exceeding the no-decompression limits.

- With limited gas and a higher MGR, divers don't have the luxury of making their remaining gas anything but "all usable."

This helps explain why wrecks are popular for deeper diving, as wreck divers seldom travel farther than the length of the wreck.

# Avoid Surface Swims

Heavy exertion before and, especially, following deeper dives can significantly increase the risk of DCS. Unfortunately, surface swims generally require a lot more exertion than swimming under water.

- The good news is, most deep diving takes place from boats. As boat captains know it's best to get directly over the dive site whenever possible. This reduces or eliminates the need for any surface swimming.

- If deep diving from shore, unless there is an immediate drop off, try to return to your starting point under water, as opposed to surfacing. Doing so will effectively extend your safety stop and reduce overall exertion.

# Key Points to Remember

- Deep divers must avoid conditions that might increase gas consumption, the risk of DCS or the possibility of buddy separation or loss of your down line. These include strong currents and reduced visibility.
- Deep divers are best off limiting the distance they travel from their descent/ascent lines. This is why wrecks are popular for deeper diving; wreck divers seldom travel farther than the length of the wreck.
- Heavy exertion before and, especially, following deeper dives can significantly increase the risk of DCS. Plan deep dives to minimize or, better still, eliminate the need for surface swimming.

# Determining Minimum Gas Reserve (MGR) with Greater Accuracy

In the section on Minimum Gas Reserve (MGR), you learned why it's important that each dive team member establish the minimum amount of breathing gas it will take to surface himself and a buddy, if that buddy also needs to share air during the ascent. It is vital to keep this gas in reserve throughout the dive so that, if the unthinkable happens, each team member has sufficient gas to deal with it.

In that section, we gave you some general MGR values that *might* apply to many divers, given common breathing rates and use of a popular cylinder size. While these values are better than having none at all, there are many situations they don't cover, including:

- Divers with substantially different SAC rates.
- Use of varying size cylinders.
- Dives to depths other than the 10-, 20-, 30- and 40-meter depths discussed earlier in the course.

NASE has created two Microsoft Excel spreadsheets that can help you more accurately determine MGR, using actual SAC rates, dive depths and cylinder sizes. We'll explain their use at the end of this section and provide you with a link to download them.

However, as with dive tables and computers, you should not use these tools without first understanding the underlying principles behind them. This is what we will cover next.

# ATA: The Magic Number

*Depth in Atmospheres Absolute* (ATA) is a value that is integral to nearly every calculation dealing with gas consumption and diving physics. Think of it as a "magic number" that will help you solve almost any diving problem.

You already know, from your beginning diver training, that pressure increases by one atmosphere for every 10 m/33 ft of descent. You may even have the ATA values for 10 m/33 ft, 20 m/66 ft, 30 m/99 ft and 40 m/130 ft committed to memory. What do you do, however, when your planned dive depth doesn't conform to these values?

 

There is a simple formula that will help you determine depth in ATA for any value in meters or feet.

METRIC

$$\frac{\text{Depth}+10}{10}=\text{ATA}$$

IMPERIAL

$$\frac{\text{Depth}+33}{33}=\text{ATA}$$

Here is a variation on that formula that some divers prefer. It yields exactly the same values.

METRIC

$$(\text{Depth}/10)+1=\text{ATA}$$

IMPERIAL

$$(\text{Depth}/33)+1=\text{ATA}$$

# SAC Rate: Gas Mileage for Divers

Knowing your Surface Air Consumption (SAC) rate is like knowing what sort of fuel economy you can expect of your car, truck or SUV. If anything, it's more important to know your SAC rate. If you run out of gas *above* water, you walk to the gas station, gas can in hand. If you run out of gas *under* water, you'd best hope for a nearby and responsive buddy with sufficient gas remaining for both of you.

Determining your own personal SAC rate involves making one or more *gas consumption runs*. The procedure for doing so is fairly simple.

- Swim for a fixed amount of time (five minutes or more is best) at a constant depth. Swim at a normal, relaxed pace. Your goal is to emulate how fast you consume air during a typical dive.
- Note your starting and ending pressures in bar or psi.

The total amount of gas consumed, divided by the number of minutes you swam, is your gas consumption rate at depth. Divide this by the depth, in ATA, to get your SAC.

$$\frac{\text{Gas Consumption Rate at Depth}}{\text{ATA}} = \text{SAC}$$

If possible, repeat your gas consumption run at varying depths and under varying real-life conditions. Averaging the results of these runs will give you a more accurate number to work with.

> Actual gas consumption varies directly by depth. By converting gas consumption rate at depth to its equivalent Surface Air Consumption rate, we arrive at a constant value that we can use to solve a variety of problems.

To convert SAC rate to gas consumption rate at depth, simply reverse the SAC rate formula.

**SAC x ATA = Gas Consumption Rate at Depth**

# Converting Pressure to Volume6

Your initial SAC rate calculation will give you a SAC rate value in bar or psi. If you know, with certainty, that you will always dive the same size cylinder, this may be sufficient. To assume this will happen, however, is naive.

> Divers frequently use cylinders of varying sizes. Tech and cave divers routinely switch back and forth between doubles and singles — often on the same dive.

For this reason, it's best to convert SAC in bar or psi to SAC in actual liters or cubic feet. By the way, when expressed in volume, SAC becomes what is known as *Respiratory Minute Volume* or RMV. For simplicity's sake, however, we're just going to keep referring to it as SAC.

Here is the formula for metric cylinders, in which capacity is measured in liquid volume.

$$\text{SAC in Bar} \times \text{Liquid Capacity} = \text{SAC in Liters}$$

The formula for doing so with imperial tanks is slightly more complex, given the peculiar way in which these cylinders are rated.

$$\frac{\text{SAC in PSI} \times \text{Rated Volume (ft}^3\text{)}}{\text{Rated Pressure in PSI}} = \text{SAC in ft}^3$$

$$\frac{30\ \text{PSI} \times 78.8\ \text{ft}^3}{3{,}000\ \text{PSI}} = 0.79\ \text{ft}^3$$

Reversing these formulas will give you SAC in bar or psi.

METRIC

$$\text{SAC in Liters} / \text{Liquid Capacity} = \text{SAC in Bar}$$

IMPERIAL

$$\frac{\text{SAC in ft}^3 \times \text{Rated Pressure in PSI}}{\text{Rated Volume (ft}^3\text{)}} = \text{SAC in PSI}$$

# NASE SAC Rate Calculator

You could call up the calculator function on your smart phone and do each of the calculations needed to determine SAC rate manually. Unfortunately, all it takes is a single mistyped digit or a formula entered incorrectly and your entire calculation collapses like a house of cards — possibly without you knowing it.

For this reason, NASE distributes SAC Rate Calculator spreadsheets in both metric and imperial versions.

| NASE SAC Rate Calculator | |
|---|---|
| 66 | Depth of run, in fsw |
| 3.00 | Depth of run in ATA |
| 5 | Time of run in minutes |
| 3000 | Starting pressure in psi |
| 2700 | Ending pressure in psi |
| 300 | PSI used |
| 20 | SAC rate in psi/minute |
| 77.4 | Tank capacity in cubic feet |
| 3000 | Tank pressure when full |
| 0.52 | SAC rate in cubic feet/minute |
| Change the data in orange to reflect actual numbers | |

To use these spreadsheets, simply replace the numbers in orange with actual values.

# MGR Formula: Components

To determine a Minimum Gas Reserve value that would provide sufficient gas for two divers to make a slow ascent and a safety stop while sharing air, you need to first determine the MGR for four distinct phases of that ascent.

Gas Needed at Depth for Problem Solving + Gas Needed for Ascent to Safety Stop Depth + Gas Needed at Safety Stop Depth + Gas Needed for Ascent to Surface = MGR

- First, you need to allow up to a minute between the time divers begin sharing gas and the initiation of the actual ascent. This allows for divers getting into position, sorting out any communication issues, traveling a short distance at depth to re-acquire the descent/ascent line and dealing with possible problems such as entrapment or entanglement.
- Next, you need to allow for the amount of gas consumed between the depth at which the ascent begins and the safety-stop depth of 5 m/15 ft.

- You have to then allow for the gas consumed during the safety stop.
- Finally, you need to allow for the amount of gas consumed from safety stop depth to the surface.

# Finding MGR for Individual Segments

To determine the Minimum Gas Reserve for each segment of a gas-sharing ascent, use the following formula:

$$\text{SAC Rate} \times 1.5 \times \text{Average Depth in ATA} \times \text{Time} \times \text{Two Divers} = \text{MGR for Ascent Segment}$$

- To start, you have to assume divers will be breathing somewhat faster than their normal, relaxed SAC rate. In our examples, we use 150 percent of the normal SAC rate for this.
- You will need to multiply this increased SAC rate by depth in atmospheres (ATA). This gets complicated during the actual ascent phase because divers are not at a constant depth. The easiest way to resolve this is to subtract ending depth from starting depth and dividing by two. This gives you the average depth and, thus, the average ATA for the entire segment.

- Next, you need to multiply the resulting value by the time of the segment in minutes. In addition to the one minute at depth and three-minute safety stop, you will need to divide the two ascent distances by an ascent rate of 10 m/30 ft per minute.
- Finally, as there are two divers, you need to multiply the results by two. If the divers have substantially different SAC rates, you need to calculate the MGR for each diver individually, then add the results together.

# NASE MGR Calculator

As with its SAC Rate Calculator, NASE provides metric and imperial versions of a spreadsheet designed to help calculate Minimum Gas Reserve values.

**NASE Minimum Gas Reserve Calculator**

Variables

| | |
|---|---|
| 0.66 | Normal SAC rate in cubic feet/minute (see SAC calculator) |
| 0.99 | Contingency SAC rae (150% of normal) |
| 77.4 | Cylinder capacity in cubic feet |
| 3000 | Cylinder working pressure in psi |
| 35 | Maximum depth in feet |

Replace numbers in orange with actual values as needed

Calculations

| Step | Description | Starting Depth (Ft) | Ending Depth (Ft) | Average Depth (Ft) | Average ATA | Time (Minutes) | Single Diver Volume in Ft3 | Single Diver Volume in PSI | Two Diver Volume in Ft3 | Two Diver Volume in PSI |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | One minute to solve problems at depth | 35 | 35 | 35 | 2.06 | 1.00 | 2.04 | 79 | 4.08 | 158 |
| 2 | Ascent to safety-stop depth | 35 | 15 | 25 | 1.76 | 0.67 | 1.16 | 45 | 2.32 | 90 |
| 3 | Three-minute safety stop | 15 | 15 | 15 | 1.45 | 3.00 | 4.32 | 167 | 8.64 | 335 |
| 4 | Ascent to surface | 15 | 0 | 7.5 | 1.23 | 0.50 | 0.61 | 24 | 1.22 | 47 |
| Totals | | | | | | 5.17 | 8.13 | 315 | 16.26 | 630 |

Again, you replace the numbers in orange with actual values and see the results in green for both one and two divers.

> If the two divers have significantly different SAC rates, run the spreadsheet for each individual diver, then add the two single-diver results together.

As you run various scenarios with the MGR Calculator, one thing is going to become readily apparent: *The average recreational diver allows nowhere near sufficient Minimum Gas Reserve, especially on deeper dives*.

> On a dive to 40 m/130 ft, the typical recreational diver needs to begin ascending after using less than half a tank. The good news is he might need to begin ascending at this point anyway, to avoid decompression.

If diving along a wall or slope, one strategy you may want to consider is remaining at your maximum depth until you hit the MGR for that depth, then moving to a shallower depth where the MGR is less. This will go hand-in-hand with what your dive computer allows for multi-level dives.

- Link to download SAC/MGR spreadsheet package.

# Pre-Dive Checklist

## Before You Leave Home

### Tasks

☐ Regulator and BC serviced/inspected in the last year?
☐ Dive computer battery changed in the last year?
☐ Camera system, dive light and other batteries charged?
☐ If diving locally, did you check the weather?
☐ Any rental gear picked up, tanks filled and analyzed?
☐ All necessary reservations/bookings made?
☐ Tell someone else where you are going and when you should return

### Packing List

Depending on whether or not you are diving locally, or from a beach or boat, not all items may be necessary

☐ Mask, fins, wetsuit boots
☐ Exposure suit/undergarments
☐ Hood and gloves for cold?
☐ Weight system or weight belt
☐ Weights?
☐ Regulator and BC
☐ Dive computer
☐ Cutting tool

#### Emergency Kit

☐ First-aid kit (topside)
☐ Oxygen? (topside)
☐ Audible surface signal
☐ Visible surface signal
☐ Folding snorkel
☐ Pocket mask

#### Other Items

☐ Dive tables?
☐ Slate?
☐ Sunscreen
☐ Motion-sickness medication
☐ Camera?
☐ Float/flag?



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## On Site Assessment

This list is for shore dives; on boats, listen to and follow the crew briefing

☐ Conditions okay for diving?
☐ Safest entry/exit point?
☐ Easiest and safest entry/exit technique?
☐ Note current, waves, etc.
☐ Restrooms, other facilities?
☐ How do you summon EMS?
☐ Phone number for DAN: (919) 684-9111 (use another number?)
☐ Nearest dive group or facility you can go to for help?

## Final Gear Check Before Suiting Up

☐ Scuba unit fully assembled?
☐ Weight pockets installed (or ready to install)?
☐ Air turned all the way on and pressure checked?
☐ All other equipment present and ready to go?

## Dive Plan Review

☐ Where are you going? Who is primarily in charge of navigation?
☐ Planned depth and time?
☐ Maximum depth and time?
☐ Minimum Gas Reserve (MGR)?
☐ Is remaining gas *half usable* or *all usable?*

## Final Equipment and Buddy Check

Depending on circumstances, this takes place on the surface before descending or just before entering

☐ **A** Air all the way on?
☐ **B** BC functioning and inflated to the right level?
☐ **C** Computer activated, functioning and set to right FO2?
☐ Final visual check and buddy okay

## Sample Minimum Gas Reserve (MGR)

*Minimum Gas Reserve* is the amount of gas each diver must have to be able to share air with another and still make a slow ascent and safety stop. The values shown here assume a minute on the bottom to solve problems, a 10 m/30 ft per minute ascent and a three-minute safety stop. They also assume a "stressed diver" breathing rate of 30 L/1 $ft^3$ per minute, using the common 11 L/80 $ft^3$ tank. *These values may not be sufficient in every situation.* For more precise data, download the NASE SAC and MGR Calculators from *www.ScubaNASE.com/forms/aow.html.*

| Depth | Minimum Gas Reserve |
|---|---|
| 10 m/35 ft | 45 bar/700 psi |
| 20 m/65 ft | 60 bar/900 psi |
| 30 m/100 ft | 90 bar/1300 psi |
| 40 m/130 ft | 120 bar/1700 psi |

# Data Record

## SAC Data


☐M ☐FT — SAC Run Depth

SAC Run Time in Minutes

☐BAR ☐PSI — Starting Pressure

☐BAR ☐PSI — Ending Pressure

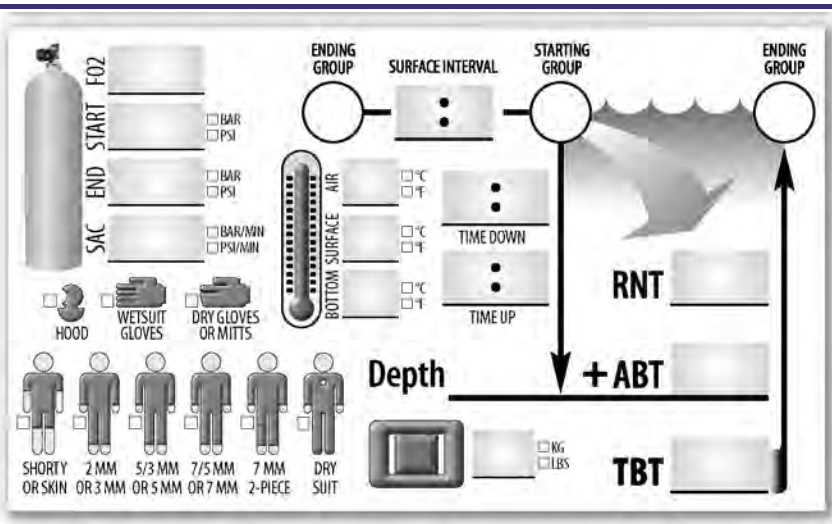
## Nav Data

☐M ☐FT — Measured Distance

Kick Cycles

☐MIN ☐SEC — Time

## Dive Data



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# Data Record

## SAC Data

☐M ☐FT — SAC Run Depth

SAC Run Time in Minutes

☐BAR ☐PSI — Starting Pressure

☐BAR ☐PSI — Ending Pressure

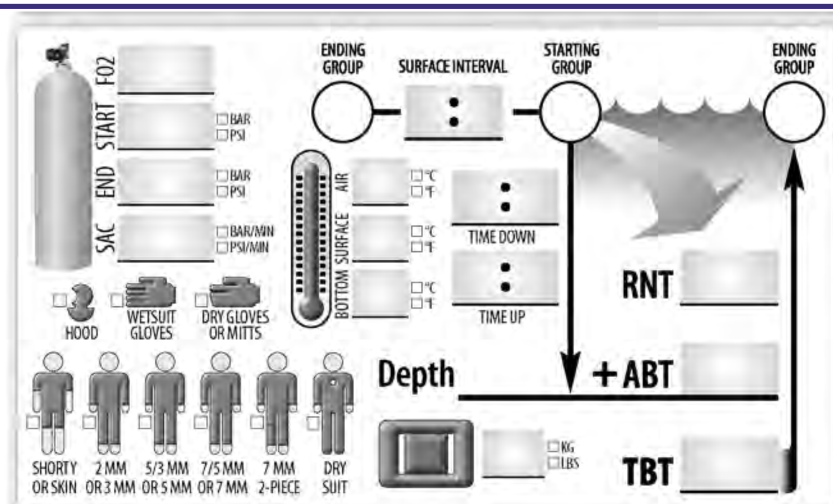
## Nav Data

☐M ☐FT — Measured Distance

Kick Cycles

☐MIN ☐SEC — Time

## Dive Data



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