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The Underwater Communication

PADI DISTINCTIVE SPECIALTY COURSE
Students Guide

Sergio Gamberini

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Underwater Communication
Distinctive Specialty Course Guide for STUDENTS

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Table of Contents

1. Introduction

This section includes suggestions on how to use this guide, an overview of course philosophy and goals and ways you can organize and integrate student diver learning.

1.1 How to Use this Guide

This guide speaks to you, the Underwater Communication Specialty Instructor. The guide contains four sections – the first contains standards specific to this course, the second contains knowledge development presentations, the third considers confined water and surface training and the fourth details the open water dives.
All required standards, learning objectives, activities, and performance requirements specific to the Underwater Communication Distinctive Specialty course appear in boldface print. The boldface assists you in easily identifying those requirements that you must adhere to when you conduct the course. Items not in boldface print are recommendations for your information and consideration. General course standards applicable to all PADI courses are located in the General Standards and Procedures section of your PADI Instructor Manual.

1.2 Course Philosophy and Goals

The purpose of the PADI Underwater Communication Specialty Diver Course is to explain what diving communication is, how it works, and how it can be used. We will be discussing how to get the best performance out of today's technology and how communications can be fully integrated into the many activities that are performed during dives for business, study, research, recreation, and even teaching.

The goals of Underwater Communication training are:

Conducting dives with communications gives the ability to deliver the necessary information and instructions clearly and unambiguously instead of using gestures that can cause confusion or be misinterpreted.
The communications are often essential. In some cases it can save a human life. People who work underwater need to communicate with their colleagues underwater and the surface both for logistical support and safety. The same is true for people whose business is teaching, education, or recreation. How many times have you found it necessary to inform your colleague or even your boat of what you were seeing, hearing, intending to do or not to do, or even simply to ask a question.
Finally, and just briefly, we ask what any type of human pursuit or discovery might be without

communications, and above all whether it would have been possible to achieve the levels we're accustomed to without the development of communications in every field.
We believe that an in-depth understanding of how to communicate underwater is a crucial step in the development, civil use, and protection of the oceans, as well as the safety and growth of dive professionals.
PADI advocates the use of underwater communication devices in their training programs and OCEAN REEF, in full support of this initiative, has partnered with DiveNav to develop of multimedia material to facilitate the education of divers planning to use OCEAN REEF full face masks and communication units (the Neptune System) in their scuba activities. By integrating the multimedia material into this Distinctive Specialty, PADI offers you – the Distinctive Specialty Instructor – a tool to further the education of your students.

1.3 Course Flow Options

This course contains knowledge development, a confined water skill development session and 2 open water training dives. When possible, you should conduct the knowledge development session before any confined water training. The knowledge development session of this specialty may be composed by the OCEAN REEF UW COMMUNICATION Online Class developed with the support of DiveNav and available at DiveComputerTraining.com. The student must complete the knowledge development and obtain a certification of completion from DiveComputerTraining.com before the open water training dive or follow the procedure of the conventional course. The confined water skill development session must precede the open water training dives.

There are 2 open water dives to complete. You may rearrange skill sequences within each dive; however, the sequence of dives must stay intact. You may add more dives as necessary to meet student divers' needs. Organize your course to incorporate environment friendly techniques throughout each dive, to accommodate student diver learning style, logistical needs, and your sequencing preferences. Two open water dives are required for the student diver to complete this course.

Classroom presentation

KNOWLEDGE DEVELOPMENT

- Roles and rules UW and on Land
- Surface checks of the units
- Transmittinmg receiving
- Donning and adjusting

SURFACE PRACTICE AND CONFINED WATER - MRT tables

- UW Communication Dive One
- UW Communication Dive two

OPEN WATER DIVES

IF IDM and UW communication courses are combined, the Confined water Dives may be limited to 1, longer enough to cover all expects, the Open Water Dives may be limited to 2 total, longer enough to cover all expects.

2. Course Standards

This section includes the course standards, recommendations, and suggestions for conducting the Underwater Communication Distinctive Specialty Course.

2.1 Instructor Prerequisites

To qualify to teach the Underwater Communication Specialty course, an individual must be a Teaching status PADI Open Water Scuba Instructor or higher and certified as Distinctive Full Face Mask Specialty Instructor. PADI Instructors may apply for the Underwater Communication Specialty Instructor rating after completing a Specialty Instructor Training course with a PADI Course Director. PADI Instructor can also apply directly for this rating after completing a factory sponsored course.

Topic	Course Standard
Minimum Instructor Rating	Underwater Communication Specialty Instructor
Prerequisites	PADI Open Water Diver
Minimum Age	15 years
Ratios Open Water	Confined water 6:1 Open Water 4:1
Site, Depths and Hours	Depths: 18 meters / 60 feet recomm. Hours Recommended: 12 Minimum Confined water Dives: 1 Minimum Open water Dives: 2 IF IDM and UW communication courses are combined, the Confined water Dives may be limited to 1, longer enough to cover all expects, the Open Water Dives may be limited to 2 total, longer enough to cover all expects
Materials and equipment	Instructor Underwater Communication Distinctive Specialty Course Instructor Guide Full Face mask & Underwater Communication (with appropriate accessories) Student Diver Full face mask & Underwater Communication (with appropriate accessories)

2.2 Student Diver Prerequisites

By the start of the course, a diver must be:

1. Be at least 15 years old.
2. Be certified as a PADI Open Water Diver or have a qualifying certification from another training organization or as a PADI Open Water Diver (or qualifying certification) with proof of at least 10 dives logged beyond training dives for Open Water Diver certification. Verify student diver prerequisite skills and provide remediation as necessary.

2.3 Supervision and Ratios

Confined Water Dive

Completion of a confined water full face mask and underwater communication training session is required of student divers. This confined water practice session must be completed prior to making the first open water dive of this specialty course but can be combined with it.

During the confined water session, student divers must be accompanied by the course instructor or certified assistant. Additional confined water sessions may be added at your discretion and may include a scuba skills review.

The maximum in water ratio for confined water sessions is 6 student divers per instructor (6:1).

Open Water Dives

A Teaching status Underwater Communication Specialty Instructor must be present and in control of all activities. During the underwater communication open water dives, student divers must be accompanied by the course instructor. The Specialty Instructor must ensure that all performance requirements are met.

The ratio for open water dives is 4 student divers per instructor (4:1).

2.4 Site, Depths, and Hours

Site

Practice skills in a confined water sessions first to better prepare divers to apply skills in open water later.

The location for the first open water dive (harmonizing/training session) must be selected carefully. It must be easy to interrupt the dive, meet to verify results, and prepare for subsequent phases. A beach or wharf can work well, and a convenient boat anchored to a shallow bed does too. It's a good idea to avoid deep or inaccessible areas or those with a current. It's always helpful to equip yourself with logistical supports like a floating basket that is anchored in which to store tables or pens, and a support where members can take a break without tiring. If using a surface unit, it should be fastened securely and protected. Make sure that the transducer does not touch the bottom, walls, keel or anything else in the operating environment.

Choose sites with conditions and environments suitable for completing requirements. Shallow dives will provide divers with more time to complete tasks. Use different open water dive site for the 2nd one, to give student divers experience in dealing with a variety of environmental conditions (incorporate environment friendly techniques throughout each dive) and logistical challenges.

Depths

Max 15 meters/60 feet recommended for first dive
30 meters/100 feet limit for Dive 2

Hours

The UW Communication Specialty course includes two open water dives.

2.5 Materials and Equipment

A. Instructor Materials and Equipment

Required

- OCEAN REEF full face mask and appropriate accessories (such as quick disconnect hose, nose plug extensions, SAV surface air valve, NACS)
- Screw drivers for student divers to adjust the equalization plugs
- Spare mask (traditional diving mask)
- UW Communication device for Full Face Mask
- The Underwater Communication Specialty Guide for Instrurctor

Recommended

- Maintenance and spare parts kit and tools
- Surface Communication device (SURF-T)

B. Student Materials and Equipment

Required

- OCEAN REEF full face mask and appropriate accessories (such as quick disconnect hose, nose plug extensions, SAV surface air valve, NACS)
- UW Communication device for Full Face Mask
- Spare mask (traditional diving mask)

2.6 Assessment Standards

The student diver must demonstrate accurate and adequate knowledge during the open water dives and must perform all skills (procedures and motor skills) fluidly, with little difficulty, in a manner that demonstrates minimal or no stress.

2.7 Certification Requirements and Procedures

By the completion of the course, student divers must complete all performance requirements for Underwater Communication Confined Water Dive and Open Water Dive One and Two. The instructor certifying the student diver must ensure that all certification requirements have been met.

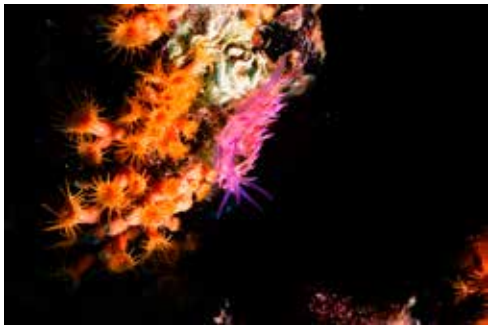
2.8 Links to other Courses

The Underwater Communication Specialty Course can be credited towards the Master Scuba Diver rating.

3. Knowledge Development

The biggest achievement of the last 50 years that has had the greatest effect on our daily lives wasn't man landing on the moon (despite its incredible importance), but the invention and development of the cell phone.
The life of the entire planet changed when the use of cell phones began to spread in the late '80s. Today, there are countries that have more operational cell phones than people.
The internet has also had an equally jarring effect on our everyday lives. With regards to the realm of the internet, special mention must be made of the phenomenon of social networks, which show the extraordinary human search for communications and interaction.
In every phase of human history, communications have made a powerful impression; without communications, no civilization would have been able to develop, nor would any of them have been able to achieve predominance. Those who are able to control energy and communications have always had an advantage over others.
On the other hand, without an efficient communications network, information does not circulate, or it moves too slowly, and the entire system gets clogged or moves forward only at a crawl; work, finance, entertainment, safety... everything depends on the quality and power of the communications network.
The introduction of cell phones into our lives has been very beneficial in many ways. With safety being a concern in today's day and age, even children are carrying some form of communication.
As in all things, communications have at times reached situations of excess. The reaction is to flee, searching for the peace that is often denied to us by the pace the contemporary world has reached.
As always, it's a question of education and the proper approach. The mere availability of means should not lead us to use them poorly or improperly. This too is yet another distinctive sign of our times, in which extremes are sometimes increasingly focused upon.
The world of diving explores many different directions, from recreational freediving, to spearfishing, to diving with respirators to admire the underwater world, take photographs, or conduct one's profession. One of the most classic representations of the underwater world (in so many famous movies) is to call it THE WORLD OF SILENCE, and to enjoy this special state in which certain senses are cut off, favoring sight and concentrating on colors and often on spectacular landscapes.

Nonetheless, capitalizing on this opportunity does not require you to forgo the objective advantages that modern technology can put at our disposal. A cell phone can easily be turned off if we don't want to be called or disturbed, but it's very convenient to have it available at all those times when, for pleasure or necessity, it's vital to communicate with those around us



In this reference book we have tried to bring together everything needed to build a true understanding of what underwater communications are and how they can be managed most effectively.
We believe that it's the new frontier in the development of both commercial and recreational diving. We think that this big shift has just begun and we're convinced that the growing application and use of underwater communicators will make it possible to make diving much safer.
We're also convinced that this evolution will be ensured by sharing the experiences of many divers around the world, and we invite everyone to send in their suggestions, stories, and ideas for developing and improving "the science of underwater.

3.1 Conduct

Use the following teaching outline as a road map of the conduct, content, sequence and structure for the Underwater Communication Specialty Course. The result should be student divers with theoretical knowledge and pragmatic experience who can adapt what they have learned to future underwater communication diving situations.

3.2 Knowledge Development Learning Objectives

By the end of knowledge development, student divers will be able to explain:

Communication in diving – historical notes
- Sign language
- Night diving signals
- Line-pull communications

Audible method for simple communications
- Speaking underwater
- Hydrophones

- Communication by cable
- Laryngophone

The basic physical principles of radio waves and ultrasound
- Radio waves and Ultrasounds
- Why can ultrasound be used for underwater communication
- How to generate and received ultrasounds waves
- Propagation of the sound
- How does sound intensity change with distance?
- What is a DMic microphone and how does it relate to pressure differences

The effect of the environment to the ultrasound communications
- Reduction of range in pools or oxygenated environments
- Use of underwater communication units in closed environments
- What can we use to reduce the power of transmission
- Directionality of transmission
- Power – Intelligibility – recognizability
- Quality of communication in different environments and situations

Theory of underwater communication equipment and diving procedures
- What may the Ocean Reef set of UW communication equipment be composed of?
- What should be checked regarding UW communication equipment before the dive?
- How is the receipt and transmission test before the dive conducted?
- What are the basic rules for underwater communication?
- What is the correct breathing pattern for effective underwater communication?
- Why do we need to apply controlled breathing technique when speaking underwater?
- How can we help improve the intelligibility of communications
- The Modified Rhyme Test and the harmonization of the Group

3.3 Knowledge Development Teaching Outline

A. Course Introduction

1) Staff and student diver introductions

Introduce yourself and assistants. Explain your background with Underwater Communication equipment and underwater communication diving if your student divers aren't familiar with you. Have divers introduce themselves and explain why they're interested in underwater communication diving. Break the ice and encourage a relaxed atmosphere.

Give times, dates and locations as appropriate for classroom presentations, confined water skill development sessions, and open water dives.

Review with student divers other skills they'll master as an Underwater Communication Divers. These opportunities, through additional specialty course training, may include, but are not limited to: PADI Enriched Air Diver, PADI Deep Diver, PADI Diver Propulsion Vehicle (DPV) Diver, PADI Ice Diver, PADI Digital Underwater Photographer, and DSAT Tec Rec.

2) Course goals - this course will help:

a) Develop your practical knowledge of diving with underwater communication equipment.
b) Improve your diving ability and provide you with additional supervised experience.
c) Increase your diving skills.
d) Learning a new way to make your and other diver dives safer.

3) Course overview

a) Knowledge Development: performed independently by student by taking the OCEAN REEF UW COMMUNICATION Online Class – available at DiveComputerTraining.com. Student must complete such online class and obtain the Certificate of Completion from DiveComputer-Training.com (see sample in Attachment). Student can enroll in the OCEAN REEF UW COMMUNICATION Online Class independently or by obtaining an Activation Code from the dive store or from the Instructor. It is recommended that dive store or Instructor provides to student an Activation Code to allow student to enroll in the OCEAN REEF UW COMMUNICATION Online Class and a Store Certificate Code so student can obtain the Certificate of Completion. See Attachment II for detailed instructions on how a dive store can provide to student both the Activation Code and the Store Certificate Code. See Attachment for detailed student instructions on how to enroll in the OCEAN REEF UW COMMUNICATION Online Class and on how to obtain the Certificate of Completion of the Knowledge Development portion of this course.
b) In case of conventional course: Classroom presentations and confined water and surface practice session.
c) Open water dives There will be at least two open water dives.

4) Certification

a) Upon successfully completing the course, you will receive the Underwater Communication Specialty certification
b) Certification means that you will be qualified to:
c) plan, organize, and make and log open water dives using an underwater communication in conditions generally comparable to or better than, those in which you are trained.

5) Class requirements

a) Complete paperwork. In case of online course. Student must provide Certificate of Completion of the Knowledge Development portion of this course. Student should request such certificate from DiveComputerTraining.com. Instructor must include such Certificate of Completion in the PADI Student Record File

b) Course costs To be defined by Dive Store / Instructor. The course has four components

a) In case of online class, enrollment in the OCEAN REEF UW COMMUNICATION Online Class: MSRP = 14.65 US$ - Student can enroll in the online class either by purchasing the online class directly at DiveComputerTraining.com or by using an Activation Code. It is recommended that dive store or Instructor provides to student an Activation Code to allow student to enroll in the OCEAN REEF UW COMMUNICATION Class. See Attachment for detailed dive store instructions on how to obtain Activation Codes. See Attachment for detailed student instructions on how to enroll in the OCEAN REEF UW COMMUNICATION Online Class

b) Certification of Completion cost: MRSP = $5.00 - Student can obtain the Certificate of Completion either by purchasing it directly or by redeeming it using the Store Certificate Code. See Attachment for detailed dive store instructions on how to obtain Store Certificate Codes. See Attachment for detailed student instructions on how to obtain the Certificate of Completion

i) OW dive costs – to be defined by Dive Store / Instructor

ii) PADI Specialty card Cost

c) Equipment needs

i) As outlined in the PADI Instructor Manual, General Standards and Procedures

ii) OCEAN REEF full face masks and uw communication units + accessories

d) Schedule and attendance

c) Complete paperwork.

IMPORTANT NOTICE with regards to The Knowledge Development Portion

The Knowledge Development portion of this course may be managed by the OCEAN REEF UW COMMUNICATION Online class available at
www.divecomputertraining.com

The OCEAN REEF UW COMMUNICATION Online class is an easy to navigate, structured class with 9 modules, 47 sections, several quizzes and a final test.

Each section contains a professionally made, effective video with accompanying notes.

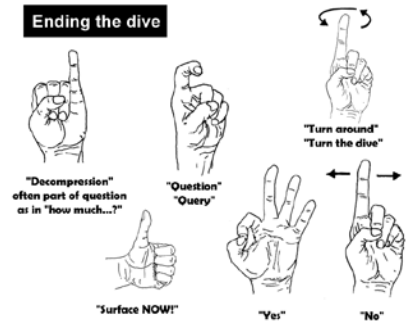
The OCEAN REEF UW COMMUNICATION Online class is available to the student for 12 months since enrollment and could also be used as an online multimedia User Manual that can be con-

sulted from anywhere around the world. To complete the online class, student should view all videos, answer all quizzes, pass the final test, accept the Liability Release and review the Closing Recommendations section.
The class is organized based on progressive learning and as such the student is recommended to take the online class following the modules and sections in sequence. At the same time, the interactive organization of the class allows student to directly access a specific section for easier reference.
Also, it is recommended that while taking the class, the student should consult the OCEAN REEF UW COMMUNICATION manual and be in possession of the OCEAN REEF full face mask and communication systems for direct reference and practice.
Upon completion of the OCEAN REEF UW COMMUNICATION Online class, the student must obtain from **www.divecomputertraining.com** the Certificate of Completion of the Knowledge Development portion of this course and provide a copy to the Instructor.
As an Instructor you can verify the Certificate of Completion at
http://www.divecomputertraining.com/membercheck.php by entering the Certificate ID number printed on the certificate.
See Attachment for a sample of the Certificate of Completion and Attachment for student instructions on how to enroll in the OCEAN REEF UW COMMUNICATION Online class and obtain the Certification of Completion.

A. Communication in diving

What kind of communication do we typically use in diving?

1) Sign language

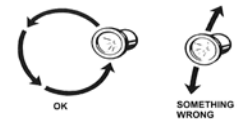


For decades, before the industrialized manufacture of full-face masks - which allow for comfortable speaking - and before the development of underwater communicators, visual forms of communications were developed that are similar to sign language.
Teaching organizations adopted an alphabet, assigning a meaning to specific certain gestures and creating a language that could be used while diving. Sign language, despite the objective limitations vderiving from the requirement that it be used over short distances and facing the subject with whom you wish to communicate, has a certain importance that should not be underestimated. In fact, every system should have a backup, a solution to use when the primary system fails. This is a crucial principle in all activities in which error must be eliminated or limited to the greatest extent possible. The use of radio or television as forms of complete communication does not eliminate alternative forms or our need to understand them. A good example is Morse code, which in its simplicity can be used visually, or as a frequency with audible tones, which can be incredibly useful. Therefore the crucial recom-

mendation is: Understanding signaling forms of communications used by commercial organizations or training agencies is critical to achieving full mastery of communications methodologies. Imagine for example that for some reason your communicator is not functioning properly; you still need to make yourself understood to others.

2) Night diving signals

During night dives, underwater torches are used to communicate. Naturally, a simplified language was adopted to indicate "Everything is OK" or instead if there are "Problems"! The use of these diving signals vhas been proven to be more manageable then using Morse code (which clearly isn't terribly practical during a dive). On the left are the signals provided in the PADI manual.



3) "Line-pull" communications

"Line-pulls" is one of the oldest methods used to communicate between divers and surface. A diver descends pulling along a line from the boat that stretches through the water and is always kept gently taut. To communicate, either end uses a series of one, two, three or four tugs - agreed upon before the dive and depending on the dive itself - and in general a long tug means "I'm about to speak", and an equal pull in response means "I'm listening". It seems primitive, and it is, but it is still widely used by people working who only need to communicate occasionally.

4) Audible methods for simple communications

Another form of communication that can be compared to sign language and Morse code is the use of so-called "bangers": basic acoustic signalers that generate audible noises underwater.
They are usually elastics with a rigid cylinder affixed to the tanks. Pulling on the elastic and then releasing it causes noises against the tank that propagate easily through the water. These audible acoustic signals can then be organized by the diving group to create a simplified language. For example: one bang = everything's ok, 2 bangs = go back to the boat, etc.

Two things are required in order to speak underwater: a sufficiently large volume of air in front of the mouth, and the facial mobility needed to speak as we do on the surface.
This requires a full-face mask, or a half mask in front of the mouth to which the regulator is attached. The latter was the first affordable system offered. This mask was relatively inconvenient because of the precarious seal and the laces. It was also too small for good performance. Further-

more, it alters the performance of a conventional regulator, which is designed to be kept in your mouth and not a few centimeters away. By wearing a full-face mask, you can communicate without a transceiver; simply speak inside the mask. The Neptune Space is facilitated by the rigid polycarbonate window that transmits sound well to the surrounding environment. Clearly, the operating distance is limited to a few meters, and is a function of the volume of the voice, but it is undoubtedly an efficient form of short-distance communication. In the past, half masks were produced that could be connected to the regulator. These masks featured a metallic insert: a dot of copper alloy. This insert was meant to function as a "phonic membrane" that could transmit audio from inside to outside. This method is a very affordable solution, but one of little importance that never managed to take off because the communications distance was severely limited. Breathing was impaired and very uncomfortable.

The transmission of audible sound underwater is technically feasible, but contingent upon the elements we described above. Consequently, methods typical of communications on dry land were developed: cable, or wireless, with the latter using the transmission of ultrasound waves as the "carrier".

5) Hydrophones

Forms of communication using hydrophones have also been attempted. Hydrophones are waterproof loudspeakers that use more or less elevated frequencies and full protection from the water to transmit sound waves in the audible band underwater. They are often used to broadcast music in the pool, and less frequently for classic dive communications. They are also widely used in scientific research as a passive tool (listening for audible underwater communications among cetaceans), and an active one (sending audible signals). Additionally, hydrophones are used in fishing to attract specific types of fish depending on the frequency used.

The limited use of hydrophones for classic dive communications has not developed further because it requires considerable power to reach great distances.
Therefore, it is not easily compatible with portable individual systems and because of its powerful interaction with surrounding marine environment.

6) Communicating by cable

Since the earliest days in the history of diving, there has always been talk of creating/maintaining a connection between a diver and the surface or among multiple divers. A powered console on the surface with a microphone and speaker, a cable that reaches the diver connected to a microphone and speaker installed inside and above the helmet or full-face mask. These are hardwired com-

municators. Hardwired communications include a powered console on the surface with a microphone and speaker, a cable that reaches the diver connected to a microphone and speaker installed inside and above the helmet or full-face mask. Wired connections are certainly the simplest (they re-create underwater the concept of an intercom or a wired telephone) and in some ways also have the best audio qualities.

Obviously, their use is limited by the requirement for dozens or hundreds of meters of cable, which is often difficult to manage and restrict the diver's movements However, this method does make possible the telephonic type of communication known as "full duplex". Full duplex means that you can speak and listen at the same time, while "half duplex" (as in walkie-talkies) allows users only to speak or listen, but not simultaneously. The user must press a button to transmit, and release the same button to listen (a well-known operation in the use of terrestrial radio transmitters). Underwater communication systems using cables are very widespread, and are used especially in the commercial/industrial sector where it is often necessary for the diver to remain ALWAYS connected to the surface with an umbilical cord. For this reason, communication cables are often furnished with stranding around the electrical cables that increase the resistance to tensile stress. This cable becomes a part of the recovery line which is firmly connected to the diver's body, and which can be used to bring the operator back to the surface should it become necessary.

7) Laryngophone

The laryngophone is a type of microphone that captures sound in contact with the neck. Contact capture eliminates or at least reduces environmental noise, where other microphones would not work well because the voice would be overpowered by background noise. This type of microphone can even capture whispers, and works well in environments where people need to remain silent while communicating with others over long distances, such as during a covert military operation.

Laryngophones were used intensively in airplanes during the Second World War, and by crews in German tanks. New single-element designs are available that make the laryngophone much more comfortable to wear than older models. Additionally, this next generation of throat microphones provides varying outputs and frequency responses to accommodate a wide variety of communication devices such as digital and analog portable radios, Tetra & P25 systems, and cellular phones. In diving, they are very useful for amphibious operations in which most activity takes place on dry land. A user opting for a conventional mask over a

full face mask means accepting a reduction in quality. This is because of the difficulty in speaking with the regulator in your mouth. This also provides indisputable flexibility and comfort for activities on land. In any event, laryngophones require either a wired or wireless transmission system.

B. Radio and Ultrasound waves

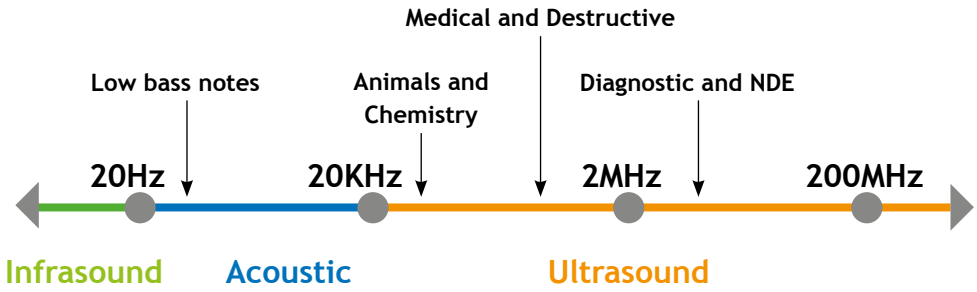
What are radio waves and how are they used for transmission of information?
Radio waves are a type of electromagnetic radiation with frequency ranging from 0 Hz to 300 GHz or in terms of wavelength with a wavelength from 1 mm to infinity. The range of radio waves is conventionally divided into the following bands

Band	Frequency	Wavelength	Main uses
	< 3 Hz	> 100,000 km	
ELF (Extremely low frequency)	3-30 Hz	100,000 km-10,000 km	Radio communication with submarines, tubing inspections, study of the terrestrial magnetic field
SLF (Super low frequency)	30-300 Hz	10,000 km-1,000 km	Communications with submarines, such as the Russian
ULF (Ultra low frequency)	300-3000 Hz	1,000 km-100 km	Used for communications in mines
VLF (Very low frequency)	3-30 kHz	100 km-10 km	Navy communicationwith emerging submarines
LF (Low frequency)	30-300 KHz	10 km-1 km	Intercontinental AM radio transmissions, Transmission of thestandard timesignal for radio-controlled clocks
MF (Medium frequency)	300-3000 KHz	1 km-100 m	AM radio transmissions
HF (High frequency)	3-30 MHz	100 m-10 m (Short waves)	Ham radio operators,cell broadcast, intercontinental transmissions in Morse code
VHF (Very high frequency)	30-300 MHz	10 m-1 m	Commercial FM radio, aviation, marine, law enforcement, television, ham radio operators, radio beacons
UHF (Ultra high frequency)	300-3000 MHz	1 m-100 mm	Television, cellulartelephony, WLAN
SHF (Super high frequency)	3-30 GHz	100 mm-10 mm	Radar, satellites, WLAN
EHF (Extremely high frequency)	30-300 GHz	10 mm-1 mm	Satellite and ham radio transmissions

The UHF band overlaps the radio wave and microwave areas; the boundary is indistinct. The ELF, SLF, ULF, and VLF bands have frequencies equal to those of sound waves, but while the former are electromagnetic waves, the latter are mechanical vibrations of the air.
Ultralow frequencies are used for communications with submarines because the water attenuates the electromagnetic waves proportionally to frequency, with a high coefficient.

Only very low frequencies can propagate over hundreds of kilometers, but they require enormous antennae consisting of sunken wires covering several dozen kilometers. Only a very small amount of information can be conveyed with these waves: messages parceled out slowly, and certainly not a voice. Therefore, in order to achieve sufficient range, it would be necessary to work with incredibly long antennae (impractical on the individual level) and considerable levels of power. In any case, because of its low frequency, a radio wave would be unable to convey a sufficient amount of information to sustain an audio conversation. Water is highly electro-conductive (and saltwater in particular). This means that a radio wave has incredible difficulty propagating in such a conductive environment.

Ultrasound waves, on the other hand, is a cyclic sound pressure with a frequency greater than the upper limit of human hearing (approximately 20,000 hertz). Their speed and propagation are therefore affected by the element in which they travel. Differently from acoustic phenomena properly speaking, the frequencies that characterize ultrasound waves are superior to those generally audible to the human ear. The frequency conventionally used to distinguish between sound waves and ultrasound waves is 20 kHz. The very term itself - "ultrasound" – clearly indicates that it is beyond (ultra) sound, identifying only audible physical phenomena as sound.
Like every other type of wave phenomenon, ultrasound waves are subject to reflection, refraction, and diffraction phenomena. They can be defined using parameters such as frequency, wavelength, propagation speed, intensity (measured in decibels), and attenuation (due to the acoustic impedance of the medium traversed).



Generating ultrasound waves
Ultrasound waves are generated using materials with special mechanical and electrical characteristics known as piezoelectric materials. These special materials, such as quartz or barium titanate, have the characteristic such as generating a potential difference if compressed or stretched transversely; conversely, If a potential difference is applied to their ends, they compress or expand transversely. It is this latter characteristic that is exploited to generate these mechanical waves beyond the audible range (ultrasound). Therefore, based on the material selected, different frequencies of ultrasound waves are achieved, they propagate differently through materials, and the generating machines have different power characteristics. The physical phenomenon of piezoelec-

tricity or magnetostriction that was used to generate the wave is reversible. It follows that the same crystal capable of emitting ultrasound waves can also generate an electrical or magnetic signal, when it collides with a band of elastic waves. Therefore, when the wave reflected or emitted by the obstacle returns to the probe that generated it, it will issue an electrical signal that, when properly amplified and filtered, can be visualized on the display of an oscilloscope or a monitor, which ultrasound detection devices always feature.

Why can ultrasound be used for underwater communication?

Using ultrasound as the means of transmitting and receiving information, a diving communicator can be small compact and light, yet still guarantee a reasonable capacity and good quality in spite of, and in compatibly with, existing natural barriers. Communicators that use ultrasound waves are generally classified as wireless devices.

Propagation of sound

We've said that sound propagates in elastic media, and clearly these media include air and water. To understand how this occurs in practice, let's look at the structure of air. Air is made of many molecules linked together by elastic bonds. We can imagine air molecules as something like spheres joined to other spheres by springs. When a body vibrates, it communicates its movement to the first air molecule (the first sphere in the model). As it moves forward, this molecule "pushes" the next molecule, which in turn "pushes" the next, and so on. A moment later,the elastic bonds (the springs in our model) "pull" the molecule back toward its original position of equilibrium. Because of the force of inertia, the molecule moves past its central point of equilibrium, reaching a distance nearly as far from the center as it traveled in its largest trip forward. These movements are transmitted to the contiguous molecules in a certain period. The effect of these movements is to create areas in which the air is compressed, and others in which it is rarefied. These different areas repeat starting from the source, in the direction of the propagation of sound. This effect is called longitudinal wave. A wave is called longitudinal when the direction of oscillation and the direction of propagation coincide. Given a source of sound, it propagates in all directions in the same way. We can say that it propagates according to spherical wave fronts. The surface of the wave front increases in proportion to the square of the distance from the source. Consequently, the energy that the wave front possesses is distributed across its entire surface, and therefore on a single unit of surface we have a quantity of energy that decreases proportionally to the square of the distance. Because the energy is proportional to the intensity of the sound, we can say that:

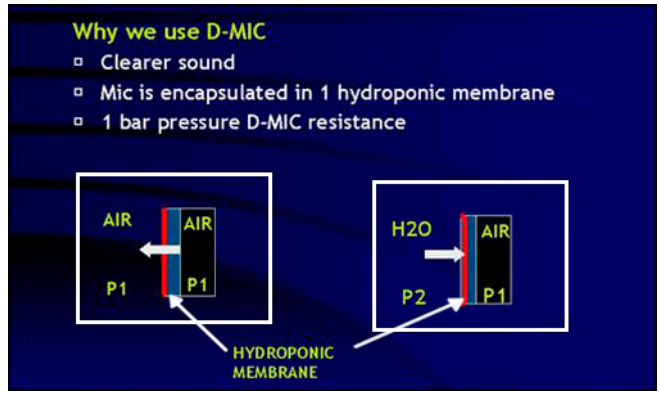
Sound intensity decreases with the square of the distance.

We can see then how the factor of distance is very important in the constriction of acoustic intensity. Sound propagates at a speed that depends on the nature of the elastic media in which it spreads. In addition, this speed is influenced – albeit to a lesser degree – by temperature, pressure, and humidity. Let's see what the speed of sound is in various elastic media (in meters/second): The propagation speed, in relative terms, can be represented by the formula below:
V= ð/T
Where ð= the density of the water and T is the temperature.

Therefore, sound will have greater speed (propagation) in a dense environment at low temperatures. In particular, in water it will travel 4.5 times faster than it does in the air. If the water is salty, this proportion rises even further. Sound that spreads through areas with differing densities or temperatures is reflected and refracted. Therefore, the progressive drop in power equal to the square of the distance will be joined by an additional filter factor. In addition to losing strength as it moves away from the source, it will also be further constricted every time the density and temperature changes (rocks, algae, fish, wrecks, dissolved air, etc.) and the temperature changes. In particular, stark discontinuities (thermo clines, abrupt changes in the density of a material) cause very significant drops in the ultrasound signal.
Refraction is the deviation undergone by a wave that occurs when it passes from one media to another in which its propagation speed changes. The refraction of light is the most commonly observed example, but any type of wave can be refracted: for example, when sound waves move from one media to another

The DMic microphone
What is a DMic microphone and how does it relate to pressure differences?

The DMic is a dynamic microphone with hydro phonic protection. A membrane that is impermeable to water but permeable to air allows for maximum sensitivity to sound yet still protects the delicate electromagnetic components. The hydro phonic membrane allows the pressure to balance between the inside of the microphone and the mask, which in turn maintains the pressure of the outside environment thanks to the incorporated regulator. This balance between pressures makes it so that even if the mask is removed underwater, the microphone is still insulated from the water.
But what happens if the diver removes the mask and starts back toward



the surface (a possibility perhaps when practicing ascending without your mask) or the mike goes back down (improbable, but it's always possible that your dive equipment could be sent to depth again for some reason)?
In the first scenario, if an ascent speed of 10 meters/minute is maintained, the air expands inside the microphone and filters through the hydro phonic membrane. If the ascent speed is excessive, the expansion of air will cause the membrane to flex outward and eventually rupture, flooding the microphone.
In the second case, the membrane will flex inward because it is impermeable to water. It will withstand the pressure to a maximum of -10 meters, at which point it will burst, with the same consequences as the previous case. At this point the microphone cannot be repaired and must be replaced, while no damage was caused to the electronics of the communicator.

How to communicate effectively underwater

6a - Before diving

The set of equipment that allows a diver to communicate with other divers or with the surface is called a communications network.
It may be composed of:

- An underwater transceiver unit called a SUB T (or more than one: SUB T1, SUB T2, etc.)
- An underwater receiver unit called a SUB R (or more than one: SUB R1, SUB R2, etc.)
- A surface transceiver unit called SURF.

Before diving, users should check that each unit is correctly switched on, following the unit's directions. If the units do not turn on, the battery or other power source should be checked and replaced if necessary. For wireless underwater units, it's important to keep the following on hand:

- Replacement batteries
- Silicone grease to lubricate the O-rings
- Phillips screwdriver for removing and refitting the battery compartment cover.

For surface units, the charge in the rechargeable internal batteries should be checked (in models M105, M105 DC, ALPHA PRO X Divers, Gamma 105, and Gamma ALPHA the charge is shown on a LED scale on the panel). For wireless SUB T and SUB R units, these checks must be conducted BEFORE entering the water.
The battery compartment must be closed and have no defects on the outside.
See the attached chapter regarding MAINTAINANCE
Power on test: Wet two fingers and short-circuit the two wet contacts on the case. You should hear a beep. The unit turns on. If not, check the battery and replace if necessary.

Transmission test (1): Keeping your wet fingers on the contact, press the PPT button. You will hear a loud monotone signal lasting approximately 1 second: this means that the unit is on and transmitting.

Transmission test (2), with the help of a buddy: hold two units near each other (a few centimeters apart), with both turned on as described in step 2. Press the SUB T1 button and say a few words into the microphone. You should hear your voice through the SUB T2 or SUB R1. If you have a SURF, bring the SURF transducer antennae near the unit you are testing. Ultrasound waves can penetrate in the air too, provided that the distances are very small (best if no farther than 1 meter). Following the verification that the SUB T1 unit is transmitting, repeat the same test inverting the roles.

If all of these tests are successful, the only thing left to do is finish your preparations and get in the water.
Check that the SUB T1 communicator is firmly mounted on the full-face mask (firmly fastened NACS, O-ring present on the NACS, adjustment of same), that the strap is adjustable, and that the surface breathing valve is open.
Enter the water wearing the mask equipped with a communicator. With conventional masks, the receiver can be attached to the strap.

6b - Receipt and transmission tests before the dive

The tests run before the dive should be repeated on the surface of the water.

1. Check that all the SUB T, SUB R, and SURF units are operational.

The user wearing the SUB T1 full-face mask tilts his or her head to the left to wet the two contacts on the case so that the communicator turns on (you will hear a beep every time the contacts get wet). Then press the button to call the surface station or a dive buddy, as follows:

- Press the PTT and listen for the activation beep = the unit is powered and the PPT works.
- Wait a few seconds after the beep and then speak (example): “George transmitting, everything’s okay, over.”

- Then request that the surface unit send a brief message: “Surface to George, reception level (0 to 10), over.” The quality of this transmission must be verified by the diver, who responds, saying: “George to surface received, quality (0 to 10), over.”

Having verified that all units can transmit and receive, it’s time to begin the dive.
It’s always a good idea to conduct these checks BEFORE beginning the dive.

6c - Basic rules for underwater communications

1. Before beginning the dive, if there are more than two divers on the system, a communications sequence must be established (who speaks first, second, and so on). Everyone needs to know who comes before them and who is next in the conversation. This sequence is important to prevent communications from multiple divers overlapping when two or more start speaking at the same time.
2. Press the button to begin transmitting. After hearing the activation beep, wait a few seconds before speaking. The purpose of the beep is to attract the attention of other divers and/or people on the surface. If you speak over the beep you may not be understood because others are not paying attention or because a portion of the conversation overlaps the beep itself.
3. Speak slowly and pronounce your words carefully. Speaking into the nose/mouth pocket (when wearing a mask) causes reflections and changes in the tone of your voice. Try putting your hands around your mouth like a shell and then speaking. Anyone who hears you will immediately notice the change in tone. Your speech is less clear. Underwater, this obstacle is joined by the element of water surrounding you, which “compresses” your tone of voice downward. That means that you should speak at a normal level, but speak slowly and pronounce each word very clearly. Otherwise your words will get jumbled together and be difficult to understand. This is fairly common even in conversations on dry land with people who speak quickly, or who have accents and pronounce words inaccurately and as a result are difficult to fully understand. This is why you will notice that the voice of the person on the surface is much clearer than those of the divers. Keep in mind that in order to hear as well as possible, divers will preferably hold their breath for short periods or breathe more slowly after hearing the beep that announces communications will begin. It is therefore advisable for people on the surface to speak in short sentences, using brief and clearly pronounced communications.
4. Every communication should end with the word “over”. This alerts all participants (by clearly defining the end of the communication) and gives them confirmation that they can begin their turn speaking.
5. After the end of a transmission, it’s a good idea to leave 5 to 10 seconds of silence so that anyone who urgently needs to step into the conversation may do so. After the 5 to 10 seconds of silence, the next person in order speaks (see point 1).
6. In a group, it’s a good idea to start your communications by stating your own name followed by “transmitting”, thus: “George transmitting”.
7. Air bubbles create a barrier against ultrasound waves, and as they break into micro-bubbles, they tend to adhere to the antenna of the communicator. These micro-bubbles can reduce the range of communicators by up to 80%. That means that during the dive you need to take a few countermeasures.

a. Every so often, it's a good idea to run your fingers along the antenna on your communicator to remove the micro-bubbles that have stuck there.
b. You can also spread a thin layer of silicone grease on the antenna. Silicone makes it more difficult for the air to adhere to the plastic.
c. You can direct the flow of air you exhale away from the communicator by turning the swiveling discharge valve to the opposite side.

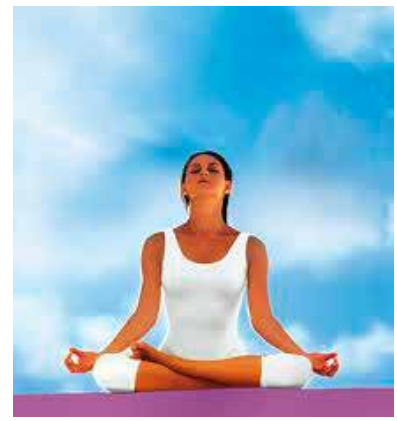
8. Knowing your dive buddies and being used to how they speak helps you understand. A person I speak with every day out of the water will understand me much better than a stranger, even underwater. (To an even greater extent, a person with whom I speak often underwater will understand me even better.)

6d - How to breathe underwater

- Speaking requires greater air consumption. You should always keep this in mind when planning your dive. It's a good idea to calculate a 10 to 15% increase in consumption due to conversation. Some people mistakenly think that full-face masks lead to higher consumption, but that is only true if the mask has leaks (which should be eliminated before the dive) or if it provides continuous flow. In all other cases, after an initial acclimation period, consumption returns to the levels of a normal regulator. "Speaking" means consuming more air!
- You'll need to practice underwater communications, and learn to speak while exhaling slowly (see the next chapter). The faster or stronger you exhale, the more bubbles you create. Bubbles create noise, which deteriorates the quality of the sound by creating vibrations and sounds that drown out your speech. They also create noise that can cover up or muddle what you hear. It's a good idea to practice keeping control over the quantity and intensity of bubbles you make when speaking.
- Even when you're just listening, you should still breathe slowly, and hold your breath for brief periods if necessary.

6di - Controlled breathing

When you talk, large quantities of CO2 are emitted. This gas is crucially important for activating exchanges with oxygen on the cellular level and the resupply of oxygen to the cell. With carbon dioxide, "CO2", in the body at approximately 6.5%, and outside in the air that we breathe at 0.03%, a fast "movement" is created in which this gas moves in the maximum/minimum direction trying to achieve equilibrium.



This results in large losses of carbon dioxide, which is crucial for the optimum exchange of gases at the cellular level. In fact, oxygen can only be "delivered" to the cell thanks to the presence of CO2, which has the ability to "detach" it from the red blood cell and send it to the cen-

ter of the cell, thereby resupplying it with its precious fuel. People who speak a lot (and poorly), either by profession or for some other reason, get to the end of the day feeling exhausted and worn down, and this fatigue is caused by the loss of CO2 due to speech and excited breathing through an open mouth. The result is that the cells are not well supplied with oxygen, and like any engine, without fuel it simply doesn't go. Our bodies feel tired... very tired!
Therefore, it's very important to be aware of how you speak, AND ESPECIALLY UNDERWATER!
We need to apply the controlled breathing technique, which allows us to:

- Maintain good physical condition
- Use less air
- Make our communications more intelligible

6e - Reduction of range in pools and oxygenated environments

If communicators are used in a pool you may run into problems caused by the filtering system, which generates micro-bubbles of air, or because the air exhaled from the tanks in large quantities is partially dispersed in the water in the form of micro-bubbles. Solutions in this situation are:

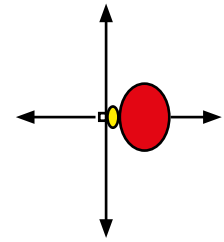
- Suspend the filtering of water and stir up the water for a few minutes with pool brushes to bring the micro-bubbles to the surface.
- Disturb the water in any event to help bring bubbles to the surface so they can be eliminated.

6f - Use of electronics in closed environments

Another obstacle in closed environments is the echo effect, or more frequently, audio distortion caused by excessive transmission strength. The transmitters are relatively powerful, and if they're used in a pool or very close to each other, distortion can be created. The audio goes "off the scale", and becomes difficult to understand. You need to reduce the power, by creating attenuators/filters on the antenna transducer. "Dampers" have been created that can be inserted on the antenna; they are made of a spongy material with many tiny air pockets. The combination of the two materials creates the filter needed to reduce the transmission power as needed and make conversation intelligible again. If you don't have a damper, you can use spongy material held over the antenna.

6g - Directionality of transmission

The ceramic on the transducer is a cylinder with its neutral axis perpendicular to the communicator. Transmission occurs as shown in the next diagram, with the maximum radial to the antenna and the minimum axial. In addition, there is a signal reduction zone caused by the skull and the body when the unit is worn on the mask. The skull, brain, and other tissues create a discontinuity



in the matter surrounding the antenna, and attenuate the signal. It's true to say that the very best performance is achieved when you're face to face with the other party, but this is true even if that person is above us, below us, or behind us, while someone to the side, and particularly on the side away from the communicator, suffers the most deterioration in signal.
An easy, handy exercise for getting familiar with all the various aspects of underwater communications is to dive as a pair with two communicators. One diver begins talking, while the other turns in place, 360 degrees. Then switch roles, rotating 360 degrees while your buddy holds still. During rotation, it's important to repeat the same phrase each time and always use the same tone of voice.
In both cases you'll notice a marked change in reception volume. The very best performance is achieved looking at the other person directly or at 180 degrees, depending on the radial axis of the antenna transducer. This feature is especially useful for getting your bearings underwater or for locating a buddy or a boat that has a SURF unit installed.

6h - Power - Intelligibility - Recognizability

The power of a communicator can be expressed on two scales. The power of the amplifier (value in watts, but which is expressed as a "potential" more than a power, because it does NOT take into account environmental factors, which have a significant effect), and the propagation strength of the ultrasound waves, which is measured using practical tests (testing whether a signal is heard at x meters/miles from the emitter).

Intelligibility is a crucial characteristic. What if you say "kelp" and but someone hears "help"?! Intelligibility always characterizes the quality (whether high or low) of an underwater communicator.

Recognizability
Every human voice has its own "vocal timbre", which when visualized looks like a sound track in which the frequencies, distortions, and everything else that characterizes and personalizes your voice can be detected. An excellent underwater communicator can combine all three of these characteristics.

Exercises that help improve the intelligibility of communications
Harmony in a group is a quality that can improve any endeavor. We'll now take a look at a series of exercises that will allow you to glean the very best performance from your communications during the dive.
In order to be successful, a group of musicians practices and fine-tunes their coordination. Each member senses what the others will do before it happens, thanks to habit and practice.

Intelligibility training by using the Modified Rhyme Test (MRT)

The MRT is a table of 50 lines, and each line contains six words with similar sounds (help, yelp, kelp, etc.). Each diver receives this table. A reading sequence is established in which diver A selects and reads only one of the six words on each line (such as "kelp"), marking it off on his table, and working from the first line he proceeds downward with a five second pause between each word. The diver listening has the same table, and using a marker ticks off each of the words pronounced (or at least the one that he thinks is correct). At the end of the exercise, the transmission and reception word tables are compared. The more words were understood correctly, the higher the level of communications intelligibility.

This exercise was created to verify the quality of communications between two units, and can also be applied in training among groups of divers who use underwater communications often (such as instructors at the same dive school).

This exercise should also be repeated between the underwater (SUB T) and surface (SURF) units, between SUB T and SUB R, and between SURF and SUB R.

Intelligibility is considered:

Excellent	if the listeners (both) understand more than 45 words.
Acceptable	if the listeners (both) understand more than 38 words.
Unacceptable	if the listeners (both) understand fewer than 38 words.

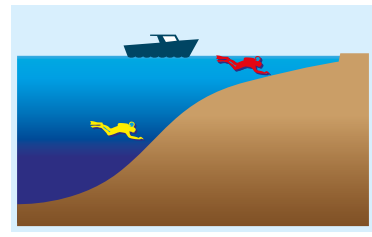
The test is considered invalid if the results between the two divers differ by more than 20%.

6i - Quality of diving communications in different environments and situations

To define the cases more clearly, we will always use the terms SUB T – SUB R and SURF.

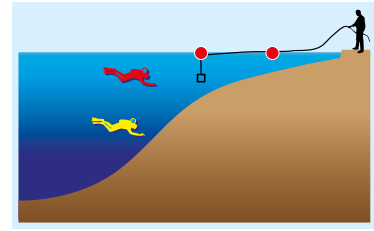
SUB T in shallow water, SURF or SUB R off shore

Ultrasound waves are reflected, losing power, and near the coast there is more air dissolved in the water thanks to the motion of the waves. In this case the transmission range may be low. If the SUB T is the guide, it's advisable for that user to stay near the SUB R in the early phases of the dive from the beach.



SURF on the shore and SUB T further off shore

It's advisable to use a small buoy and a weight anchored near the shore, and ties the surface communicator cable so that the antenna is held below the water's surface. Resting the transducer on the bottom not only reduces the transmission range; it also causes additional noise and wear as the transducer is dragged over rocks, sand, etc.



Rocks and algae

It depends on the structure of the rock, but if it is compact it tends to reflect sound, while types like coral tend to absorb it. In particular, the so-called "living rocks", full of microorganisms, are the perfect insulators of ultrasound waves. Algae, and especially those with reserves of air (such as Sargasso or kelp); create an additional barrier that attenuates the diffusion of ultrasound waves.

Open water and thermoclines

In general, communications in open water are excellent and save for the presence of drastic changes in temperature. In fact, the purpose of the length of the antenna cable for surface units is so that it can be placed at the best performing depth and getting past a thermocline when necessary.

What to do in a cave

Beyond all the precautions normally required when diving that are described in the various dive education manuals, communications in caves are either impaired or improved depending on the material the walls are made of. It's a good idea to maintain continual audio contact when entering a cave and to stop immediately if you notice the signal has dropped or the quality has deteriorated.

Wrecks

Follow all the applicable precautions described in the diving manuals. Communications inside iron wrecks can still be excellent so long as coral concretions and algae do not create thick layers on sheets of metal the sheets absorb and reflect ultrasound waves well. Biological strata function as an attenuating sponge. Air bubbles

present or generated inside a wreck can be responsible for additional decreases in range and quality. A SURF antenna can be placed on the bow or stern of the wreck, along the central axis and as close as possible to the horizon of the bridge of the wreck where most the activity will take place.

3.4 Knowledge Development Summary

We have covered:

A. The theory of different ways of underwater communication and it's history.

a) What kind of communication do we typically use in diving?
b) What are the two things required in order to speak underwater?
c) What are hydrophones?
d) How can we communicate underwater by using a cable?
e) What is a laryngophone?

B. The basic physical principles of radio waves and ultrasound.

a) What the radio waves are and how are they used for transmission of information
b) What are radio waves and how are they used for transmission of information?
c) List the most common radio bands.
d) Why are radio waves impractical for underwater communication between divers?
e) What is ultrasound
f) How is ultrasound generated?
g) Why is ultrasound a good choice for underwater communication between divers?
h) Why can ultrasound be used for underwater communication?
i) How is ultrasound received?
j) How is sound propagated and what are longitudinal waves?
k) How does sound intensity change with distance?
l) What is a DMic microphone and how does it relate to pressure differences?

C. The theory of underwater communication equipment and diving procedures.

a) What may the Ocean Reef set of UW communication equipment be composed of?
b) What should be checked regarding UW communication equipment before the dive?
c) How is the receipt and transmission test before the dive conducted?
d) What are the basic rules for underwater communication?
e) What is the correct breathing pattern for effective underwater communication?

f) Why do we need to apply controlled breathing technique when speaking underwater?
g) How do pools and oxygenated environments affect the range of communication?
h) What can we use to reduce the power of transmission?
i) How does the direction of the antennae affect the power of transmission?
j) How are power, intelligibility and recognizability defined?
k) How can we help improve the intelligibility of communications?
l) What the MRT tables are?
m) What's the definition of intelligibility by using MRT tables ?
n) What is the quality of UW communication in different environments and situations?

4. Confined Water Dives

This confined water dive is required of all student divers enrolling in a UW Communication with Full Face Mask Specialty Diver course.

4.1 Conduct

Student divers must complete this confined water dive prior to making the first UW communication open water dive of this course. The confined water dive provides time to eliminate potential equipment problems, allow student divers to try-out their full face mask and communication devices, and practice different roles.

4.2 Confined Water Dive Performance Requirements

By the end of the confined water dive, student divers will be able to:

Before entering the water:

- Adjust the full face mask straps and the equalization nose plugs for proper fit.
- Check the communication device of the Full Face Mask between Buddies.
- While wearing the full face mask, equalize the air pressure in the ears using the nose plugs in the full face mask.
- Knowing the organization procedures and rules of communicating underwater

In the water:

- On the surface check the communication device of the Full Face Mask between Buddies.
- On the bottom check the communication device of the Full Face Mask between Buddies.
- In shallow water, perform Modified Rhyme Test (MRT) being Receiver (SUB – R).
- In shallow water, perform Modified Rhyme Test (MRT) being Transmitter (SUB – T).
- If available by the instructor – on land perform Modified Rhyme Test (MRT) being
- Surface station (SURF – T).
- Students alter all available roles during this confined dive.

4.3 Confined Water Guidelines for the Dive

A. General Confined Water Considerations

It is highly recommended, but not required that student divers use the same type of full face mask, dive equipment, and accessory equipment during the confined water session they intend to use on their open water dives.

B. Briefing of uw confined water dive

1. Review objectives and sequence of skills.
2. Coach divers through assembly and gear-up as needed.
3. Evaluate student equipment for adequacy.
4. Identify potential problems and offer suggestions.
5. Demonstrate donning and adjustment of a full-face mask.
6. Explain how the MRT tables work and how to use
7. Gear up and enter water

C. Predive Procedures

1. Evaluate student diver equipment for suitability for full face mask and UW communication training.
2. Assist student divers with equipment adjustments for use with full face mask and UW communication.

D. Confined Water Tasks

1. Check UW Communication device between Buddies on land.
2. Check UW Communication device between Buddies on the surface.
3. Check UW Communication device between Buddies on the bottom.
4. In shallow water, perform Modified Rhyme Test (MRT) being Receiver (SUB – R).
5. In shallow water, perform Modified Rhyme Test (MRT) being Transmitter (SUB – T).
6. If available by the instructor, on land perform Modified Rhyme Test (MRT) being the surface station (SURF – T).

E. Post-dive procedures

F. Debriefing

Have student divers compare all lists they marked during the Modified Rhyme Test (MRT). Log confined water dive (instructor signs log).

5. Open Water Dives

Student divers must complete two open water dives wearing a full face mask with UW communication device.
The first is a repetition of the confined water dive exercises
The second is real dive with the use of UW communication for the normal dive activity.

5.1 Conduct

In addition to the typical predive equipment familiarization exercise, dive buddies should orient themselves to the location of their partner's spear mask (BCD pocket, suit pocket or elsewhere). During the predive check, dive buddies also check full face mask regulator operation and seal functions before entering the water.
On the first dive, student divers work stationary and perform the Modified Rhyme Test (MRT) and alter roles as SUB-T, SUB-R and if available SURF-T.
On the second dive, student divers make practice fun dive with the full face mask and UW communication device. Bottom time on each dive should not exceed the no decompression limits of the Recreational Dive Planner or each diver's computer, if used. Regardless of how you conduct the open water dives, student divers must demonstrate the following performance requirements.

5.2 Open Water Dives Performance Requirements

Performance requirements
By the end of the open water dives, student divers will be able to:
Before entering the water:

- Adjust the full face mask straps and the equalization nose plugs for proper fit.
- Check the communication device of the Full Face Mask between Buddies and even receiving units.
- While wearing the full face mask, equalize the air pressure in the ears using the nose plugs in the full face mask.

In the water:

- On the surface check the communication device of the Full Face Mask between Buddies.

- On the bottom check the communication device of the Full Face Mask between Buddies.
- In deep water, perform Modified Rhyme Test (MRT) being Receiver (SUB – R).
- In deep water, perform Modified Rhyme Test (MRT) being Transmitter (SUB – T).
- If available by the instructor – on land perform Modified Rhyme Test (MRT) being Surface station (SURF – T).
- Students alter all available roles during this open water dive.

5.3 Open Water Guidelines for UW Communication Dives

General Open Water Considerations

1. Involve student divers in dive-planning activities. Give special attention to student diver anxiety and stress levels, in addition to student diver equipment preparedness.
2. Conduct a thorough briefing. The better the briefing, the more smoothly the dive will proceed. Assign buddy teams according to ability (weak with strong) and establish a check-in/check-out procedure.
3. Assign logistical duties to staff and review emergency protocols.
4. Remind divers to familiarize themselves with their buddies equipment.
5. Evaluate diver's thermal protection for appropriateness for the dive site and expected conditions.
6. Make yourself available to answer questions during equipment assembly, safety checks and gear-up.

A. General Open Water Considerations

Pay particular attention that students check their UW communication device on land and on the surface properly before entering the water and descending. As well as all student divers have the necessary MRTs.
It may be appropriate to provide a park our marked with the different roles student divers will play during this first dive. Choose a dive site, preferably a sandy bottom, where fragile marine life will not be damaged during skills practice for descents, ascents and other mask skills.

B. UW Communication Open Water Dives

Dive One

- Adjust the amount of weight needed to be neutrally buoyant at the surface
- On the surface check the communication device of the Full Face Mask between Buddies
- On the bottom check the communication device of the Full Face Mask between Buddies
- In deep water, perform Modified Rhyme Test (MRT) being Receiver (SUB – R)
- In deep water, perform Modified Rhyme Test (MRT) being Transmitter (SUB – T)
- If available by the instructor – on land perform Modified Rhyme Test (MRT) being Surface station (SURF – T)

- Alter the role of “instructor” and students by using full face mask + transceiver and receiver only
- Students alter all available roles during this open water dive
- Demonstrate a neutrally buoyant ascent from the bottom at a rate no faster than 18 meters/60 feet per minute

Briefing

1. Evaluation of conditions
2. Facilities at dive site
3. Entry technique to be used – location dependant
4. Exit technique to be used – location dependent
5. Bottom composition and topography around training site
6. Depth range on bottom
7. Ending tank pressure – when to terminate the dive
8. Interesting and helpful facts about the dive site
9. Sequence of training dive – review Dive 1 skills
   a) Suiting up
   b) Predive Safety check
   c) Buoyancy check at the surface
   d) UW com units check
   e) MRT tests
   f) Ascent
10. Predive Procedures
11. Descent
12. Dive 2 skills
13. Post-dive procedures
14. Debriefing
15. Log dive (instructor signs logbook)

Dive One tasks

1. Check UW Communication device between Buddies on land.
2. Check UW Communication device between Buddies on the surface.
3. Check UW Communication device between Buddies on the bottom.
4. In deep water, perform Modified Rhyme Test being Receiver (SUB – R).
5. In deep water, perform Modified Rhyme Test being Transmitter (SUB – T).
6. If available by the instructor, on land perform Modified Rhyme Test (MRT)being the surface station (SURF – T).
7. Controlled ascent.

Post-dive Procedures

Debriefing
Have student divers compare all lists they marked during the Modified Rhyme Test (MRT).
Log dive (instructor signs log)

Dive Two

- Adjust the amount of weight needed to be neutrally buoyant at the surface
- Demonstrate proper equalization and descent techniques.
- Demonstrate proper use of UW Communication device between the buddy and the surface, if available in a regular dive.
- Demonstrate proper ascent techniques.

1. Briefing
   a) Dive sequence – review Dive One tasks
2. Predive Procedures
3. Dive One Tasks
   a) Suiting up — donning and adjusting the full face mask.
   b) Predive safety check — includes checking full face mask function, uw communication device and reviewing use with buddy.
   c) Controlled descent and equalization.
   d) Communication under water with buddy and surface, if available.
   e) Controlled ascent.
4. Post-dive Procedures
5. Debriefing
6. Log dive (instructor signs log)

Appendix / Notes

Table 1

	1	2	3	4	5	6
1	BAT	BAD	BACK	BASS	BAN	BATH
2	BEAN	BEACH	BEAT	BEAM	BEAD	BEAK
3	BUN	BUS	BUT	BUFF	BUCK	BUG
4	CAME	CAPE	CANE	CAKE	CAVE	CASE
5	CUT	CUB	CUFF	CUP	CUD	CUSS
6	DIG	DIP	DID	DIM	DILL	DIN
7	DUCK	DUD	DUNG	DUB	DUG	DUN
8	FILL	FIG	FIN	FIZZ	FIB	FIT
9	HEAR	HEATH	HEAL	HEAVE	HEAT	HEAP
10	KICK	KING	KID	KIT	KIN	KILL
11	LATE	LAKE	LAY	LACE	LANE	LAME
12	MAP	MAT	MATH	MAN	MASS	MAD
13	PAGE	PANE	PACE	PAY	PALE	PAVE
14	PASS	PAT	PACK	PAD	PATH	PAN
15	PEACE	PEAS	PEAK	PEAL	PEAT	PEACH
16	PILL	PICK	PIP	PIG	PIN	PIT
17	PUN	PUFF	PUP	PUCK	PUS	PUB
18	RAVE	RAKE	RACE	RATE	RAZE	RAY
19	SAKE	SALE	SAVE	SANE	SAFE	SAME
20	SAD	SASS	SAG	SACK	SAP	SAT
21	SEEP	SEEN	SEETHE	SEED	SEEM	SEEK
22	SING	SIT	SIN	SIP	SICK	SILL
23	SUD	SUM	SUB	SUN	SUP	SUNG
24	TAB	TAN	TAM	TANG	TACK	TAP
25	TEACH	TEAR	TEASE	TEAL	TEAM	TEAK

Table 2

	1	2	3	4	5	6
26	LED	SHED	RED	BED	FED	WED
27	SOLD	TOLD	HOLD	FOLD	GOLD	COLD
28	DIG	WIG	BIG	RIG	PIG	FIG
29	KICK	LICK	SICK	PICK	WICK	TICK
30	BOOK	TOOK	SHOOK	COOK	HOOK	LOOK
31	HARK	DARK	MARK	LARK	PARK	BARK
32	GALE	MALE	TALE	BALE	SALE	PALE
33	PEEL	REEL	FEEL	HEEL	KEEL	EEL
34	WILL	HILL	KILL	TILL	FILL	BILL
35	FOIL	COIL	BOIL	OIL	TOIL	SOIL
36	FAME	SAME	CAME	NAME	TAME	GAME
37	TEN	PEN	DEN	HEN	THEN	MEN
38	PIN	SIN	TIN	WIN	DIN	FIN
39	SUN	NUN	GUN	FUN	BUN	RUN
40	RANG	FANG	GANG	BANG	SANG	HANG
41	TENT	BENT	WENT	DENT	RENT	SENT
42	SIP	RIP	TIP	DIP	HIP	LIP
43	TOP	HOP	POP	COP	MOP	SHOP
44	MEAT	FEAT	HEAT	SEAT	BEAT	NEAT
45	KIT	BIT	FIT	SIT	WIT	HIT
46	HOT	GOT	NOT	POT	LOT	TOT
47	NEST	VEST	WEST	TEST	BEST	REST
48	BUST	JUST	RUST	MUST	GUST	DUST
49	RAW	PAW	LAW	JAW	THAW	SAW
50	WAY	MAY	SAY	GAY	DAY	PAY

Exercises for communicating better underwater

General preparations

General preparations before a dive should always comply with the rules established by your dive instruction organization. Only after having completed all the preliminary dive safety steps should you focus on preparing your communication systems.

Apply, start up, and distribute the communicators to the members of the team with whom you'll be conducting the dive training.

Decide:

1. Team leader: the person with the most knowledge/experience necessary to teach others to use communicators with full-face masks. (This person must be a SUB T; they cannot be a SUB R or SURF).

Define

2. SURF 0 – surface unit that will open communications (if present)
3. SUB T1, priority 1 (this is who will speak first when diver conversations begin)
4. SUB T2, SUB T3, and so on will follow in order.
5. SUB R (receiving units do NOT need an order of priority).
6. Explain that in the water, SURF 0 will make the first call, followed by the other SUB Tx.
7. Check that every SUB T, SUB R, and SURF unit works properly
8. Conduct the surface tests as described in the instructions on page 18/19 and make sure that all units assigned to each operator function correctly.

Begin the dive

DO NOT BEGIN THE DIVE WITHOUT:

- **having checked for complete communications between SUB T and SURF and SUB R (if using)**
- **having checked the assigned communications priority.**

The SURF begins:

"SURF (it's best to use one's own name) transmitting, verify communication quality. Please respond specifying the level of intelligibility from GOOD - NOT CLEAR. At the end of the test I will give the "GO" signal to begin."

If there is no SURF, the test will be conducted by SUB T1.

"SUB T1 (again, it's best to use one's own name) transmitting, verify communication quality. Please respond specifying the level of intelligibility from POSITIVE- NEGATIVE. At the end of the test I will give the "GO" signal to begin, over."

SUB T2 responds.

"SUB T2 transmitting, reception quality GOOD. Over."

And so on through to the final SUB Tx.

SUB T1 takes over communications again.

"SUB T1 transmitting, reception quality of: EVERYONE / (say the name of the person) is POSITIVE,

quality of ... NEGATIVE. Verify reception of SUB R unit. I will call you by name. Respond with a hand gesture according to the following signals if you understand what I am saying."
SUB R, confirm POSITIVE reception. SUB R makes an affirmative or negative signal.
SUB T1 checks the reception of each SUB R.
Having conducted the check, SUB T1 confirms if the dive will proceed or not, using the following words.
"SUB T1 transmitting. OK/ I CONFIRM the dive begins. Meet... (At the bottom, at x meters). Position yourselves... ...."
Once you reach the meeting point, the real dive operations begin.
We recommend that you conduct an initial orientation session (in the pool or shallow water) to familiarize the operative members of the team with each other.
"Operative members" are the instructor, the dive master, and assistants, including those on the surface. In the first harmonization session, all the SUB Ts and SURF will have the tables
Each SUB T needs to be given as many tables as there are SUB Ts + SURF (3 SUB Ts + SURF = 4 tables). One table must be labeled TRANSMISSION, and on the others the word RECEPTION must be circled.
The location for the harmonizing/ training session must be selected carefully.
It must be easy to interrupt the dive, meet to verify results, and prepare for subsequent phases. A pool is excellent, but in that case the difficulties created by communications in closed environments must be taken into consideration. A beach or wharf can work well, and a convenient boat anchored to a shallow bed does too. It's a good idea to avoid deep or inaccessible areas or those with a current. It's always helpful to equip yourself with logistical supports like a floating basket that is anchored in which to store tables or pens, and a support where members can take a break without tiring. If using a surface unit, it should be fastened securely and protected. Make sure that the transducer does not touch the bottom, walls, keel or anything else in the operating environment.
If the SURF is present, SUB T1 calls the surface and invites it to begin the RHYME test, ending the message with the customary word "over".
SURF begins the test by asking each SUB T, one by one, to confirm that they are able to conduct the test. This check must proceed through the following phases:
SURF transmitting, will all SUBs confirm in their order of priority:
"All equipment is operating properly, physical condition is good. I confirm the beginning of the test, over." The various SUB Ts respond, repeating the sentence after saying their own name. If conditions are not all positive, the test is aborted and the divers return to the surface to solve the problem.
Having reached the final SUB T, the SURF resumes control of communications and begins the test. When there is no SURF on the system, the procedure proceeds in the same fashion but with SUB T1.
SUB T1 begins to read one word of their choice from each line of table 1 – TRANSMISSION.
ONE per line, randomly! On the TRANSMISSION table, use a pencil to circle each word read aloud. Leave a 5-second pause between each word until reaching the 25th line. On their own RECEPTION table 1, all the divers circle the words they believe were said by the SURF or SUB T1.
Upon reaching the 25th line, SURF or SUB T1 confirms the conclusion of the test and passes the turn to speak along the priority sequence, and the remaining divers repeat the transmission test in the same way. Each therefore will use the TRANSMISSION table 1 for the step in which they read, and

the RECEPTION table 1 for each listening step.
This exercise must be conducted WITH BOTH TABLES by the members of the team. Between table readings, the dive must be paused so that results can be checked and discussed.

COMMENTS - ANALYSIS - GOALS

Comparing the TRANSMISSION table with the various RECEPTION tables can indicate which words were Misinterpreted by other divers. This misinterpretation can be caused by a number of factors. If every RECEPTION table has different errors, it may be only a question of familiarity among team members. However, if the same word was misheard by more than one diver, it may be that the problem is caused by an incorrect reading or pronunciation.
In this case, it's a good idea when training continues to repeat the reading of all six words on the line in which the word was misunderstood,reading randomly and marking next to each the position in which it was read/heard. Then the results must be compared.
These exercises must be repeated in order to improve mutual understanding among the team members as well as to alter both pronunciation and listening styles. For example, the divers will learn to hold their breath briefly when they hear that a communication is coming, and also to change their orientation compared to the others, how they exhale and emit bubbles, how they inhale, how they speak, how they analyze the surrounding
environment, how often they remove bubbles from the antennae, etc. This is why it's important to mention once again that in order to remove these hurdles to understanding, team members need to follow the suggestions provided in these chapters. Indeed, the quality goals are achieved by applying all the notes provided in this course that explain the methods required to obtain the very best performance from the communicators. Achieving mastery of underwater communications means adding an additional qualification to your list of professional diving skills. It's a mistake to think that all you must do is wear your mask and press the transmission PTT to know how to communicate underwater. Although it's a simple operation, this technique can be intensified and analyzed in depth to obtain the utmost from the devices available and to communicate successfully in every situation. Underwater communications are, for all intents and purposes, a science that requires an understanding of Physical phenomena and the appropriate use of the means that technology provides. Repeat these exercises until the number of errors or misunderstandings is reduced to a physiological level (precisely as happens in Conversations on dry land).
In the final analysis, it is possible to simulate any specific activity in one's own work (teaching an exercise, illustrating things or the environment) by carrying on a longer or shorter dialogue with your partners and ensuring that in the various positions/conditions, understanding is kept at good levels. Remember that when you expect a response, you need to end your own transmission with "over", while if the conversation doesn't require a confirmation you should end with "out".

ADDITIONAL NOTES

It is crucial that each participant understands the special dive "sign language" that is used by their own teaching organization. If this language has not been learned or is unavailable, the students must be taught certain fundamental signals, described below.

OK

I DO NOT UNDERSTAND

"No" indicated by wagging the index finger back and forth is appropriate. If this gesture is followed by pointing to the communicator with the index finger it means: *"I can't hear."*

Refer to the reference teaching material to learn the other signs.

Instructions before the dive - Briefing

The instructor/guide informs the students that individual and group communications will be conducted, and that:

1. When they hear the "beep" indicating the start of transmission, they must slow their exhalations by holding their breath briefly and paying attention to incoming communications. Stop and face toward the instructor.
2. Periodically check that there aren't excessive micro-bubbles on the antenna of the receiver, and in any case rub off the bubbles frequently.
3. If the communicator begins to beep every 30 seconds, the battery is running out of power. Inform the instructor by a communication or point to the receiver, and make the signal for low air. This means that the RECEIVER is running out of power. The receiver will still be able to receive communications for quite a few minutes - see the corresponding instructions. The steps required to check the proper operations of the equipment are the same reported earlier.

When you ask a student to "do something", you should comment on the exercise or task with a direct dialog (OK, that's right, you can continue, etc.). Speaking calmly and with short, reassuring sentences motivates students and makes their activities more rewarding. It's also easier to understand what to do and what NOT to do.

The use of a single SURF surface unit makes the activities with your group safer and more complete. The SURF must primarily address the instructor or dive master in the group. It's only appropriate to make general announcements if there are important communications for the entire group.

Communications should ideally begin with:

"Surface unit here, I am _____, attention (name of the dive master or whomever is being called), transmitting, please confirm reception, over."

Or alternatively,

"Surface unit here, general announcement, general announcement, your attention please. [Pause for a few seconds.] *Begin general communication. [Content.] Over."*

ATTACHMENT - MAINTAINANCE

Few important notes to keep working your uw communication equipment

1. **Replacement of the DMic**
   DMic is a strong and sophisticated part of the transceiver unit but it may go our of work by not providing the proper care or assistance
   a) Clean by fresh water but w/out any water pressure that might damage the Hydrophonic membrane
   b) If the unit doesn't transmit but it turns on, makes the beep and receive it might be possible that the DMic must be replaced. Use the in packaging screw driver after the removing of the silicone protective band over the contacts. Release the two screws and replace the DMic with a brand new one after a slight lubrication of the contacts.

2. **Flooding of the battery compartment - watch online video or tutorial on OCEAN REEF web site**
   a) In case of flooding, open the battery compartment by removing the two screws, remove the water, the battery, clean and dry completely the compartment.
   b) If the battery contacts are still fine, lubricate a little bit the two springs and the o-ring, install a new battery and turn on the unit.
   c) Refit the caps with the o-ring (use some silicone grease) on the battery compartment and screw the cover by checking that the o-ring is in it's the right position
   d) If you do not use for a while the com unit, remove the battery, storage the caps with the or into the battery compartment and lock the cover by screwing it in (two screws)

3. **Replacement of a broken clear part of NACS**
   a) NACS is the Neptune Adjustable Communication Support that has a clear flexible clip to be connected to the mask frame and hold the communication unit.
   b) The clear flexible part may be broken and for safety reason (entrapment) it has been built with material that may crash if a strong action is directed on.
   c) In case of replacement watch the online video or tutorial on OCEAN REEF web site where it is clearly reported how to repair the NACS.

In Conclusion

In this reference book we have tried to bring together everything needed to build a true understanding of what underwater communications are and how they can be managed most effectively. We believe that it's the new frontier in the development of both commercial and recreational diving. We think that this big shift has just begun and we're convinced that the growing application and use of underwater communicators will make it possible to make diving much safer.
We're also convinced that this evolution will be ensured by sharing the experiences of many divers around the world, and we invite everyone to send in their suggestions, stories, and ideas for developing and improving "the science of underwater communications"

Attachment

Certificate of Completion of Knowledge Development (sample)

Online Class – Instructions for Dive Store

1. OVERVIEW

As earlier indicated students must independently perform the Knowledge Development portion of this course by taking the OCEAN REEF UW COMMUNICATION Online Class – available at www.dive-computertraining.com – and providing to Instructor a Certificate of Completion.

Student may enroll in the OCEANREEF UW Communication online class either by purchasing it directly or by obtaining an Activation Code from the dive store. In the same way, student may purchase directly the Certificate of Completion or redeem it using a Store Certificate Code obtained from his/her local dive store.

It is recommended that the dive store includes in the cost of this course both the Activation Code and the Store Certificate Code. In this attachment you can find instructions on how a dive store can obtain both types of codes.

2. REGISTER WITH www.divecomputertraining.com

Before a dive store can order our codes, it must first register with the DiveComputerTraining.com

service as a ”Scuba Shop”; to do so, just go to www.divecomputertraining.com and click on the REGISTER button then select the Scuba Shop option and fill in the required form (make sure to write down your Username and Password !).

3. ENTER DIVE STORE

Once you have completed the registration, go back to the main page and log-in using your Username and Password. As a dive store you will be able to access DiveNav’s online store by clicking on the Store button.

Once inside the online store you will be able to purchase both the Activation Codes and the Store Certificate Codes.

4. ACTIVATION CODES FOR ONLINE CLASS

To purchase Activation Codes for online classes, click on the Activation Codes button

a. Select Manufacturer Then click on the OCEAN REEF logo ….
b. Select Product & Quantity
   i. … select the OCEAN REEF UW COMMUNICATION COURSE for which you would like to purchase Activation Codes ….and decide how many Activation Codes you would like to purchase

Digital Activation Codes vs. Printed Activation Codes

When you reach the quantity selection page you will notice that the first line refers to DIGITAL ACTIVATION CODE. Our Activation Codes are available in 2 forms: Digital and Printed.

Digital Activation Codes are easier to order (you can order just one – when you need it) and easier to get (the Digital Activation Code will be emailed to you shortly after you complete the transaction) but it is our responsibility to then provide the Digital Activation Codes to your students (print out the email and hand it over to your students… or just forward the email to them). Just make sure that you do NOT provide the same Activation Code to 2 different people … otherwise one of them will be very disappointed.

Printed Activation Codes are the preferred choice for large dive stores/chains that include them in the dive computer box. The Printed Activation Codes have the size of a business card, have an UPC code printed on them, are customized with your dive store name and have a minimum quantity requirement.

If you want, we can also replace the default background image with an image of your choice, but there is a one time set-up fee for this.

Depending on your location, it could take between 5 to several days to receive the Printed Activation Codes.

Please note that each Activation Code is valid for 12 months since activation and could be used ONLY by ONE student.

c. Complete the transaction using PayPal
   Review your cart, and then proceed to PayPal to complete the transaction.If you do not have a PayPal account, you can use a credit card to pay for the activation codes; once you reach the PayPal page just click on the link “pay with credit card” and PayPal will take care of it for you.

5. STORE CERTIFICATE CODES

Store Certificate Codes allow students to obtain the Certificate of Completion by redeeming the code.

Each Store Certificate Code is a unique string of 9 alphanumeric digits and could be used only once – and only by one student.

To order Store Certificate Codes just click on the Certificate Codes button

a. Then select the amount,0… select amount of Store Certificate Codes you would like to order… Note that the Store Certificate Codes are DIGITAL ONLY. This means that they will be emailed to you shortly after you complete the transaction and it is your responsibility to provide the Store Certificate Codes to your students (print out the email and hand it over to your students… or just forward the email to them). Just make sure that you do NOT provide the same Store Certificate Code to 2 different people … otherwise one of them will be very disappointed. Please note that each Store Certificate Code could be used ONLY ONCE and ONLY by ONE student.
b. Complete the transaction using PayPal. Review your cart, and then proceed to PayPal to complete the transaction. If you do not have a PayPal account, you can use a credit card to pay for the activation codes; once you reach the PayPal page just click on the link “pay with credit card” and PayPal will take care of it for you.

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