NITROX DIVER MANUAL

Product n° M0011

Editor: Mauro Bertolini

Formative project, development, consulting and revision: Mauro Bertolini, Mario Romor, Miho Tsuruoka, Egidio Trainito, Maria Laura Careddu

Text and photos: Mario Romor

Illustrations: Stefano Trainito, Jacopo Pasqualotto

Index

Chapter One

New chances

It's a beautiful day, the sky is clear, the sea is calm and the temperature is warm outside and in the water as well. These are the perfect conditions to dive on the KT, one of the most interesting and well kept wrecks of the Mediterranean Sea.

Karen and Denise, two ESA Wreck Diver licensed divers, are enthusiast: the good weather conditions and the favourable sea state let them have a great dive, and now, back on the boat, they are discussing it with Robert, the Diveleader who escorted them. One only regret: "It's a pity the dive was so short!"

Several minutes later, while the three divers are still talking, another group of divers emerge. They are guided by Lucy, the other Diveleader that works at the diving centre. After the divers are onboard, Karen asks Lucy why they dived for longer and if a decompress stop was needed.
Lucy explains that, according to the rules of the diving centre, dives exceeding the no decompression limits are forbidden, and that she and the other divers could stay longer because they used a gas mix similar to air, but with less nitrogen and more oxygen: Nitrox.

Karen and Denise, happy for chance to dive longer, ask Robert to use Nitrox during the second dive, so that they could visit the bow of the boat, that is surrounded by many fish such as corvinas and groopers.
Robert tells them that is not possible to dive with Nitrox because there are not enough cylinders and they need to be trained to use it.

The most greater time granted by the Nitrox allows a more accurate exploration

Needless to say that, after noting that they must finish their second dive before than the other divers that are using Nitrox, the two friends decide go get informed the ESA Nitrox Diver course. Getting the ESA Nitrox Diver license is really easy; this manual and your ESA Nitrox Diver Instructor will provide all the information needed to diver longer without exceeding the no decompression limits, using properly the two most common Nitrox mixes: NOAA Nitrox 1 and NOAA Nitrox 2 (i.e. Nitrox with 32% and 36% of oxygen respectively).

You will learn to analyse the gas mix what you will use, to plan your dives and to monitor exposure to oxygen.

During your course the ESA Nitrox Diver Instructor will show how to perform all needed actions and will give suggestions on the best usage of the "hyper-oxygenated" gas mixes, in order to take advantages from their potentiality avoiding any potential problems.

Read and answer the questions you find in the "miniquiz" and the "What have you learned?" questionnaires, start this new adventure and add your new important license to your collection.

The ESA Nitrox Diver license enables you to recharge and hire Nitrox cylinders, dive with Nitrox and satisfy the need to have it as a prerequisite for other courses.
This manual deals with the new limits established for recreational dives with Nitrox; anyhow, your new license does not authorize you to go beyond the limits of your main license. For instance, the limits for an ESA Open Water Diver (or similar license released from other organisations) is 18 metres without exceeding the no decompression limits.
If you have not done it already, in order to better use the potentiality if Nitrox, you may think to attend the ESA Advanced Diver course, in order to extend your depth limit to 30 metres, always within the no decompression limits.

The ESA Nitrox Diver program can be carried out during other courses, such as ESA Open Water Diver and ESA Advanced Diver; ask your instruc-

tor what you need to do to get the two licenses during two integrated training programs.

What will you learn?
Knowing the composition of Nitrox, its effects, how planning dives correctly and getting ready for them makes the divers fully use the potentialities of hyper-oxygenated gas mixes (or with reduced amount of nitrogen) without exposing themselves to risks.
What is Nitrox? What are the associated risks? What do I need to do to plan dives with Nitrox? How can I prepare my dive at the best? How should I behave while diving? How will I analyze the gas mix and check the oxygen percentage?
You will find the answers to the above and other questions in this chapter. The information you will get will be useful already during the first dive; should you have any doubts or additional questions, don't hesitate to ask your ESA Nitrox Diver Instructor.

The Nitrox certification that you will receive is essential to participate to immersions with the Nitrox

Nitrox
The word Nitrox is composed by two words: nitrogen and oxygen, the two main gasses that constitute the air you breath everyday.
The air can be considered to be a Nitrox mix with 21% of oxygen, that is the "normal" percentage of oxygen contained in the air. Such a mix, with 21% of oxygen and 79% of nitrogen is called air, while the word "Nitrox" is specially used to indicate an oxygen enriched air mix. By Nitrox we intend all those breathable mixes with more oxygen and less nitrogen.

You can easily understand that, in order to maintain the overall equilibrium and pressure of a given amount of air, you need to increase the quantity of oxygen when reducing the amount of nitrogen.

How does it happen? You will find the answer in the next chapter which deals with preparation of Nitrox. **Please note that Nitrox can be prepared by qualified people only.**
Any mix containing a percentage of oxygen higher than 21% can be called Nitrox or Enriched Air; the oxygen percentage in mixes used for recreational dives ranges between 21% and 40%. For safety and practical reasons, the ESA Nitrox Diver course deals mainly with the two most tested, diffused and convenient ones: NOAA Nitrox I e NOAA Nitrox II, containing 32% and 36% of oxygen respectively.

In specific dives such as technical, military, explorative, scientific or during which people work under water, Nitrox mixes with oxygen percentage higher than 40% can be used; this is to reduce the decompression time. The ESA Nitrox Diver course is for divers who want to extend the no decompression limits respecting all safety margins. Therefore, this manual does not treat any of the specific dives listed herabove.

Definitions
To avoid confusion and use the potentiality given by Nitrox to the maximum extent, some definitions are needed. It may looks like things get more complex at the beginning, but you will be able to remember them easily.
Let's start from the two main gasses: as you may already know, O2 is the symbol for oxygen and N2 is that for nitrogen.
Many divers refer to Nitrox calling it EANx, that is Enriched Air Nitrox, where "x" indicates the oxygen percentage. EAN 32 and EAN 36 are the two "standard" mixes and are equivalent to enriched air with 32% of O2 (the former) and 36% of O2 (the latter).
The **National Atmospheric and Oceanic Administration** (NOAA), is an US organisation involved in many subjects, mainly for commercial reasons.
Its field of application ranges from dives on oceanic sea bed to aerospace; it published the dive planner with two Nitrox mixes mentioned above in the seventies.
The person who standardised the two mixes was Doctor Morgan Wells, who is know for having managed the "Nitrox" program at NOAA. The

Minitest

1. *True or False*
The gas mixture preparation must be performed by recreative divers.

2. *The word Nitrox is composed from the names of:*
a. *Nitrogen and oxygen*
b. *Oxygen and dioxide of carbon*
c. *Nitrogen and helium*

3. *The denominated mixture NOAA Nitrox 1 are essentially composed from:*
a. *21 % oxygen and 79% nitrogen*
b. *32% oxygen and 68% nitrogen*
c. *36% oxygen and 64% nitrogen*

Answer:1 False, 2 a; 3 b.

standardisation was needed to optimise the use of Nitrox having regards to the maximum level of safety.
It is thanks to his colleague, Dick Rutkowksi, that Nitrox started to be used in sportive dives in the eighties and, subsequently, in the recreational dives.

It will happen that you will listen about “de-azotised air”; this is due to the fact that you can produce Nitrox by subtracting nitrogen from air. Indeed, we can refer to Nitrox also in relation to the fact that the percentage of nitrogen is reduced instead of talking about the higher quantity of oxygen. Anyhow, considering the effect that the latter has while diving, the Nitrox mixes are defined on the base of the quantity of oxygen they contain.

Gas percentages are often called “fraction of a gas” (Fg); for instance, fraction of O2 (or FO2) that indicates the quantity of oxygen, and Fraction N2 (or FN2) for nitrogen. Remember that by subtracting FO2 to 100 you calculate FN2.

Always address to a specialized center

The effect of a gas on the organism is dependent upon its partial pressure, usually indicated with pp or Pg. For instance, PO2 indicates the oxygen partial pressure and PN2 the nitrogen one.
At sea level, where the ambient pressure is 1 BAR or 1 ATM, you can easily calculate the partial pressure of the two gasses: it is the 21% of 1 BAR for oxygen (0,21 BAR) and 79% of 1 BAR for nitrogen (0,79 BAR). You will have already noted that 0,21 + 0,79 = 1.
The next paragraph will teach you to process other mathematical operations related to dives with Nitrox.
As already done for the ESA Open Water Diver course, the pressure is indicated in BAR, that corresponds to 1 atmosphere or 14,7 PSI.
ATA indicates absolute pressure, that is the ambient pressure, that is calculated adding 1 BAR (the atmospheric pressure) to the hydrostatic

pressure (1 BAR every 10 metres of salt water).

Calculations
Usually mathematics helps solving problems, discovering new things and, during your ESA Open Diver course, to calculate how the pressure changes with depth. Furthermore, the dive planner are based upon mathematical calculations. Once again, mathematics will help you in understanding principles and plan dives with Nitrox, maximising amusement and making sure safety is fully guaranteed.
Planning dives is one of the most important activities when you use Nitrox. Planning has a fundamental role for safety and to better use the potentiality offered by Nitrox.

You have already learned to plan dives with air during your diving courses. Planning dives with Nitrox is based on the same steps and care, but, in addition to this, you need to take in due account the different gas percentages. While a smaller quantity of nitrogen extend the no decompression limits, the higher quantity of oxygen reduces the maximum depth you can reach and increases the exposition to oxygen rate. Furthermore, in relation to the breathed gas, you will have to take into consideration the equipment you use (more information will follow in the next chapter).

Extended no decompression limits imply a longer dive, for which you must consider Nitrox consumption (breathing) and temperature of the water (you may be cold).
How can you calculate the extended no decompression limits when using Nitrox? You will use dive planners similar to those used for air, that takes into account the reduced quantity of nitrogen; you can also use special computers specifically designed to dive with Nitrox.
You can use the “ESA Dive Tables” for air and find the no decompression limits using the Equivalent Air Depth (EAD) defined shortly, or the ESA “EAN 36 - EAN 32 - Air Dive Tables”, specifically designed to plan dives with the most diffused Nitrox mixes and, if needed, with air.

Just like the ESA “Dive Tables”, the ESA “EAN 36 - EAN 32-Air Dive Tables” contains three table that

Minitest

1. EANx initials it is used for pointing out:
a. Enriched Air Nitrox
b. Air Enriched of Oxygen
c. a and b are exact

2. The term "air nitrogen free" :
a. It is reported to the fact that Nitrox can be produced escaping nitrogen from the air
b. It is to point out a mixture with high nitrogen concentration
c. It points out a composed specific mixture of 80% of oxygen and 20% of nitrogen

3. The sigles pp and Pg point out:
a. The percentage of oxygen
b. The nitrogen percentage
c. The partial pressure of a datum gas

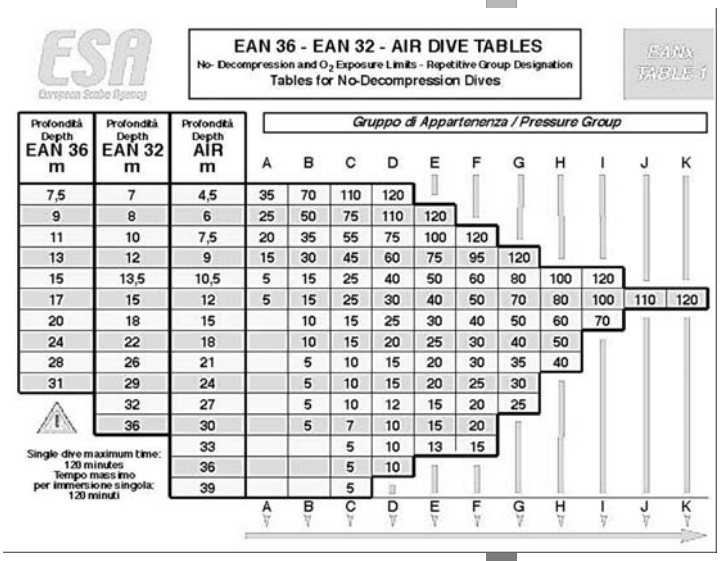
Answers:1 c; 2 a; 3 c.

enables you to plan single dives and provide pressure groups after the dive (EANx Table 1), find the new pressure group after a specific surface interval (EANx Table 2) and plan the repetitive dive (EANx Table 3).
The ESA EANx Table 1 includes three columns for EAN36, EAN32 and AIR respectively. The three columns show the actual depths related to each specific mix; using this table you don't need to calculate the EAD to plan you dives.

What is the EAD? To answer this questions, let's refresh the partial pressure of gasses.
As you will remember, the effect of a gas on the organism is dependent upon its partial pressure. During your ESA Open Water Diver course you learned that a small quantity of carbon monoxide may be tolerable at the sea level but can be toxic under water because of its increasing partial pressure.

The ESA Nitrox Dive table used for Nitrox 36 and 32 point out in 120 minutes the maximum time of single immersion

1



EAN 36 - EAN 32 - AIR DIVE TABLES
No- Decompression and O_2 Exposure Limits - Repetitive Group Designation
Tables for No-Decompression Dives

EANx TABLE 1

Profondità Depth EAN 36 m	Profondità Depth EAN 32 m	Profondità Depth AIR m	Gruppo di Appartenenza / Pressure Group										
			A	B	C	D	E	F	G	H	I	J	K
7,5	7	4,5	35	70	110	120							
9	8	6	25	50	75	110	120						
11	10	7,5	20	35	55	75	100	120					
13	12	9	15	30	45	60	75	95	120				
15	13,5	10,5	5	15	25	40	50	60	80	100	120		
17	15	12	5	15	25	30	40	50	70	80	100	110	120
20	18	15		10	15	25	30	40	50	60	70		
24	22	18		10	15	20	25	30	40	50			
28	26	21		5	10	15	20	30	35	40			
31	29	24		5	10	15	20	25	30				
	32	27		5	10	12	15	20	25				
	36	30		5	7	10	15	20					
		33			5	10	13	15					
		36			5	10							
		39			5								
			A	B	C	D	E	F	G	H	I	J	K

Single dive maximum time: 120 minutes
Tempo massimo per immersione singola: 120 minuti

The effects of nitrogen are due to its partial pressure; for this reason, nitrogen narcosis and nitrogen absorption increase with depth.
It is easy to understand that the higher the nitrogen partial pressure, the smaller the no decompression limits; there are to ways of increasing them, or reducing the nitrogen narcotic effect: 1) reducing depth and, therefore, the nitrogen partial pressure; 2) reducing the quantity of nitrogen in the gas mix, so that, at the same depth, the partial pressure is less.
For instance, the quantity of nitrogen in an air cylinder breathed at 20 metres as a partial pressure of 2,37 BAR (0,79 BAR x 3 ATA), while the ppN2 for the EAN36, at the same depth is 1,92 BAR (F N2 x ATA at 20 metres salt water = 0,64 bar x 3 bar =1,92 bar).

As you can see, the two partial pressures are sub-

stantially different: 2,37 BAR vs 1,92 BAR; the diver who breaths Nitrox absorbs the same amount of nitrogen of a diver that breaths air at the same depth in a longer time.

When you breath Nitrox at a given depth it is as if you were breathing air shallower; such shallower depth is called Equivalent Air Depth (EAD).
You can find the EAD's for EAN32 ed EAN36 in the "AIR" column of the ESA "EANx Table 1" or calculate them with a simple mathematical operation:
{ [F N2 x (Profondità + 10)] diviso 0,79} – 10.
This formula can be used to calculate the EAD for any Nitrox mix; all you need to do is use the proper FN2 and the desired depth.
For instance, 0,64 times 30 divided 0,79 and reduced by 10 = 14,3 metres, that is the EAD equivalent for 20 metres with EAN36. Diving at 20 metres breathing Nitrox 39, is equivalent to diving at 14.3 metres with air; indeed the ppN2 at 20 metres with Nitrox 36 is the same of that at 14,3 metres with air.
Note: all these operations (and the following ones) are considering that the ambient pressure in salt water increases by 1 BAR every 10 metres.

The modern computers behave the same more or less; you need to set the correct percentage of O2 measured in the mix you are going to use, and the computers calculate the no decompression limits based upon the EAD.
You will plan your dives many time during your course, both with ESA "EAN 36 - EAN 32-Air Dive Tables" and computer (if available).

You will have understood why Nitrox provides extended no decompression limits; anyhow, as usually happens, you have advantages and disadvantages. In our case the latter is due to the increased quantity of oxygen and is constituted by a limitation in the maximum depth.
As you have already learned during your ESA Open Water Diver course, the oxygen is needed for living but, when its partial pressure exceeds a given amount, it becomes toxic; the maximum partial pressure of O2 (PO2) that can be tolerated is set to 1,6 BAR.
This is a very critical limit and, to guarantee safety, you should not exceed 1,4 BAR PO2 when diving. This gives you a safety margin in case you

Minitest

1. The smaller nitrogen quantity in the Nitrox:
a. It allows times of permanence longer than with the air
b. It forces the scuba diver to long standstills of decompression
c. It reduces the times of permanence within the limits of not decompression

2. The "EAD":
a. It is to point out the Equivalent Air Depth (equivalent depth with the air)
b. It serves for planning the immersions with the Nitrox
c. a and b are exact

3. The effects of the gases are due:
a. To their partial pressure
b. To the temperature of the underwater environment
c. To the partial pressure of another gas

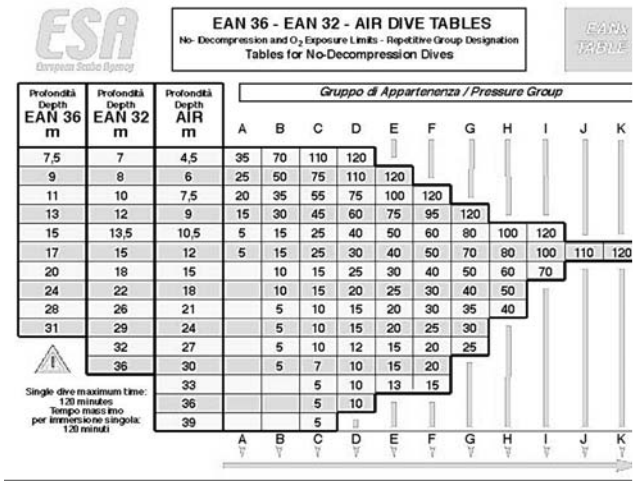
Answers:1 a; 2 c; 3 a.

should inadvertently dive deeper or longer than you should.
Air, that contains 21% of oxygen, cannot cause troubles due to oxygen toxicity (hyperoxia) diving not deeper than 56 metres if such limit is respected.
As the limit for recreational dives is set to 40 metres, all breathing air divers that respect it are far away from suffering any oxygen intoxication.
Be careful! The maximum depth is not constant when breathing Nitrox; it changes with the quantity of oxygen, therefore you must carefully analyse the mix contained in your cylinders.

EAN breathing 36 to 31 meters the same nitrogen quantity is absorbed that to 24 meters with the air

Maximum Operative Depth (MOD)
A workshop arranged to evaluate the conditions of dives with Nitrox held in the 2000. Decompression physiologists, researchers, equipment manufacturers and technicians attended it. It was appraised that diving within the limit of 1,6 BAR PO2 can be considered safe, provided that it is strictly respected and that exposition to oxygen is not excessive. Many computers consider safe setting the PO2 limit at 1,5 BAR.

To guarantee safety, you can decide to plan your dives in order to set the PO2 limit at 1,4 BAR, so that you can still have a good safety margin in case you dive slightly deeper (it should never happen even when diving with air) provided you don't exceed 1,6 BAR.
The ESA "EAN 36 - EAN 32-Air Dive Tables" provides the MOD for the two common mixes: 36 metres for EAN 32 e 31 metres for EAN 36. These limits are based upon the PO2 set at 1,5 BAR. You must plan and dive with Nitrox in order to never exceed such depths. The operation that enables you do calculate the MOD for a given mix is the following:
[(1,5 x 10) : FO2] - 10 = MOD
Computers can work for you. Indeed, there are computers for dives with Nitrox that provide acoustic or visual alarm to the diver when reaching the PO2 limit set before diving. We will talk about computer shortly.



ESA
European Scuba Agency

EAN 36 - EAN 32 - AIR DIVE TABLES
No- Decompression and O_2 Exposure Limits - Repetitive Group Designation
Tables for No-Decompression Dives

EAN TABLE

Profondità Depth EAN 36 m	Profondità Depth EAN 32 m	Profondità Depth AIR m	Gruppo di Appartenenza / Pressure Group										
			A	B	C	D	E	F	G	H	I	J	K
7,5	7	4,5	35	70	110	120							
9	8	6	25	50	75	110	120						
11	10	7,5	20	35	55	75	100	120					
13	12	9	15	30	45	60	75	95	120				
15	13,5	10,5	5	15	25	40	50	60	80	100	120		
17	15	12	5	15	25	30	40	50	70	80	100	110	120
20	18	15		10	15	25	30	40	50	60	70		
24	22	18		10	15	20	25	30	40	50			
28	26	21		5	10	15	20	30	35	40			
31	29	24		5	10	15	20	25	30				
	32	27		5	10	12	15	20	25				
	36	30		5	7	10	15	20					
		33			5	10	13	15					
		36			5	10							
		39			5								
			A	B	C	D	E	F	G	H	I	J	K

Single dive maximum time: 120 minutes
Tempo massimo per immersione singola: 120 minuti

Minitest

1. The Nitrogen pp (PN2) to 30 meters, EAN breathing 36 is:
a. 1,92 bar
b. 2,56 bar
c. 2,72 bar

2. The EAD for an immersion to 30 meters EAN 32 breathing is:
a. 22,4 meter
b. 15,8 meter
c. 24,4 meter

3.3. Considering the limits of the course ESA Nitrox Diver, the MOD for EAN 32 are _____; while for EAN 36 correspond to_____:
a. 40 meter / 34 meter
b. 36 meter / 31 meter
c. 31 meter / 36 meter

Answers:1 b; 2 c; 3b.

Planning
Plan your dives as always done, making arrangements with a dive mate that is not less qualified than you.
Note: Instructors must be specifically trained to dive with Nitrox too.
Make sure the equipment is suitable for Nitrox and analyse the cylinder. The ESA Instructor will teach you how to do it; concentrate and try as many times as possible; don't hesitate to ask questions if you don't feel confident.
Analysing the cylinder is mandatory for each dive with Nitrox and is the first thing to do when preparing and planning your dives.
The preceding paragraph explained that all you need to do is concentrating on the percentage of oxygen in the cylinder you will use. You will have to analyse it personally, sign a specific register and declare that you are aware of what you are about to use and how to use it.
You will find this procedure really simple after having applied a few times, and you will feel more confident after having checked the content of the cylinder yourself. In many countries this procedure is dictated by the existing laws and local rules; get informed about them when you are planning a travel, as always. You can be properly assisted if you get in touch with an ESA Point or with ESA Nitrox Diver Instructor.
After having checked the cylinder you can plan your dive, bearing in mind that a 1% tolerance is allowed; this means that a mix containing a quantity of oxygen that ranges between 31% and 33% can be considered to be EAN32.

Tables
Respect all the rules you learned during your ESA Open Water Diver course. Set the maximum depth you want to reach and make sure it is compatible with the limit set for the specific mix you will use (EAN 36 = 31 metres – EAN 32 = 36 metres).
If the depth is compatible with such limit, you can look for it in the ESA "EAN 36 - EAN 32-Air Dive Tables" – Table 1, in the column related to the mix you are about to use (EAN 36, EAN 32 or AIR); otherwise, you can use the next higher value.
After you have identified the correct depth, move to the right; you will find the EAD in the "AIR" column, then all times and the no decompression

limit or, should it not higher, the Exposition to Oxygen limit (120').
From this point you can proceed as if you were planning your dives with air.
For instance, should you want to dive at 21 metres using EAN32, while this depth is clearly displayed on the instruments you use during the dive, you will not find it on the table, therefore, you will have to consider the next higher available value. For the "EAN32" column, this value is 22 metres, equivalent to 18 metres EAD in the "AIR" column.
The no decompression limits (50') is the same at 24 metres with EAN36, at 22 metres with EAN32 and at 18 metres with air. Based upon the duration of the dive, the same applies to the pressure group.
The procedure for repetitive dives with air applies also to repetitive dives with Nitrox. Once you decide the maximum depth of the new dive, look for it in the "EANx Table 3", in the column related to the Nitrox mix you intend to use. Intercept the line related to depth with the column related to the pressure group and complete planning your dive as you already know. For instance, assume you have dived at 20 metres for 39 minutes using EAN32 during the first dive, your pressure group is G. After 1:30 hour-surface interval, the pressure group is E (see the EANx Table 2) and you decide to dive at 15 metres using EAN32.
Identify the line of the "EANx Table 3" related to the chosen depth and intersect if with the column related to the pressure group (E). you will find the Residual Nitrogen Time of 49' (yellow cell) and the No Decompression Limit of 81' (green cell).
You should not dive more than three times using Nitrox during the same day; indeed, should you choose to dive three times, it is advisable to dive using air within 18 metres the third time.
You can plan to have repetitive dives using different Nitrox mixes and air. Be careful when using the dive planner, specifically when looking for the

Before use remembers to always analyze the air mixture

depth and the column related to Nitrox or pressure group: should you make any mistakes you may be subject to Decompression Disease or hyperoxia. For the same reason, remember to set the correct oxygen percentage before diving with the computer.

Let's consider the following example: Andrew and Michael are going to dive at 27 metres using EAN32. what is the maximum operative depth for this Nitrox mix considering a limit PO2 of 1,5 BAR? 36 metres, therefore they made the right choice. To plan the dive, they look for the depth in the "EAN32" column of the "EANx Table 1"; as 27 metres is not included in the table, they must consider 29 metres. They read the Equivalent Air Depth in the "AIR" column (24 metres) then the no decompression limit (30'), choose the duration of the dive and identify the related pressure group. The two friend decide to dive at 27 metres for 25 minutes; the pressure group at then of the five is F.

They plan a repetitive dive on a rocky seabed close to Butterfly Head; they have to sail for about 2 hours and 30 minutes, a good surface time that makes the F pressure group turn to C. The maximum depth for the second dive is 20 metres, and they will use EAN36. After having checked with the analyser that the oxygen percentage stated on the card attached on the cylinder is correct, they use the "EANx Table 3". They look for the chosen depth in the EAN35 column and intersect the related line with the column specific to the C pressure group. The Residual Nitrogen Time is 21' (yellow cell) and the new No Decompression Limit is 49' (green column).

The place is really nice, but they dive for 45 minutes only. Adding the actual duration of the dive with the Residual Nitrogen Time they can use the pressure group at the end of the second dive (45 + 21 = 66 minutes, corresponding to the I pressure group).

As you see, things change if you compare dives with air to dives with Nitrox. You must take care of the oxygen percentage, identify the related maximum operative depth and make sure you never dive deeper.

You must make sure you will never exceed the allowed exposition to oxygen, although this is almost automatically respected if you respect all parameters related to recreational dives. Avoid

The EANx Table 3 point out the nitrogen residue and the new limit of not decompression for the consecutive immersions

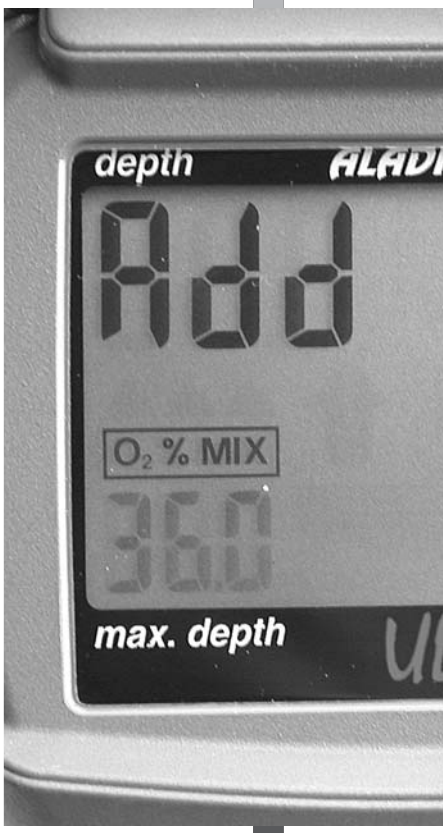
			12:00	8:50	5:40	4:02
			8:59 12:00	5:49 8:58	4:20 5:48	3:22 4:19
			New Group Designation	A	B	C	D
EAN 36	EAN 32	AIR					
6	5	3		39	88	159	279
				•	•	•	•
9	8	6		18	39	62	88
				•	•	•	•
13	12	9		12	25	39	54
				•	•	•	•
17	15	12		7	17	25	37
				120	113	105	93
20	18	15		6	13	21	29
				64	57	49	41
24	22	18		5	11	17	24
				45	39	33	26
28	26	21		4	9	15	20
				36	31	25	20
31	29	24		4	8	13	18
				26	22	17	12
Profondità Immersioni Consecutive	32	27		3	7	11	16
				22	18	14	9
	36	30		3	7	10	14
				17	13	10	6
Ripetitive Dive Depth		33		3	6	10	13
				12	9	5	2
		36		3	6	9	
				7	4	1	
		39		3			
				2			

diving more than three times, or to dive for more than 120 minutes for a single dive or 180 minutes for repetitive dives over 24 hours.
Some computers calculate the exposition to oxygen based on the percentage of the maximum tolerable quantity: make sure you don't exceed 90% over 24 hours; indeed, make sure you maintain well under this limit. You will see that diving cautiously you will enjoy your dives more.

With the computer
Should you wish to dive with a computer, make sure it can calculate dives with Nitrox. Check carefully the oxygen percentage set; for instance, the display must show that the it is set to 36% in case you dive with EAN36. Remember, there are several models of computers able to plan dives with gas mixes other than air; read the user manual carefully to be sure you use your computer correctly and safely.
Dive applying the techniques you learned during your ESA OWD course and as stated in the ESA Advanced Diver manual and ESA Computer Diver manual.
Remember that you must respect the maximum depth related to the PO2 and that you always must verify the percentage of oxygen set, specially when changing mixes from one dive to the other.
Try to imagine the consequences of diving with first time with EAN36, setting the oxygen percentage at 36% and the second time with air without changing the computer settings. You would believe that you have not exceeded the no decompression limits while you have already exceeded them; you would ascend unsafely and be subject to the decompression disease.
As you have read in the previous paragraph, the computer provides the exposure to oxygen percentage showing numbers or graphically. Should you exceed the 50% of the tolerable exposure, wait at least for an hour before diving again (this should be done anyway), make sure you don't exceed 90% over 24 hours (or any other value indicated the computer manufacturer). Whenever you should exceed such

Always verifies personally , with the O2 analyser, that the percentage of O2 pointed out on the label is exact

A computer for the immersions Nitrox that visualizes the nitrogen absorption and the exposure to the oxygen



limit, don't dive for 12 hours at least.
At this stage you may be asking yourself if you can dive with Nitrox when the oxygen percentage is set to 21% (air) in the computer. Yes, you can do it. indeed, the no decompression limits with are more stringent than those for Nitrox, so you would be safer. Some divers use this procedure to increase the safety margins in case of repetitive dives. Anyhow, you must remember to analyse the gas mix you are about use for your dive and not to exceed the maximum operative depth related to the oxygen percentage, in order not to be subject to PO2 beyond 1,5 BAR (the computers for air don't provide any alarm in case you exceed it, so you must respect it).
Should the computer fail while diving, react in accordance with the procedure you learned during the ESA OWD course: ascend without waiting any longer but slowly to 5 metres and have a long safety stop, as far as the left quantity of Nitrox you have enables you to do it.
The usage of computers for dives with Nitrox is quite similar to that for air and the rules to be respected are the same. Once again, read carefully the user manual supplied by the manufacturer. Should you wish to improve your knowledge on computers, you can attend the ESA Computer Diver course.
Be cautious! As you know, thanks to its capability to calculate the nitrogen absorption, the computer let you dive longer if you dive starting deeper and then ascend to shallower depths in order to reduce the nitrogen absorption rate. You will be able to dive even longer using Nitrox, so plan your dives in order to start to ascend well in advance of getting close to the no decompression limit, respect the maximum operative depth and take into account the exposition to oxygen.

British system
Some countries use the British system. For instance, if you dive in the Caribbean Sea and hire your equipment, you will use instruments that measure depth in feet. Therefore, you will have to convert measures. Remember that 10 metres correspond to 10 feet and that 1 BAR is 14,7 PSI. The appendix to this manual will provide conversion tables and formulas to calculate maximum operative depth, equivalent air depth and partial pressures. If you bring your computer with you, you

will not need to make any conversions.

Diving

Diving with Nitrox is just like diving with air; you only need to take care of all the parameters and don't exceed the maximum planned depth.

Oxygen intoxication can affect the Central Nervous System and have no premonitory symptoms ; therefore respecting the maximum operative depth is mandatory.

For instance, should the limit be 31 metres, prepare yourself mentally and physically in order not to exceed 29/30 metres; this gives you a good safety margin in case of distractions. If you are supervised by a Diveleader, dive shallower than him and plan your dives in sites where exceeding the maximum operative depth is not that easy.

To avoid problems due to oxygen intoxication, remember to respect the limits established for the global exposition to oxygen over 24 hours.

Your ESA Instructor and the dives included in the course will teach you to control these two important parameters and avoid problems. By the way, the depth limits are established also for dives with air, therefore, we can barely state that diving with Nitrox doesn't introduce anything new: either way, a good diver must be able to control all the instruments to monitor all parameters and respect all limits. You do the same when you drive your car: you monitor the speed to avoid to exceed the limits and check any warning lights. This helps in avoiding fines, running out of petrol or damaging the engine.

So, checking your instruments while diving, and making sure your dive mate does it as well, you avoid exceeding the depth limits in order to prevent nitrogen narcosis or oxygen intoxication, and make sure you don't exceed the no decompression limits, reducing the chances to get decompression sickness; you avoid running out of air or Nitrox in order to prevent sudden and uncontrolled ascends. Being perfectly trimmed helps in exceeding the limits, so that you can be more relaxed while diving, and concentrate on what you are doing.

Considering how dangerous the effects of oxygen can be, should you feel and symptoms imputable to this gas, ascend and get out of water without wasting time, and don't dive for 24 for hours as a minimum.

Minitest

1. In the immersions with Nitrox, the analysis of the oxygen from who uses it is a considere procedure:
a. obligatory
b. useless
c. optional

2. To plan an Nitrox dive with the ESA table is necessary to know:
a. the EAD
b. the MOD
c. a and b are exact

3. Using the underwater computer, when we changes type of mixture it is important:
a. to vary the percentage of O2 on the tool
b. to wait for 24 hours between an immersion and the other
c. a and b are exact

Answers:1 a; 2 c; 3 a.

Minitest

1. *In the Nitrox dives:*
a. *it needs to foresee to ascend with at least 100 bar in the cylinder*
b. *it behaves us as in the other immersions, monitoring with attention depth, time and manometer*
c. *variations of depth cannot be effected*

2. *To respect the time and depth limits is important for:*
a. *to prevent the MDD and the oxygen poisoning*
b. *to avoid excessive loss of heat*
c. *to prevent the MDD*

3. *If imputable symptoms to oxygen poisoning are manifested:*
a. *ascent for 1 meter and continue the dive*
b. *immediately ascent, on surface, to go out of the water and not to effect dives for at least 24 hours*
c. *stop on the bottom and to restore the control of the respiraton*

Answers:1 a; 2 c; 3 b.

Analysing oxygen

As you have read, you must analyse Nitrox cylinders to check the oxygen percentage before using them. This procedure is one of the few things that change from diving with air. It may look a bit complicated at the beginning, but you will find it easier and easier as you get experienced; the most important things is that the oxygen analyser must be correctly set. This component was originally developed for health purposes, and is widely used in hospitals to monitor the percentage of oxygen supplied to patients. Specific oxygen analysers have been developed since when different gas mixes are used for diving. Usually, the analyser consists of a sensor, a transducer, a coaxial cable, a computer with liquid crystal display, buttons to switch it on and set its functions and parameters. Some analysers can provide maximum operative depth and equivalent air depth for the analysed Nitrox.
The same rule applicable to computers apply to analysers: you must read the instruction in the user manual and respect them. Your ESA Nitrox Diver Instructor will teach you (maybe he has already done it) to use one or more analyser models. Pay attention to his lessons and don't hesitate to ask questions; try the procedure until you feel you have learned perfectly. Should you buy or use an analyser different from what you have used during your training, ask information to the dealer or the operator that is supplying it. Anyway, some procedures are always the same, no matter the analyser model:

- make sure you deal with professional and reliable diving centres

- read the user manual

- check that it is fit and that the batteries are charged (or perfectly connected to the electric line)

- verify that the sensor is properly working and not expired (read the terms related to its substitution provided by the manufactured)

- connect the cable to the computer and to the sensor correctly

- its operability can be compromise by extreme temperatures, altitude and pressure variations, humidity and condensate (see the instructions)

- avoid holding the sensor and your hand palm

- turn on the analyser and check the display and wait that the numbers it shows stabilise to fixed values

- set the instruments using air (21% O2) and, possible, with pure oxygen (…99% O2)

- use a flow meter to make sure that the sensor is receiving the correct flow of gas; this is of fundamental importance to prevent dangerous consequences due to wrong readings by the analyser

- make the analyses 3 times and make sure you always get the same values

- if appropriate, make the check with air (21% O2)

- should the instrument provide additional functions (maximum operative depth, pp O2, no decompression limits, equivalent air depth...)make sure you have correctly set the right data and respect the instructions provided by the manufacturer

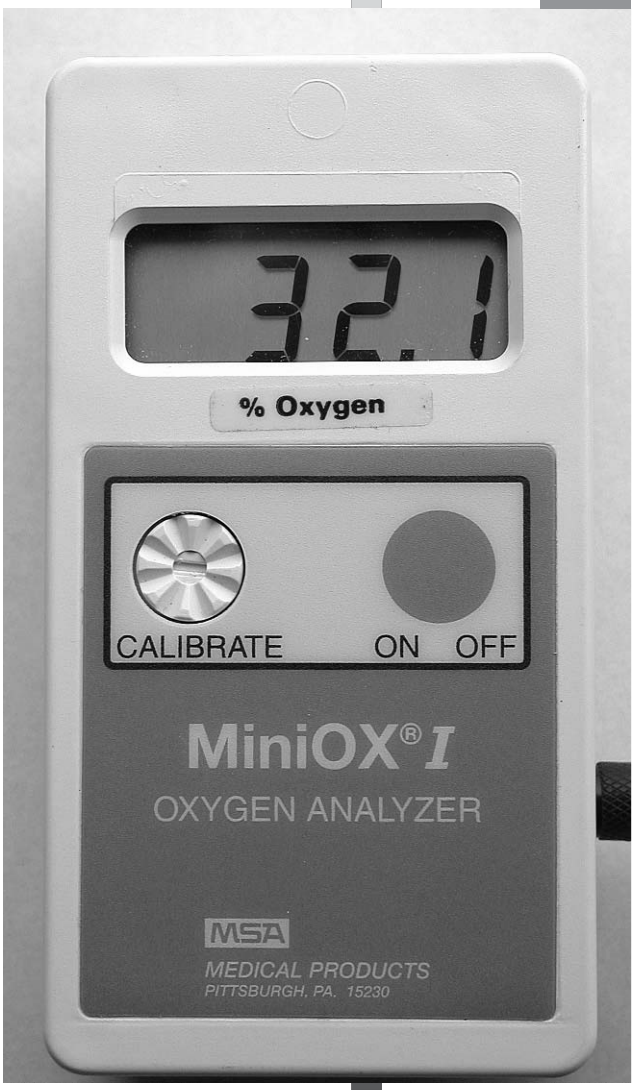
- turn off the analyser and store it adequately (unless anybody else needs to use it)

- write the oxygen percentage on the card and on the register

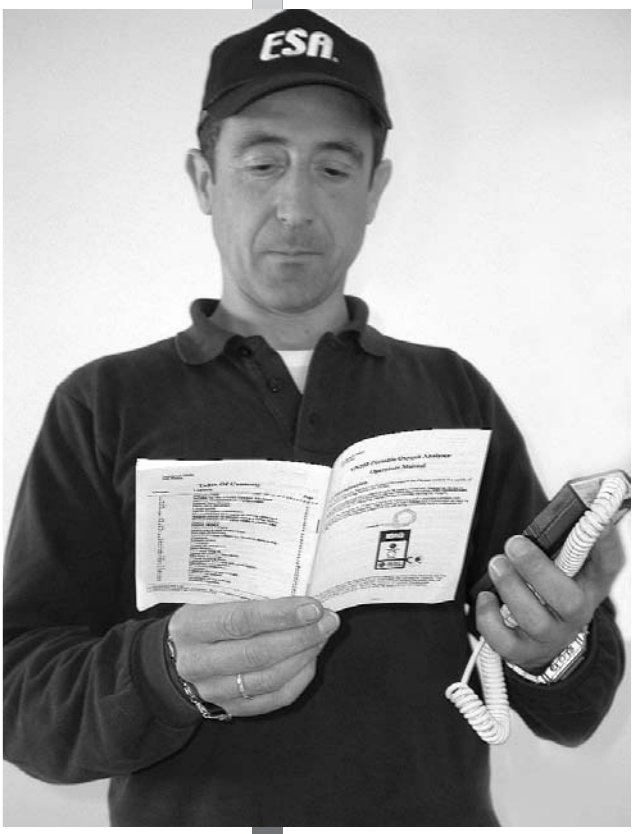
- write the MOD for the analysed depth on the card

- sign to confirm you have analysed the cylinder and that you know the O2 percentage in the cylinder you will use

Example of O2 analyser



Is fundamental to read with attention the instructions of the producer of the O2 analyser



When the flow meter is not available, some divers use to measure the oxygen percentage putting the sensor in a space saturated of the Nitrox mix to analyse.
You can use a plastic bag with a hole for the sensor and another for the regulator; in this case, as the sensor doesn't work well when the pressure increases, you must avoid to inflate the bag too much. Furthermore, it is important to "wash" the bag, filling it up with Nitrox and then emptying it 3 times before proceeding with the analysis. Anyhow, a flowmeter is preferable.
Should you not use the instrument for long, remove the batteries and disconnect the sensor before putting it away; the sensor must be stored in its specific container. You must put everything in a place with no humidity, away from sunlight and extreme temperature.
Respect all instructions related to the sensor substitution. You must know that the life of the sensor depends on its exposition to oxygen, irrespective from the fact that it is connected to the analyser.
You will have understood that the oxygen analysis is the most important part of the preparation for the dives with Nitrox, therefore, you must get skilled in analysing your cylinder. Anyhow, as already stated, it is not a complex operation; furthermore, remember that the new analysers provide reliable results if the instructions provided by the manufacturers are respected.

Watch OUT!

The sensor contains a liquid that can be harmful, it avoids to touch it if you notice losses of liquid, both that you deal with a sensor in use or that you deal with a new sensor, in this case it is advisable to avoid to open the wrapping that contains it (usually transparent).
If the sensor introduces signs of usury and loss of liquid it must be replaced, in any case it is had to try to mend its hull with glue or other.
In case of accidental contact with the liquid it is necessary to wash abundantly the stricken area with current sweet water and to look for medical intervention.

Congratulations!

Now you can plan, together with your ESA Nitrox Diver Instructor, your first dives with Nitrox. You will be exited and curious of trying it. You have already established the basis to become a skilled ESA Nitrox Diver: you know what Nitrox is, you know the basic terminology, you know why it extends the no decompression limits. You can calculate the partial pressure of the gasses at the various depths, the maximum operative depth and the equivalent air depth for the two main Nitrox mixes. You have used the mathematical formulas to plan your dives and to better understand how to use Nitrox, and know the fundamental steps for analysing it.
Analyse the cylinder you will use together with your Instructor, plan your dive and enjoy your first expe-rience with Nitrox. Next chapter will provide detailed information on other important features of diving with Nitrox.

Minitest

1. Among the O_2 analyser's components there are:
a. sensor, cable, tool and system of setting
b. sensor, cable, wrist strap and system of setting
c. system of setting, cable, microphone and tool

2. The analyser's sensor for O_2:
a. it must be replaced respecting the indications of the manufacturing house
b. it is sensitive to the damp and the variations of pressure
c. a and b are exact

3. Analyzing the air, the analyser for O_2 has to notice:
to. around 79% of O_2
b. around 21% of O_2
c. around 32% of O_2

Answers:1 a; 2 c; 3 b.

What have You learned?

This exercise will let your review all the most important information contained in this unit, so that you can improve your preparation and be ready for your next appointment with your instructor. Answer the questions choosing the right questions among the listed ones. Check you answers with your Instructors; in case of any inaccuracy, he will provide all the needed explanations.

1. The Nitrox is a gas mix composed of:
a. oxygen and nitrogen
b. helium and oxygen
c. helium, nitrogen and oxygen

2. The two most diffused Nitrox mixes are:
a. EAN 37 e EAN 25
b. NOAA Nitrox IV and NOAA Nitrox V
c. NOAA Nitrox I and NOAA Nitrox II

3. The reduced quantity of nitrogen:
a. extend the no decompression limits
b. reduces the effects of nitrogen narcosis
c. both a. and b. are correct

4. The nitrogen partial pressure in the Nitrox 36 mix at the sea level is:
a. 1 bar
b. 0,36 bar
c. 0,64 ba**r**

5. The EAD for a dive at 19 m with EAN 32 is:
a. 14,97 m
b. 24,97 m
c. 13,49 m

6. The no decompression limit for a dive at 27 metres with EAN 36, in the ESA Tables is:
a. 25 minutes
b. 40 minutes
c. 30 minutes

7. The no decompression limit for a dive at 27 metres with air, in the ESA Tables is:
a. 25 minutes
b. 40 minutes
c. 30 minutes

8. The maximum PO2 limit to take into account when planning dives with Nitrox is:

a. 1,8 bar
b. 1,5 bar
c. 0,5 bar

9. The divers that use a computer, before diving with Nitrox must:
a. read the instructions provided by the manufacturer
b. set the O2 percentage correctly
c. both a. and b. are correct

10. MOD means:
a. minimum operative depth
b. maximum operative depth
c. the ascend procedure after dives with Nitrox

11. The depth limit using EAN 30 is:
a. 30 metres
b. 40 metres
c. 38 metres

12. The analysis of oxygen:
a. can be done only by the operators what recharge the cylinders
b. can be done by the Nitrox Instructor
c. must be done by the end-user

13. In case of signs of oxygen intoxication::
a. ascend a bit and continue the dive
b. emerge and get out of the water
c. emerge, get out our of the water and don't dive for 24 hours

14. For a more accurate oxygen analysis:
a. you should use a flow regulator
b. you should keep the sensor on you hand palm
c. you should set the instrument in order to read 79% on the display

15. To avoid damages during the oxygen analysis, the sensor must be substituted:
a. every 4 years
b. in accordance with the indications of the manufacturer
c. every 6 years

I declare that I have reviewed all the wrong answers with the ESA Instructor, and that I have understood the related explanation.

Signature _____date_____

Chapter Two

What will you learn?

The preceding chapter provided the information you need to plan your dives with Nitrox; maybe you have already used such information for your first dive with such a mix. As anticipated, there other important information that can help you in making you more aware about diving with Nitrox; this will help you improving your safety and continuing your diving career.

This chapter will answer questions such as: is more convenient using air or Nitrox? Which are the advantages of Nitrox? Which are the related complications and disadvantages? Do I need to change my equipment to use Nitrox? How are Nitrox cylinders identified? How are the EANx mixes prepared? Who can recharge Nitrox cylinders? Who must analyse the oxygen percentage? What are the effects of carbon dioxide? Does Nitrox eliminate Decompression Sickness and Narcosis? What should I do if I see an accident? How can I bring help?
All the subjects answering the above questions will be treated in accordance with the recreational dives philosophy, simplifying the most difficult concepts without forgetting the information that improve your safety and the advantages of dives with Nitrox.

Miscellaneous
If you add oxygen to air, the percentages of oxygen and nitrogen change: the first increases and the second decreases. The same happens if you remove nitrogen from air. Let's have a look at advantages and disadvantages of Nitrox. As you already know, the main advantage is the extension of the no decompression limits; this feature is more appreciated when diving between 15 and 30 metres. Thanks to Nitrox you will be able to explore a site for longer without exceeding the no decompression limits.
You may think that diving with hyper-oxygenated mixes, respecting the no decompression limits for air, causes safety improvements. This is partially true if you consider that comparing to dives at the same depth for the same time, one with

Nitrox and one with air, the nitrogen absorption is reduced with diving with Nitrox.
Anyhow, under a mere statistic point of view, the degree of occurrence of decompression sickness is really small also for dives with air, therefore, Nitrox cannot be considered 100% safer than air.
Nitrox reduces the affects of nitrogen narcosis; nevertheless, high pressure oxygen can cause similar effects. Therefore, admitting that Nitrox eliminates completely the effects of narcosis is not correct.
Many divers state that after dives with Nitrox they are less weary than they are after dives with air, and that under water they are much more concentrated; indeed, it is often used on cruises boats and by guides who dive many times everyday.
Planning dives with Nitrox is not so different from doing it with air. You have to take into considerations some specific factors: availability of Nitrox, need to check the oxygen percentage, limits (depth and time) related to oxygen toxicity to the central nervous system (CNS) and for the whole organism (mainly to lunges).
Although Nitrox is still hardly available in some cases, it is getting more and more diffused. Should you participate to diving cruises with people that dive exclusively with Nitrox on a boat equipped to produce it, why not using it? Thanks to new technologies and improved systems to produce oxygen enriched air, Nitrox recharge stations are more and more diffused in many diving centres of the most famous

The Nitrox helps to reduce the effects narcotics of the nitrogen

locations for dives.
The analysis of the oxygen percentage may seem to request extra efforts but, as stated several times, a bit of experience makes it become a very simple procedure that doesn't take too long; furthermore, you will feel safer and will enjoy your dive more if you analyse your own Nitrox cylinder..
Should you have doubts on the data provided by the oxygen analyser, if the diving centre is serious and reliable, you can decide to plan your dive in order to limit the depth to the highest oxygen percentage measured and the no decompression limit to the lowest value. You will be sure to avoid both decompression sickness and oxygen intoxication to your CNS. Oxygen toxicity for the CNS is extremely serious as it can affect the divers' health; anyhow, to prevent any related problems, respect the PO2 limit of 1.5 bar and the maximum exposition to oxygen that is commonly agreed by many scientists (doctors, physiologists and researchers). As you know, there are limits to be respected also when you dive with air; while the disadvantage of diving with Nitrox is that such limits are more stringent, they are justified by the longer dive time and that, anyway, maintains the exposition to oxygen within safe and acceptable levels.
Planning dives bearing in mind the morphology of the seabed is advisable: this avoids exceeding the maximum depth and helps in taking the most from Nitrox. The recreational diver that, thanks to the ESA Deep Diver course, can dive down to 40 metres, cannot reach this depth neither with EAN36 nor with EAN32.
Oxygen toxicity to the human organism (mainly for lunges) can be controlled respecting the exposition time indicated in the NOAA tables, i.e. 120 minutes for a single dive and 180 for the repetitive ones.
Finding a balance is the only way to enjoy the

advantages of Nitrox; to do this, take in due account the type of dive and the objective to reach. Probably, diving on a wall, with the computer, following a multilevel path, you don't need to use Nitrox as this kind of dives let you stay under water considerably long. You know that, should you want to explore an area between 23 and 27 metres to look for a specific organism or to enjoy the spectacular gorgonias, the no decompression limit is 25 minutes with air and 40 minutes with EAN 36 (equivalent air depth 21 metres); you may dive at the maximum depth for about 26/37 minutes maintaining a good safety margin and being more concentrated.
Considering that when you breath Nitrox the nitrogen absorption is reduced, you can decide to use it even if a specific dive don't let you enjoy the advantages of extending the no decompression limits.
As already said, you will have to take into account Nitrox availability, but there is another factor to be considered: cold. Sometimes enjoying the advantages of Nitrox is difficult because of cold water limiting the dive duration. Another issue could be the air (or Nitrox) consumption. These issues can be solved using bigger cylinders and diving either in warm seas or with a dry suit.

The safety stop for 3 minutes to 5m must also be effected in the Nitrox dives

Calculating your air/Nitrox consumption
Consider that a person breath about 20 litres of air per minute in regular conditions at sea level; as you learned during the ESA OWD course, the consumption must be related to the specific depth you are diving. Thus, at 30 metres (4 ATA) the consumption is 80 litres per minute (20 litres x 4 ATA).
As you know, a 15-litre cylinder charged at 200 bas contains 3000 litres of gas (air or Nitrox, 15 litres x 200 bars). The cylinder duration ad 30 metres can be estimated diving 3000 by 80 (3000 litres/80 litres per minute = 37.5 minutes). The gas consumption changes from diver to diver and depends about specific conditions: breathlessness and cold, as well as fatigue, can drastically increase the gas consump-

tion. Therefore, this calculation, can only help you in understanding if the capacity of a specific cylinder can support the no decompression limits extended by diving with Nitrox. Although this calculation is based on conservative assumptions, you must check your manometer frequently, and remember to emerge when the cylinder pressure is 50 bars.

Control system of oxigen filling

Heat dispersion

To prevent excessive heat dispersions and enjoy the potentiality of Nitrox you should dive where the temperature of the water is higher than 22°C, during the warm season, when it is hot, or using a dry suit.

The dry suit reduces the heat exchange wit water thanks to the air between the suit and the skin of the diver. Remember that to use a dry suit safely you should be trained! Ask your instructor about the ESA Dry Diver Course. Using a dry suit is not difficult, but it takes the right training and experience; on the other end, it gives you the possibility to extend the dive time in cold water.

The newest diving equipment is both more and more reliable and comfortable; it gives divers the possibility to enjoy diving thoroughly. The next paragraph deals with equipment and how they relate to oxygen enriched mixes. The outcome of the analysis per next paragraph is that using Nitrox is always the best choice: it extends the no decompression limits, the chance to suffer of decompression sickness is reduced thanks to the fact that you breath less nitrogen, you can be more concentrated and, last but not least, you will be less tired also after some repetitive dives.

Equipment

The oxygen oxidizing features, as well as the combustion supporting power, depends on its concentration.

Warnings and procedures related to equipment to dive with Nitrox are based on such features.
In addition to taking into account all the precautions with equipment and related maintenance you learned during your previous courses, you need to consider that some materials (such as rubber) get worn faster if exposed to high oxygen concentration. This may cause some malfunctions.
Furthermore, remember that grease (hydrocarbon for instance) mixed with oxygen causes combustions, as well as flames or sparks due to electrical discharges.
Sudden combustions can cause explosions which put in danger people, animals and things.
The outcome of the workshop about Nitrox diving held in 2000 referred to in the first chapter, is that the standard equipment can be used with gas mixes containing up to 40% of oxygen, unless otherwise specified by the manufacturer.
Luckily, the recreational divers use enriched air mix with a 40% maximum percentage of oxygen; furthermore, the most two common Nitrox mixes, EAN32 and EAN36, contribute to making the equipment exposed to lower percentages.
Very good news! You don't need to change your equipment to start this new exiting adventure.
Be careful although! The above doesn't apply to cylinders and valves, which need to be specifically approved for oxygen enriched mixes: we will treat this topic in a while.
Although you can dive with the equipment you usually use for dives with air, you should think about using oxygen compatible components.
Every time you have to overhaul your equipment, inform the technicians that you are using Nitrox and ask them to add the improvements needed (specifically, they will take care of seals, rubber components and lubricants).
Should you have to buy a new piece of equipment, consider the possibility to buy components designed to withstand Nitrox; for instance, as buying a good regulator improves safety, you

A Nitrox-dedicatd regulator

should buy one that is designed to be used at oxygen high concentrations. This will make your dives safer and you will enjoy the more.
All the other recommendations you received during your ESA Open Water Diver course and subsequent ones apply to dives with Nitrox as well; of course, your equipment must include BCD, manometer, emergency regulator and instruments needed to measure depth and time.

Cylinders

As you know, the cylinders must comply with rules and regulations of a specific the country.
You will remember that you can find the data stamped close to the neck of the cylinder; this data is related to the gas that can be contained in the cylinder, its capacity, the nominal pressure and the hydrostatic one, as well as the date the next hydrostatic test will have to be performed.

It's fundamental to make the cylindersNitrox recognizable

Cylinders for Nitrox have the same data; the difference is that instead of specifying "air" as the usable gas, the stamped data shows "EAN". Sometimes you could find "air" cylinders charged with Nitrox. In this case, the oxygen percentage will be less than 40% and a specific adhesive label must be attached to the cylinder.

A recent European rule established that the dome of the cylinder must be painted with colours specific to the gas contained. So air cylinders have black and white segments, oxygen cylinders are all white, Nitrox cylinders are blue, helium ones are brown. Other regulations and procedures establish that Nitrox cylinders must be clearly marked with a horizontal yellow band with "Nitrox" or "Enriched Air" or "EANx" printed in green (the two colours can be exchanged between them).
Each cylinder must be equipped with card or sticker with the following information: type of the gas mix contained and when it was recharged, results of the O2 analysis performed by the blender and the name of the blender itself, the MOD (maximum operative depth) based upon the maxi-

mum PO2 and the oxygen percentage measure by the end user.
In some cases you can find Nitrox cylinders what looks like those used for air; in this case, make sure that at least the card or sticker with the above data attached to it; remember: avoid dealing with operators who don't respect those procedures useful for prevention. Remember, that Nitrox cylinders must clearly state the type of gas contained and the type of gas they were manufactured for; this is important for the two following main reasons: 1) risk of explosion due to the high oxygen concentration 2) risk of suffering of decompression sickness or because of high oxygen concentration.
Flames and sparks, as well as traces of hydrocarbons in the cylinder and lubricants used, can cause explosions because of the high oxygen concentration.
Air recharge stations can push small quantity of hydrocarbons inside the cylinders. Furthermore the valves for air cylinders don't use materials suitable for oxygen (specifically seals and lubricants)
Usually, reliable and professional recharge stations respect all the safety procedure. Therefore, you don't need to worry too much; concentrate on choosing the services offered by qualified and professional personnel instead. One point must be duly taken into account and respected by Nitrox divers: the cylinders for compresses gasses must be used for the type of gas they were prepared for, tested and certified. Recharging a cylinder with a different gas is dangerous as it can cause explosions; therefore, don't charge a Nitrox cylinder with any other gas, and vice versa.

Recharging
Although an enormous number of people drive their car everyday, very few of them know the procedures used by a refinery to produce the fuel they use. In the same way, Nitrox divers don't need to know the procedures used to obtain Nitrox perfectly. Therefore, we will not provide too many details, but some basic information is useful to better understand Nitrox. Furthermore, should you choose to become a professional diver, these notions will constitute some of the fundaments of your knowledge.
As you may have already understood reading the

2

Minitest

1. The principal advantage given by the use of the Nitrox is:
a. the facility with which can be retrieved
b. the increase of the times of immersion within the limits of not decompression
c. a greater duration in the time of the equipment

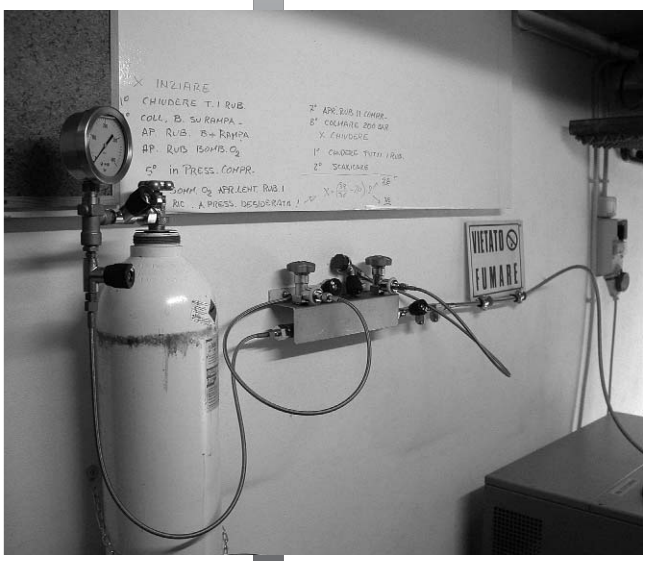
2. Another very important advantage is:
a. the best lucidity of the scuba diver during the immersion
b. the total disappearance of the problems of narcosis
c. a and b are exact

3. Considering a consumption of 20 liters to the minute in surface, how much does a cylinder of 10 liters last (x 200 bar) to the depth of 10 meters?:
a. around 100 minutes
b. around 50 minutes
c. around 35 minutes

Answers:1 b; 2 a; 3 b.

preceding paragraphs, there are to main procedures for obtaining Nitrox: 1) adding oxygen to the air 2) removing nitrogen from the air.
Let's review them together bearing in mind that they can only be performed by specifically trained and qualified blenders.

Partial pressure recharge
This procedure is quite dangerous because is based upon pure oxygen being pumped in a cylinder already containing air or that will be added after the oxygen. It seems easy to use but must be carried out by highly professional blenders with oil free equipment to avoid explosions. Specific tables tell the blenders the quantity of oxygen to be added to air or other known mixes with oxygen to obtain the chosen typo of Nitrox. Getting the desired mix with a good accuracy is quite difficult with this procedure.



Cylinder of oxygen used in the recharge Nitrox for partial pressures

Continuous flow mix
A specific equipment add oxygen, in a controlled way, to the air that before it flows through the compressor; this way the blender can analyse the mix and change the oxygen flow rate until the oxygen percentage is the needed one. This procedure avoids the pure oxygen from flowing through compressor, valves and cylinders, reducing considerably the changes to have explosions.
Anyhow, using oxygen compatible equipment are strongly recommended and usually requested by law.

Nitrogen removal from air
This procedure was conceived considering the method used by the agriculture industry to produce nitrogen (needed for fertilizers), thanks to filters capable of letting the nitrogen flow and blocking the oxygen. Changing the setting of these filters it is possible to remove form the air the proper quantity of nitrogen and obtain the chosen Nitrox. This procedure avoids contacts between pure oxygen and the equipment used. Anyhow, considering the high concentration of oxygen and the high pressure, using oil free materials and lubricants is preferable. Furthermore,

this procedure eliminates the needs of storing pure oxygen. The disadvantage is that producing different types of Nitrox is difficult; this system is more productive when preparing one specific type of Nitrox.

These are the main procedures used to produce Nitrox. Remember that to apply them you must become a trained and qualified blender. The ESA Nitrox Diver course doesn't enable you to do it; this is done by specific qualifying agencies. Furthermore, the recreational divers finds the perfect equilibrium between safety and recreation respecting the rules and procuring Nitrox from professional diving centres able to produce the most diffused and standard mixes (EAN 32 and EAN 36).
One very important feature of the oxygen used for Nitrox is that it is medical oxygen; it purer and is specifically produced to be breathed. Oxygen for welding is forbidden.
Usually, the diving centres that recharge Nitrox ask the divers to show the Nitrox Diver licence, to analyse the mix and to sign a register; it seems there are too many procedures to respect, but they are all aimed at your safety and demonstrate the people you are dealing with are professionals. Therefore, try to be collaborative and don't trust those who underestimate these procedures.
To avoid chances of contamination, the Nitrox recharge stations (as well as those for air) should be equipped with special filters and be regularly maintained with extreme care and seriousness.
These are some of the features to be taken into account when evaluating professionalism and quality of a recharge station:
• request to show the licence
• order and cleanness of the recharge area
• type of oxygen used
• well identified cylinders
• usage of the card or sticker with the information about the cylinder
• filling in and signing the register
• request to analyse the O2
Ask for information about the recharge stations of your town to your ESA Instructor or to an ESA Point (www.esaweb.net).

Oxygen
Everybody knows how oxygen is important for

Minitest

1. The use of oxygen in high concentrations (over 40%):
a. it asks for particular attentions for it's elevated inflammability
b. it doesn't foresee some type of precaution
c. improve the duration of the equipment

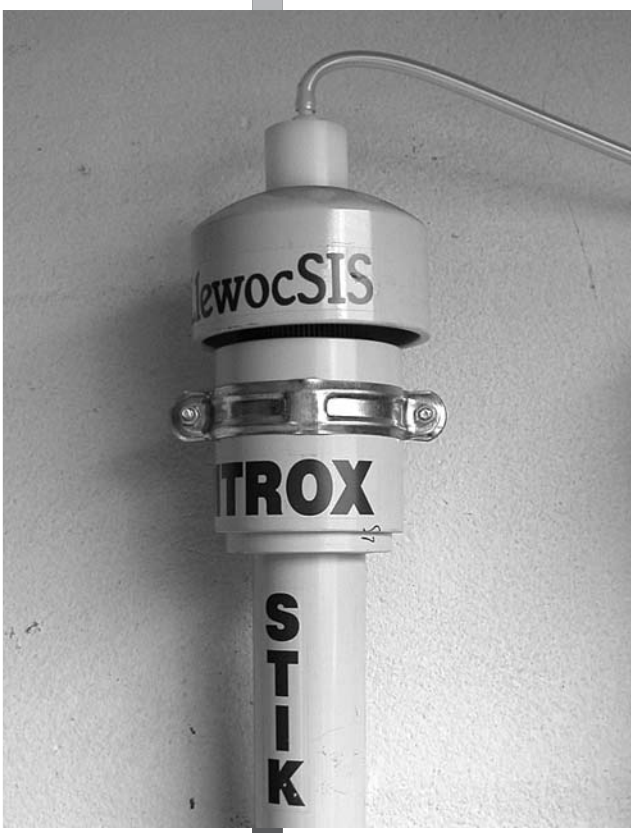
2.With EAN 32 and EAN 36, the scuba diver can use:
a. only Nitrox-devoted equipment
b. also the normal equipment for the air, if otherwise specified not from the manufacturing house
c. only equipment compatible oxygen

3*. The cylinders for the air can contain Nitrox:*
a. provided that the oxygen that comes into contact with the tank doesn't overcome 40%
b. only if the recharge happens with particular systems and the cylinders are identifiable however
c. a and b are exact

Answers:1 a; 2 b; 3 c.

livings. Not everybody knows it can become dangerous. You have already learned during the ESA Open Water Diver course that too low (hypoxia) and too high (hyperoxia) oxygen partial pressures can cause serious conditions that can put life in danger.
The oxygen partial pressure can become too low during a long free dive or while ascending from a free dive after a too long hyperventilation, making the diver faint.
These are all problems treated during the previous courses; hypoxia can also be caused by a too low quantity of oxygen in the gas mix and can be prevented analysing it before diving.

Through the transparent plastic hose a flow arrives assembled of O2 that is mixed with the air inhaled by the presser



Considering the high oxygen partial pressure in Nitrox mixes, we take a closer look at the problems caused by hyperoxia, specifically oxygen intoxication to whole body and lungs, and intoxication to the central nervous system (CNS).

Intoxication to whole body and lungs
Recreational divers can hardly suffer of this problem. Indeed, it is a problem that may affect those divers subject to long exposure to oxygen partial pressure greater than 0,5 BAR. Usually, depth and no decompression limits, as well as those related to air consumption and cold (heat exchange with water) avoid the recreational divers from being exposed to oxygen long enough to feel the symptoms. Such kind of problems, instead, can be suffered by those divers who work under water considerably long, even in shallow water. These problems must be taken into account by technical divers as well: the usage of high oxygen concentration mixes during decompression stops reduces significantly the duration but increases the exposition to oxygen which must be carefully monitored. Medical oxygen used for therapeutic purposes can cause intoxication as well.
There are two measures for exposure to oxygen: the Oxygen Toxicity Unit (OTU) and the Unit Pulmonary Toxicity Dose (UPTD). Specific tables

let you calculate these measures for given PO2 and dive duration; they are then used to calculate the exposure percentage which must not go beyond the limits established in special tables to avoid risks.
According to the outcomes of the workshop on Nitrox cited at Chapter 1, the divers that respect the limits recreational dives don't need to measure the exposure for the whole body. They need to take into consideration the central nervous systems (CNS) exposure to oxygen instead.

Oxygen intoxication to the central nervous systems (CNS)
Oxygen intoxication to the CNS is caused by high oxygen partial pressure and/or a long exposure. Long exposures can be dangerous starting from a PO2 of 1,3 BAR. Therefore, respecting the limits established by the NOAA is really important: PO2 1.5 BAR, duration of a single dive 120 minutes, overall duration of repetitive dives 180 minutes every rolling 24 hours, 3 maximum dives with Nitrox in one day.
Susceptibility to oxygen intoxication changes from diver to diver and from time to time. One important point is that the symptoms may reduce while diver is ascending, but they can start without any premonitory and proper signs; therefore, the diver is taken by surprise and, should he be victim of convulsions, he risks to drown.
Many serious accidents happened diving really deep with air were originated by oxygen intoxication to the CNS: this is another good reason to respect the limits!

"CNS Oxygen Clock"
This is a procedure used to monitor the CNS exposure to oxygen; it was established by the NOAA.
The CNS exposure to oxygen can determined thanks to the limits established in the NOAA table "oxygen exposure limits per dive" either using the maximum PO2 or analytically using other tables that provides a percentage of exposure as a function of the time spent for each PO2 during the dive (CNS%).
Safety is improved thanks to the indication provi-

Particular filters can improve notably the purity of the air during the recharge

ded by the NOAA for the maximum PO2; the analytical procedures are more useful for technical divers that breathe different oxygen concentrations for pre-assigned periods. The most recent computers used for dives with Nitrox calculate the oxygen exposure percentage based upon the various depths at which the divers remain during the dives and display it to the divers (usually with the "%CNS" symbol). You can decide to trust your computer of course, but you have to read carefully the instructions and, should you reach 50% CNS exposure during 24 hours rolling wait at 1 hour at least before diving again. Never exceed 90% CNS exposure during 24 hours rolling. Should it happen, don't dive for 12 hours at least.
Signs and symptoms: low heart beats, palpitations, depression, anxiousness, false visual effects (darkness, flashes, tunnel effect), hearing the bells or other auditory hallucinations, vertigos, irregular breathing, nausea, tremors and contraction of lips, cheeks, nose, eyelids, blackout and convulsions (with serious risk of drowning).

Should you feel any of these symptoms, ascend without waiting, exit from the water and don't dive for 24 hours, as a minimum.

Concurrent elements
Other elements can cause oxygen intoxication to CNS symptoms, such as medicines, tiredness, carbon dioxide accumulation in the organism.
Medicines
The same considerations for dives with air apply to dives with Nitrox: avoid taking congestion relief medicines before diving; should you be taking medicines, ask the doctor to get information. As you know, alcohol and drugs must be avoided before diving as well.
Carbon dioxide
As demonstrated by some analysis, there is a close connection between carbon dioxide concentration in the organism and oxygen intoxication. For this reason, remember to respect the rules you have learned during the ESA Open Water Diver Course: breathe slowly, deeply and continuously. Avoid holding your breath to save air; the most probable result would be a higher air consumption and carbon dioxide accumulation.

Minitest

1. The recharge for partial pressures is particularly delicate because:
a. the operator interacts with pure oxygen at high pressure
b. the pure oxygen passes through the compressor and the tank valve
c. a and b are exact

2. The components of the recharge station that uses pure oxygen necessarily have to be:
a. new
b. "oil free"
c. painted to yellow and green strips

3. To produce the Nitrox:
a. it can be used any type of oxygen
b. it is had to use medical oxygen
c. it is not had to use mediclaoxygen

Answers:1 c; 2 b; 3 b

The latter exposes you to fatigue, decompression sickness, nitrogen narcosis and oxygen intoxication.
Considering the limits for recreational dives using EAN32 and EAN36, monitoring carbon dioxide is not needed. Anyhow, as accumulating carbon dioxide is subjective, should you usually have headache after diving, get in touch with a doctor aware of scuba diving related issues, reduce the exposition to oxygen limiting the maximum PO2 to 1,4 BAR and avoid holding your breath while diving.

Decompression sickness, arterial gaseous embolism and narcosis
As far as decompression sickness is concerned, all that you have already learned during the ESA Open Diver Course and subsequent still applies: breathing Nitrox reduces nitrogen absorption as well as the decompression sickness risk; anyhow, a reduced risk still exists.
To prevent the decompression sickness you need to plan your dives carefully, to respect the no decompression limits, check the manometer frequently, analyse the Nitrox mix to check the oxygen percentage before each dive, set the computer properly and respect all that you have learned.
As you know, should a diver have signs and symptoms specific to decompression sickness, look for a doctor, check if he breaths and that his heart beats and make him breathe pure oxygen, if available, until the medical staff is available. The decompression sickness can be treated only in hyperbaric chambers by qualified personnel.
As far as volume variations with depth and pressure are concerned, Nitrox and air behave the same way: it decreases when going deep and increases ascending.
The arterial gaseous embolism is due to lungs overstretching; to avoid it remember to apply the

The full face mask can prevent the flood of the aerial streets in case of convulsions

most important rule you learned during your first course: don't hold your breath when scuba diving. The procedures in case of decompression sickness apply to arterial gaseous embolism as well.
Nitrogen narcosis risk is reduced when diving with Nitrox but oxygen has narcotic effects too. Therefore, should you feel a bit exuberant, remember it can be narcosis. Indeed, check your and your mate lucidity often. In case of any unusual behave, ascend a bit and signs and symptoms will disappear.

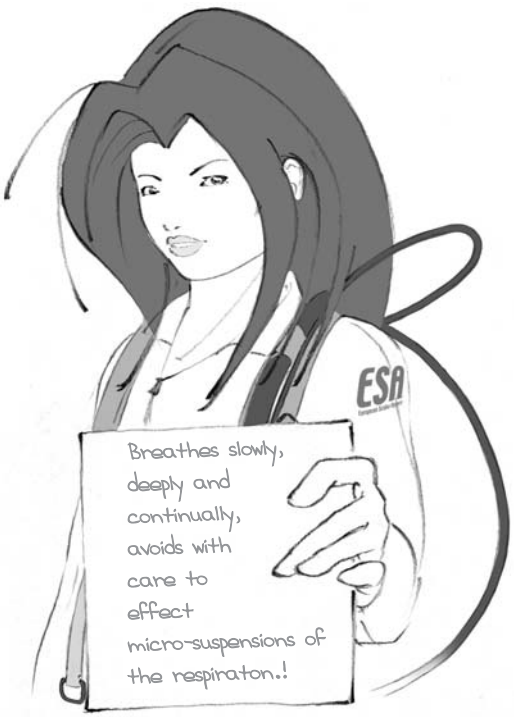
Managing emergencies

Having accident while diving is really difficult if your respect all the procedures and rules conscientiously; this applies also to Nitrox diving. Should an accident happen, this shall be managed as established in the ESA First Aid, Open Water Diver, Advanced Diver and Prevention & Rescue Diver manuals.
Anyhow, should you see a diver faint while diving, and should divers more qualified than you be not around, try to help him without risking your safety. Ascend with him, try to hold the regulator in his mouth but, should he lose it, don't waste time trying putting it back. Ascend respecting the maximum speed limit without hesitation. Once at the sea level, trim him positively, open his airways and, if needed, try to resuscitate him; look for help without stopping checking that he breaths and that his heart beats, and if necessary, without stopping the resuscitation.
Should a diver have problems after having ascended, look for medical help and, should he faint, apply the above. Once again, it is statistically demonstrated that the chances for a diver that applies conscientiously all the rules he learned during the courses and that respect all the instruction provided by the equipment manufacturer to have problems are very low.
Anyhow, considering that people are not all the same, neither learning methods nor tables can

Remember!

- max PO_2 1,5;
- maximum time for single dive is 120 minutes
- 180 minutes in the 24 hours, if You are making multiple dives;

guarantee that problems are warded off. Furthermore, you could see an accident happening by chance and being helpful is important. Therefore, continuing your training (you may have already done it) attending the ESA First Aid is important; this course can be attended by anybody. This course trains you to help people who don't feel well or victims of accidents. The ESA Prevention & Rescue Diver is a more complete course and is specific to scuba diving; the prerequisites for this course are: having the ESA Advanced Diver (or similar) licence, have at least 20 dives registered in your log book. Learning techniques to held divers, specially providing oxygen in case of decompression diseases and to those people who have risked to drown, is of paramount importance.



Minitest

1. The due greatest danger to the elevated concentration of the oxygen breathed during dive is:
a. the nitrogen narcosis
b. the poisoning from oxygen to pulmonary level
c. the poisoning from oxygen to the CNS

2. To prevent hiperoxya:
a. respect the limits of oxygen's exposure
b. to respect the limits of depth and PO_2
c. a and b are exact

3. The "CNS Oxygen Clock" it is:
a. a particular analogical tool for the Nitrox dives.
b. a system of monitoring the exposure to the oxygen of the CNS
c. the clock used by the scuba divers professionals

4. The acronym CONVUTIV is used to remember:
a. a particular procedure of equipment's control
b. the symptoms of the oxygen poisoning of the CNS
c. the formulas to plan the Nitrox dives

Answers:1 c; 2 c; 3 b; 4 b.

Congratulations!

Now you can plan your Nitrox dives and, during your next trip, you will be able to enjoy the advantages offered by Nitrox. You may choose to dive with Nitrox to feel less tired or to have time enough to explore specific sites that, due to their features, could need longer no decompression limits than those for air.
Ask the technician to apply all products and procedure needed to make your equipment oxygen compatible and remember that, with the application of such products and procedure, your equipment can stand 40% of oxygen maximum.
Now you can provide general information about Nitrox and how it is produced; you are able to choose a professional recharge station too.
Maybe you got a bit worried reading the paragraphs about effects of oxygen, decompression sickness and narcosis; anyhow, you will have understood that respecting the limits established for recreational dives helps you in avoiding them. Furthermore, being able to recognise signs and symptoms help you in preventing them.
Having problems is quite difficult for conscious divers anyhow, improving your training and knowledge attending first aid and rescue courses, will make you feel comfortable and aware; the last paragraph provided you suggestions on the ESA courses that can improve your preparation.
The Instructor will give you the ESA Nitrox Diver licence if you have attended the course, filled in and corrected the "What have you learned?" questionnaires and successfully completed the dives with Nitrox. Remember that you don't need to wait for the sticker to apply to your licence to ask the diving centres to dive with Nitrox. For any questions you may have, don't hesitate to contact ESA; you can find the email addresses on the web site www.esaweb.net

What have you learned?

This exercise will let your review all the most important information contained in this unit, so that you can improve your preparation and be ready for your next appointment with your instructor. Answer the questions choosing the right questions among the listed ones. Check your answers with your Instructors; in case of any inaccuracy, he will provide all the needed explanations.

1. If compared with air, Nitrox:
a. extends the no decompression limits
b. doubles the no decompression limits
c. enables you to ignore the no decompression limits

2. Diving with Nitrox and respecting the no decompression limits applicable for diving with air (21% O2 / 79% N2):
a. you avoid the decompression sickness
b. you absorb less nitrogen
c. nitrogen narcosis is more likely to happen

3. How long can a 15-litre cylinder charged at 20 BAR provide air at a depth of 25 metres if you breathe at a rate of 20 litres per minute at the sea level?
a. 57 minutes
b. 70 minutes
c. 53 minutes

4. The cylinders for Nitrox must be properly marked:
a. to avoid wasting time
b. to prevent accidents
c. so that the end users don't need to analyse it

5. Nitrox is produced:
a. removing nitrogen from the air
b. adding oxygen to the air
c. both a and b

6. Combustions caused by a high concentration of oxygen depend on

Minitest

1. Nitrox breathing:
a. removes the possibility to have the MDD
b. the MDD can equally be revealed
c. you cannot verify an over lung pressure

2. The treatment for MDD and EGA also foresees:
a the administration of pure oxygen
b. a physician's intervention
c. a and b are exact

3. A datum volume of Nitrox, in a flexible container, during ascending it:
to. it is unchanged
b. it increases
c. it decreases

Answers: 1 b; 2 c; 3 b;

a. type of oxygen
b. hydrocarbons and lubricants not compatible with oxygen
c. flames

7. Oxygen intoxication to the whole body:
a. is rare if the recreational divers respect the exposure limits
b. is mainly due to breathing oxygen high concentration for long
c. both a and b

8. According to the NOAA tables (PO2 1,5 maximum) the exposure to oxygen limits over 24 hours rolling are:
a. 120' for a single dive o 180' for repetitive dives
b. 180' for a single dive o 120' for repetitive dives
c. 100' for a single dive o 120' for repetitive dives

9. If you use a computer for Nitrox dives:
a. read the instruction carefully
b. don't exceed 90% (CNS%) exposure to O2 over 24 hours rolling
c. both a and b

10. Oxygen intoxication to CNS can be caused by:
a. the position of the diver during the dive
b. a regulator that provides Nitrox too easily
c. an excessive CO2 accumulation

11. In case of decompression sickness after a Nitrox dive, look for medical help, check breathing and heart beat and:
a. provide pure oxygen
b. don't provide pure oxygen
c. both a and b

12. Among the symptoms of oxygen intoxication to CNS you can find:
a. visual and auditory alterations, tremors of lips
b. pain, itchiness, tiredness
c. high temperature, paleness, swelling

13. Hyperoxia susceptibility
a. changes from person to person
b. for the same person depends on the specific moment
c. both a and b

14. Convulsions are dangerous while diving as the

Minitest

1. You can learn the techniques for managing an emergency during the course:
a. ESA Prevention & Rescue Diver
b. ESA Advanced Diver
c. ESA Ecodiver

2. The term PDD means:
a. Pathologies from Decompressure
b. Personal Diving Device
c. Pathologies from Descent

3. In case of emergency, it is important:
a. to get as soon as possible help physician
b. to establish the causes of the accident
c. to guess exactly the name of the pathology

Answers:1 a; 2 a; 3 a;

victim:
a. can hurt because of blunt instruments
b. cannot be trimmed
c. can drown

15. To avoid oxygen intoxication to the CNS:
a. apply all rules for recreational dives in a strict way
b. respect depth and exposure to oxygen limits
c. both a and b

I declare that I have reviewed all the wrong answers with the ESA Instructor, and that I have understood the related explanation.

Signature _____date_____

Device to check the flow of Nitrox on the sensor of the analyser

Open Waters 1 and 2

Briefing
Listen to the explanation from the Instructor and don't hesitate to ask questions in case you need clarifications.
Open Waters briefings are specifically important as ascending to clarify something is not convenient for many reasons; listening to the briefing and have enough time to dive and practice the exercises and repeating them is much more profitable. The Instructor will explain all you have to do – how and when – therefore putting on hold any other activity during the briefing and concentrating on it only is of paramount importance.
Again, should you need any clarifications, don't hesitate to ask questions: either the Instructor or the Diveleader will help you.

Nitrox analysis
You will analyse the chosen mix together with your mate and under the supervision of your Instructor; this is needed to verify that the oxygen percentage indicated by the blender and is correct and compatible with the dive you have planned.
Remember that any time you use a gas mixes other than air (oxygen percentage 21%), you will have to analyse the mix using a suitable instrument connected to a flow-meter. Do it with your mate: each one will analyse the content of his cylinder under the supervision of both the other mate and of the Instructor.

Planning the Nitrox dive
Use the ESA table for diving with Nitrox with your mate, as indicated by the Instructor. To take the most of the profits by diving with Nitrox having regards of safety, planning every dive carefully is of fundamental importance. Take the advantage of this exercise to improve your skill and solve any problems with your Instructor and your mate. Should anything appear not too clear or in case of doubts, don't hesitate to ask the Instructor to clarify it: this is important for your safety. Should you use a computer for Nitrox dives, verify that the oxygen percentage is correctly set.

CNS Oxygen Clock

Verify that you don't risk exceeding or getting too close to the established oxygen exposure limit, taking into account previous dives.
Oxygen intoxication to the CNS is an important factor to be considered when diving with Nitrox: don't exceed the exposure limit of 120 minutes over 24 hours rolling for a single dive and 180 minutes for repetitive dives.

Getting ready, checking the equipment and putting it on
Prepare the equipment needed for the dive, ask your mate to help you putting it on; when you and your mate are both ready, check each other equipment.
As you usually do, you can assemble BCD and regulators on the cylinder and then verify that it is charged.
The best way to put the equipment on may depend on the specific dive: should you be on a boat you may decide to do it in the water (the instructor will provide the needed information).
As you know, checking the equipment before diving is the best way to avoid equipment related problems, so do it carefully. Should you discover any problem, inform the Instructor or the Staff or your mate. Check that the oxygen percentage is properly set in the computer.
N.B.: should the weather conditions and your experience be enough, at the discretion of the Instructor, you could check the equipment after you have jumped into the water.

Getting into the water
The Instructor and the Staff will provide you the information for the best way of getting into the water based upon the boat and the dive site. Be sure you are positively trimmed and wait, together with your mate, indications from the Staff on when starting to dive and on the exercises to be carried out at the sea level.

Checking the correct quantity of ballast
This is an important check and must be done before starting to dive. Checking the correct quantity of ballast is important to be trimmed as needed; being perfectly trimmed is important while diving in to be more relaxed and to avid problems to the environment. Furthermore, you will be able to respect the established depth

limit. Get used to making this check to prevent problems due to an incorrect quantity of ballast.

Descent
Use a rope or the seabed as a reference point and don't exceed the depth planned by the Instructor. This phase is really important, remember the MOD! Specifically, remember to descend together with your mate, slowly, and checking either the computer or the depth gauge. All information about the best way to descend will be provided by the Instructor during the briefing.

Diving respecting both plan and safety parameters.
Check depth, time and manometer frequently and exchange the information with the mate. Dive one meter shallower than planned.
You must take extreme care of depth when diving with oxygen enriched mixes in order to avoid oxygen toxicity related problems. As you can dive longer, remember to check the time and the manometer. You should exchange information about the pressure in the cylinder with your mate every 20/30 bars.

Exercised for other ESA courses
Should you attend the ESA Nitrox Diver course in conjunction with other ESA courses, practice the exercises for such other courses as explained by the Instructor during the briefing. This doesn't apply in case the ESA Nitrox Diver course is attended as a stand alone course.

Repetitions and experience
Repeat the exercises under the supervision of the Staff. This will make you more familiar with the underwater environment. Should and exercise not be clear or you want to do it again, don't hesitate asking the Staff.

Ascent and safety stop
Ascend slowly (not faster than 10 metres per minute) using a fixed point of reference and stop at 5 metres for 3 minutes. Ascending slowly and complete the safety stop is important for all kind of dives, included those with Nitrox. This enables you to improve safety and diving techniques. The Instructor will provide the needed information.

Getting out of the water
Do it using the technique suggested by the Instructor.

Disassembling the equipment and taking care of it
It is important and needed to keep your equipment, including the instruments needed for orienteering, efficient. Whenever possible, rinse it with fresh water even before disassembling it, then put it into your sack to wash it when suggested by the Staff.

Debriefing
Listen to the comments the Instructor will have. This is another way of improving. Don't do anything else but listen to the Instructor during the briefing. He will have useful comments on you performance, suggestions and recommendations. Take the opportunity to improve further and don't hesitate to ask questions.

Registering your dive
Fill in your logbook and ask your Instructor to sign it. This is needed to confirm your open water training. Register all parameters (such as the CNS oxygen clock), the environmental conditions and the exercises, plus your personal comments. Remember to ask the Instructor to sign.

9 rules for diving with Nitrox

1. *Use proper and efficient equipment; make sure it is regularly maintained*

2. *Analyse the oxygen personally*

3. *Make sure the oxygen analyser works properly; respect the instruction provided by the manufacturer and make several trials with air, pure oxygen (if available) and then the Nitrox mix.*

4. *Respect the Maximum Operative Depth: don't exceed 31 metres with EAN 36 and 36 metres with EAN 32*

5. *Set correctly the oxygen percentage in the computer or choose the right column in the table ESA "EAN 36 – EAN 32 – AIR DIVE TABLES": the wrong oxygen percentage can cause decompression sickness or iperoxia*

6. *Make sure the computer is properly set before each dive: get used to check both and your mate instrument before diving*

7. *Respect the limit of 120 minutes for a single dive and 180 minutes for repetitive dives over 24 hours rolling. Don't dive more than 3 times a day with Nitrox: this simple rule helps you in preventing helps you in preventing oxygen intoxications. Should you get close to the limits, don't dive for 12 hours at least.*

8. *Breath continuously without holding your breath and prevent breathlessness: carbon dioxide accumulation can cause hypoxia. So avoid holding your breath while diving, try not to get weary and use a good performance regulator*

9. *Respect your license and local rules depth limit: the ESA Nitrox Diver license doesn't enable you to dive deeper. You must comply with the limitations of your preceding license (i.e. ESA OWD = 18 metres).*
Remember to consider the limitations cause by PO2. The CNS% value per minute must be multiplied by the minutes spent at a certain depth.

Appendix

ESA

ESA is a didactic agency and his/her principal objective it is that to form the scuba divers from the initial level up to the attainment of the professional levels as Diveleader and Instructor. To do this the ESA is established to jointly apply the most evolved operational standards to an elevated safety degree and to promote the underwater activity in his/her various forms.

The formative runs of the ESA foresee the information integration divulged by the instructor with the materials of support that accompany the various levels of brevet.

Initial practical formation happens with the development of the underwater abilities in swimming pool or delimited basin, subsequently you apply and you improve in free waters.

For every program or raced ESA it is anticipated a verification of the learning from the instructor that will have to preserve a test of the happened evaluation.

The scuba divers can receive from the ESA the initial formation, to progress toward taller levels of brevet, to specialize himself/herself/themselves in different areas tied to the underwater activity as the sea biology, the photo, the underwater archaeology, etc.

Reached adjust her credential, the scuba divers can participate in the programs for the formation type professional within the underwater activity.

The esa establishes elevated standards for the formation of his/her own affiliate: they is underwater professionals in possession of a brevet ESA Diveleader or of taller degree.

The preliminary ESAs are formed from the ESAs IC Director, prepared and qualified people adequately to transmit the techniques of teaching to the preliminary future.

The formation of the instructor is complete and foresees the acquisition of information on the theory of the immersion, on the procedures ESA, notions of psychology and marketing, the development of the abilities of management of the single scuba divers or in group, of management of the problems, of safeguard of the environment

and other.
The validations of the brevets ESAs are issued from the central center and from the offices ESA officially authorized.
The department ESA that deals him with the formation informs the affiliate ESAs on the variations of the existing procedures and on the introduction of new procedures.
You/they can also join to the ESA qualified structures that operate in the field of the recreational underwater activity.
Immersion centers, underwater club and you negotiate subacquei they are able, in fact, to acquire the qualification of ESA Point. The denominated structures ESA IC Point can promote, to organize and to conduct the courses of formation for the Preliminary ESAs.
The esa intends to also characterize him through a particular facing appointment the popularization of the knowledges on the environment, to improve the quality of the immersions and to create in the subacqueis a greater awareness toward the submerged space. The professionals ESAs, in fact, effect their formative run also receiving a solid preparation on the knowledges related to the environment. the whole formative activity of the ESA is firmly connected to objective of safeguard of the aquatic environments.

9 Suggestions to preserve the aquatic environment

If you follow these simple rules you will give a great contribution to the preservation of the aquatic environment.

1) Control your buoyancy at all times. If you are neutrally buoyant you will avoid damages to the sea floor and its inhabitants. If you don't wear gloves you will be less inclined to touch and feel about the sea floor, causing possible damages.

2) When you approach the bottom don't flap your hands and fins around. If you have to rest on the bottom, make sure your knees and fins don't cause any damage.

3) Avoid tunnels and caverns, by touching their ceiling you could damage the life living on them, besides you bubbles could not escape and turn the top of a cave into a submerged desert.

4) Don't hold on to sea turtles, large fishes and sea mammals, just swim with them but don't chase the animals, they might not enjoy it as much as you.

5) Try not to touch animals you don't know. You might get hurt or remove their protective mucus making them more vulnerable.

6) Do not remove anything from the bottom, shells (neither dead, nor alive), algae covered objects or archaeological finds.

7) Do not buy souvenirs made with shells or other materials coming from the sea. It a way to discourage their collection or fishing.

8) Do not litter the sea. Use the rubbish bins.

9) Carry on your training and extend your knowledge of the marine environment, you will discover that every location deserves a dive and that every environment has amazing discoveries to unveil.

All the inhabitants and the visitors of the underwater spaces thank you in advance for your effort

Not to be left at home

Miscellaneous
ID's
Dive Licence
Log book
Reservations/tickets
Emergency contacts
Swim suit
Sun screen
Sun glasses
Hat
Wind breaker
Towel
Bath robe
Sandals
Goggles and bathing cap
Spare clothing
Food and drinks
Medicines

Equipment
Bag
Fins, mask and snorkel
Wet suit
Thermals
Hood
Gloves
Booties
Weights
BCD
Full cylinder
Main regulator
Spare regulator
Pressure gauge
BCD pipe
Dry suit pipe
Knife

Instruments
Dive computer
Depth gauge
Timer
Compass
Thermometer
Dive tables

Accessories
Dive slate
Animal guide
Pencil
Dive buoy
Surface signalling device
Reel
Main torch
Spare torch
Strobe light
Position indicator light
Snap-hook
Anti fog spray/liquid
Equipment lanyard

Spare gear
O-ring
Cylinders
Weights
Straps
Tool kit
Wet suit repair kit

Special equipment
Underwater camera
Lens and zooms
Flash
Films
Video camera
Housing
Tapes
Video lights
Batteries
Battery charger
Wiring and connector

Notes
_____
_____
_____
_____
_____
_____
_____

PO_2 Table and O_2 exposition limits ***for Dives with NITROX as per NOAA rules (National Oceanic & Atmospheric Administration)***					
EAN 36 meter	***EAN 32*** meter	***PO_2*** ATA	***CNS %*** for minute	***Single exposure*** 1 dive within 24 hours	***Multiple exposure*** more dives within 24 hours
34	***40***	***1,6***	***2,22***	***45***	***150***
31	***36***	***1,5***	***0,83***	***120***	***180***
28	***33***	***1,4***	***0,65***	***150***	***180***
26	***30***	***1,3***	***0,56***	***180***	***210***
23	***27***	***1,2***	***0,47***	***210***	***240***
20	***24***	***1,1***	***0,42***	***240***	***270***
17	***21***	***1,0***	***0,33***	***300***	***300***
15	***18***	***0,9***	***0,28***	***360***	***360***
12	***15***	***0,8***	***0,22***	***450***	***450***

Conversion table from meters to foot (1 meter = 3,28 foot)																	
METER	***12***	***15***	***17***	***18***	***20***	***21***	***23***	***24***	***26***	***27***	***28***	***30***	***31***	***33***	***34***	***36***	***40***
FOOT	***39***	***49***	***56***	***59***	***66***	***67***	***75***	***79***	***85***	***88***	***92***	***98***	***102***	***108***	***112***	***118***	***131***

TABLE CONVERSION MEASURES OF PRESSURE
1 PSI (pound x square inch) = 0,073 kg x cm^2
1 kg x cm^2 = 14,223 PSI
1 atm = 1,033 kg x cm^2
1 atm = 14,696 PSI

Pg = Partial pressure of a gas to a certain depth

*** Fg = Fraction of the gas or partial pressure of the gas in surface**

in meter [(depth + 10) : 10] x Fg = Pg

in foot [(depth + 33) : 33] x Fg = Pg

EAD = equivalent depth in air

in meter [(FN_2 x depth + 10) : 0,79] - 10 = EAD

in foot [(FN_2 x depth + 33) : 0,79] - 33 = EAD

MOD = Maximum operational depth with limit PO2 to 1,5

in meter [(1,5 x 10) : FO_2] - 10 = MOD

in foot [(1,5 x 33) : FO_2] - 33 = MOD

EAN 36 - EAN 32 - AIR DIVE TABLES

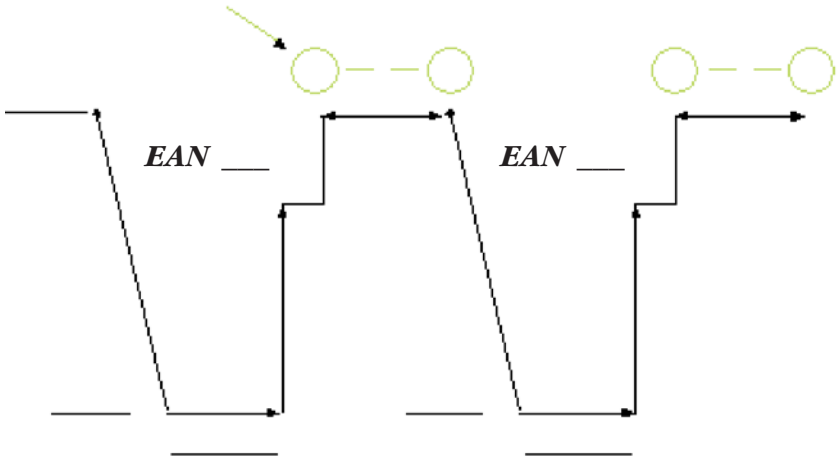
No- Decompression and O_2 Exposure Limits - Repetitive Group Designation

Tables for No-Decompression Dives

EANx TABLE 1

Profondità Depth EAN 36 m	Profondità Depth EAN 32 m	Profondità Depth AIR m	Gruppo di Appartenenza / Pressure Group										
			A	B	C	D	E	F	G	H	I	J	K
7,5	6,5	4,5	35	70	110	120*							
9	8	6	25	50	75	110	120*						
11	10	7,5	20	35	55	75	100	120*					
13	12	9	15	30	45	60	75	95	120*				
15	13,5	10,5	5	15	25	40	50	60	80	100	120*		
17	15	12	5	15	25	30	40	50	70	80	100	110	120*
20	18	15		10	15	25	30	40	50	60	70		
24	22	18		10	15	20	25	30	40	50			
28	26	21		5	10	15	20	30	35	40			
31	29	24		5	10	15	20	25	30				
	32	27		5	10	12	15	20	25				
	36	30		5	7	10	15	20					
		33			5	10	13	15					
		36			5	10							
		39			5								
			A	B	C	D	E	F	G	H	I	J	K

* Single dive maximum time with EAN x: 120 minutes
* Tempo massimo per immersione singola con EAN x:120 minuti



EANx TABLE 2

0:10 0:00											A
3:21 12:00	0:10 3:20										B
4:50 12:00	1:40 4:49	0:10 1:39									C
5:49 12:00	2:39 5:48	1:10 2:38	0:10 1:09								D
6:35 12:00	3:25 6:34	1:58 3:24	0:55 1:57	0:10 0:54							E
7:06 12:00	3:58 7:05	2:29 3:57	1:30 2:28	0:46 1:29	0:10 0:45						F
7:36 12:00	4:26 7:35	2:59 4:25	2:00 2:58	1:16 1:59	0:41 1:15	0:10 0:40					G
8:00 12:00	4:50 7:59	3:21 4:49	2:24 3:20	1:42 2:23	1:07 1:41	0:37 1:06	0:10 0:36				H
8:22 12:00	5:13 8:21	3:44 5:12	2:45 3:43	2:03 2:44	1:30 2:02	1:00 1:29	0:34 0:59	0:10 0:33			I
8:51 12:00	5:41 8:50	4:03 5:40	3:05 4:02	2:21 3:04	1:48 2:20	1:20 1:47	0:55 1:19	0:32 0:54	0:10 0:31		J
8:59 12:00	5:49 8:58	4:20 5:48	3:22 4:19	2:39 3:21	2:04 2:38	1:36 2:03	1:12 1:35	0:50 1:11	0:29 0:49		K

Ripetitive Group at the Beginning of the Surface Interval

Gruppo di Appartenenza all'inizio dell'intervallo di superficie

New Group Designation

EAN 36	EAN 32	AIR	A	B	C	D	E	F	G	H	I	J
6	5	3	39	88	159	279						
			*	*	*	*						
9	8	6	18	39	62	88	120	159	208	279	399	
			*	*	*	*	*	*	*	*	*	
13	12	9	12	25	39	54	70	88	109	132	159	190
			*	*	*	*	*	*	*	*	*	*
17	15	12	7	17	25	37	49	61	73	87	101	116
			120	113	105	93	81	69	57	43	29	14
20	18	15	6	13	21	29	38	47	56	66		
			64	57	49	41	32	23	14	4		
24	22	18	5	11	17	24	30	36	44			
			45	39	33	26	20	14	6			
28	26	21	4	9	15	20	26	31	37			
			36	31	25	20	14	9	3			
31	29	24	4	8	13	18	23	28				
			26	22	17	12	7	2				
Profondità Immersioni Consecutive	32	27	3	7	11	16	20	24				
			22	18	14	9	5	1				
	36	30	3	7	10	14	18					
			17	13	10	6	2					
Ripetitive Dive Depth		33	3	6	10	13						
			12	9	5	2						
		36	3	6	9							
			7	4	1							
		39	3									
			2									

EANx TABLE 3

Warning: These tables must be used by certified divers or under the direct control of a certified scuba instructor

39 Residual Nitrogen Time (Minutes)

39 Adjusted No-Decompression Time Limit

* Tempo totale massimo per immersioni consecutive nelle 24 h = 180 minuti
Maximum total time for ripetitive dives within 24 hours = 180 minutes

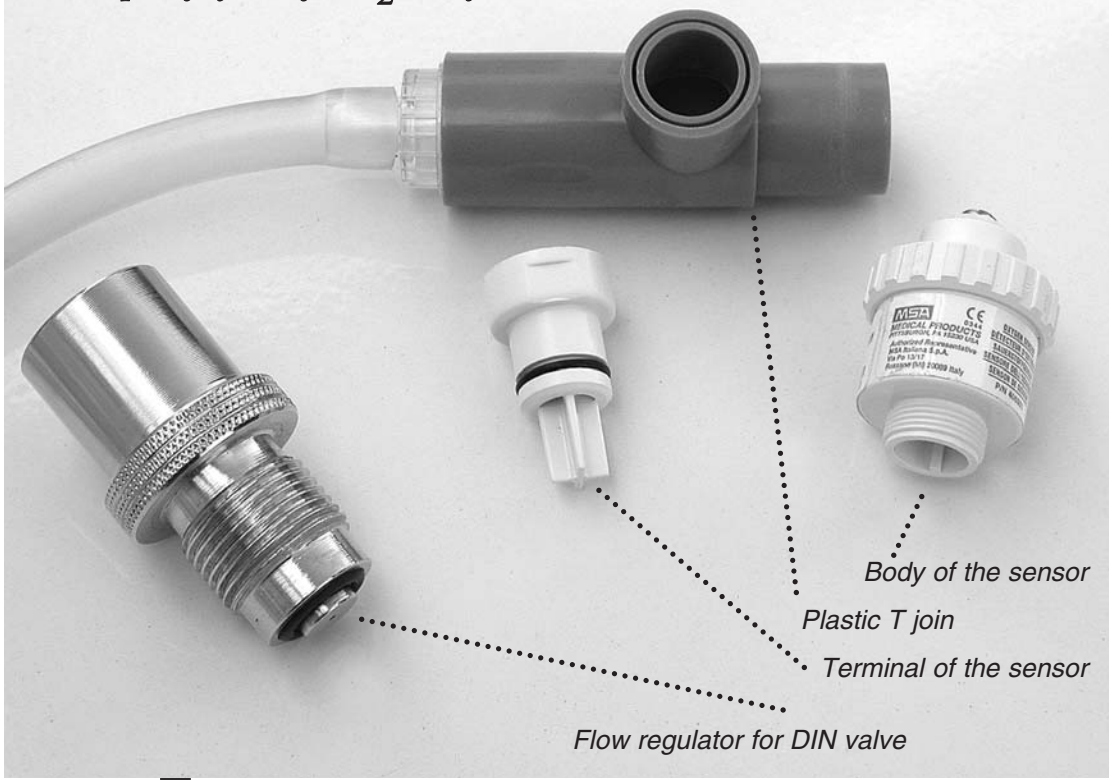
Product N° A0039

O_2 analysis

Switch on the tool and waits for some minutes that the sensor environments itself and correctly measure the percentage of ox

Note: all the connections must be completely taghtin up included the attacks to the sensor and to the tool

Example of system for O_2 analysis



1. Connection of the regulator of flow to the DIN valve
2. Graft of the link to T on the regulator of flow
3. Is important to screw well the ferrule of connection of the sensor to the cable of the tool
4. Insertion of the sensor in the special lodging in the link TO T
5. The procedure must be made first on a cylinder with air, setting I orchestrate him/it on 21
6. The procedure repeats him on the cylinder with the Nitrox. The reading does effected when the datum stabilizes him