The Sports Diver Nitrox Workshop

The revised diver training programme (DTP) introduced in January 2007 contains, for the first time, a nitrox component. Divers who trained under previous versions of the DTP will not have covered this material unless they have had supplementary training. The 'Sports Diver Nitrox Workshop' is designed to be delivered to ***Sports Divers*** (or recognised equivalents) and above who have either attended the 'Ocean Diver Nitrox Workshop' or hold the BSAC Basic Nitrox certification (or recognised equivalent).

Workshop Overview

The information contained in ***The Sports Diver Nitrox Workshop*** defines the scope, knowledge and skills required to train qualified Sports Divers (or recognised equivalent) in the use and application of nitrox breathing gases for decompression diving. Individual instructor teaching techniques and presentation styles will vary according to student needs. The details provided in the Instructor Notes are to ensure that in adapting teaching styles and techniques, the instructor can maintain the right scope and depth of training.

Student Entry Level

BSAC Sports Diver or any similarly recognised diver qualification.

Qualification with this Workshop

Sports Divers (or recognised equivalent) will be qualified to use nitrox for decompression diving on the BSAC Nitrox Tables or nitrox computers based on a maximum partial pressure of oxygen (PO_2) of 1.4 bar.

Student Certification

The Branch or Centre delivering this Workshop **MUST** supply the student with the Sports Diver **Student Workbook** and the **Qualification Application Form**.

This is the only process that enables this training to be recorded and certify the diver as being trained in the use of nitrox for decompression diving.

On receipt of the Qualification Application Form at BSAC HQ, students will be registered as Sports Diver Nitrox Divers and be issued with a nitrox qualification card and endorsement sticker.

Instructor Requirements

The Sports Diver Nitrox Workshop can be delivered by any recognised BSAC Theory Instructor or above.

THE SPORTS DIVER NITROX WORKSHOP

Workshop Objectives

To update current BSAC members qualified as Sports Divers (or recognised equivalent) who have not covered the Sports Diver Nitrox component within the revised diver training programme (DTP), introduced in January 2007.

Achievement Targets

At the end of this workshop students should be able to:

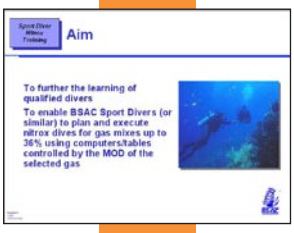
- Use nitrox for decompression diving
- Dive up to the maximum operating depth (MOD) of the selected nitrox gas
- Understand the implications of diving with enriched oxygen gas mixtures
- Use the BSAC Nitrox Tables
- Understand the pros and cons of diving with a nitrox computer

The following items will be needed:

- BSAC Nitrox Tables
- Nitrox computer
- Calculator

SPORTS DIVER SUPPLEMENTARY TRAINING NITROX WORKSHOP

The workshop presents the nitrox-related elements contained within the 2007 Diver Training Programme BSAC Sports Diver course. Divers who have not received any basic nitrox training should attend the 'Ocean Diver Nitrox Workshop' before attending this workshop.



Aim

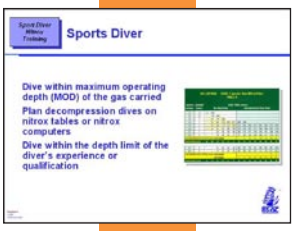
The key objectives of this workshop are:

To further the learning of qualified divers

The workshop extends the diver's knowledge by expanding on the implications of nitrox diving as the maximum operating depth is increased to 35 metres.

To enable BSAC Sports Divers (or similar) to plan and execute nitrox dives for gas mixes up to 36% using computers/tables controlled by the MOD of the selected gas

Divers will be enabled to plan and execute decompression dives using an appropriately calculated nitrox mix up to a maximum oxygen percentage of 36%.



Sports Diver

The Sports Diver qualification enables the divers to:

Dive within maximum operating depth (MOD) of the gas carried

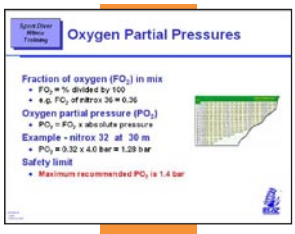
Divers must observe the maximum operating depth of the chosen gas. If they plan to dive to 35 metres, they must chose an appropriate nitrox mix that enables them to achieve their planned decompression profile safely.

Plan decompression dives on nitrox tables or nitrox computers

Divers can take advantage of the reduced nitrogen content of an enriched nitrox mix, allowing them to benefit from longer no stop times than when breathing air (Nitrox 21).

Dive within the depth limit of the diver's experience or qualification

The diver's experience should always be progressive in terms of depth or type of dive. Divers crossing over from alternative agencies may have certification constraints, for example, a PADI Advanced Open Water Diver, depending on their selected specialties, is generally limited to a maximum operating depth of 30 metres until further training is conducted.



Oxygen Partial Pressures

This section covers some of the basic definitions for managing oxygen when diving at depth. It is aimed at providing an understanding of the rudimentary calculations that allow for safe diving with enriched nitrox.

Oxygen becomes increasingly toxic as the partial pressure of oxygen increases, and the BSAC has set a limit on the partial pressure of oxygen breathed. That limit is 1.4 bar, and this should be further reduced if exertion is planned during the dive.

Fraction of oxygen (FO_2) in mix

The fraction of oxygen in the mix is defined by a decimal representation of the final mix percentage for calculation requirements.

- **FO_2 = % divided by 100**
- **e.g. FO_2 of Nitrox 36 = 0.36**

Oxygen partial pressure (PO_2)

The notation for oxygen partial pressure varies between documents and agencies. Sometimes ppO_2 or ppO2 are used. Both are incorrect. Oxygen partial pressure is simply defined as:

- **PO_2 = FO_2 x absolute pressure**

  Oxygen partial pressure = Fraction of oxygen times absolute pressure.

Example - Nitrox 32 at 30 m

Given this information, the diver is able to calculate the oxygen partial pressure:

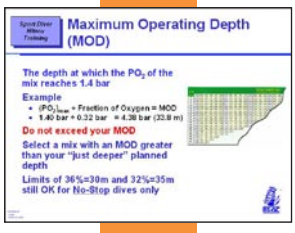
- **PO_2 = 0.32 x 4.0 bar = 1.28 bar**

Safety limit

Oxygen becomes toxic (poisonous) at high partial pressures. To reduce the risk of oxygen toxicity, there is a defined safe diving limit for decompression diving:

- **Maximum recommended PO_2 is 1.4 bar**

  This rule is relaxed for two standard mixes of Nitrox 32 and Nitrox 36 when executing a **no stop dive**. The maximum PO_2 of 1.44 bar is allowed.



Maximum Operating Depth (MOD)

The depth at which the PO_2 of the mix reaches 1.4 bar

The Maximum Operating Depth (MOD) of a nitrox mix is the depth at which the PO_2 limit is reached. The BSAC PO_2 limit is 1.4 bar for Sports Divers, but this may be further reduced if exertion is expected during the dive.

Example

Assuming that the diver continues with the chosen gas of Nitrox 32 from the previous example, to calculate the maximum operating depth, the diver can use the following formula:

- **(PO_2)max ÷ oxygen fraction = MOD**

  Substituting numbers for the words:

- **1.40 bar ÷ 0.32 bar = 4.38 bar (33.8 m)**

  The result of the calculation is an absolute pressure. To convert this into a depth it needs to be converted into a gauge pressure by subtracting 1 bar; and then multiplied by 10 to convert to metres.

Do not exceed your MOD

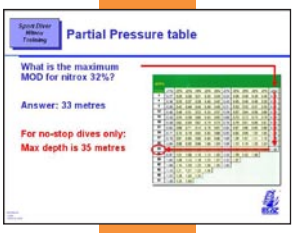
To avoid oxygen toxicity, BSAC Safe Diving recommends that the diver should not exceed the MOD of their chosen gas. The diver needs to bear this in mind when planning their "just deeper" alternative option.

Select a mix with an MOD greater than your "just deeper" planned depth

On the day, even the best laid plans sometimes go wrong and some degree of flexibility is required. For example, the planned dive turns out to be marginally deeper than expected. Selecting an MOD greater than the planned depth provides some additional flexibility if, for example, the diver is uncomfortable in the water and their buoyancy is not quite what it should be. The allowance enables them to safely complete the dive without fear of oxygen toxicity.

Limits of 36%=30m and 32%=35m still OK for No-Stop dives only

The standard mixes of Nitrox 32 and Nitrox 36, for no-stop diving, provide a calculated PO_2 of 1.44 bar. Although this exceeds the recommendation for decompression diving, i.e., 1.40 bar, this is allowable due to the no-stop diving constraint, which minimises the risk of encountering oxygen toxicity by limiting the time of exposure.



Partial Pressure table

To simplify and reduce the probability of a calculation error, the BSAC has provided a partial pressure look-up table in the back of the BSAC Nitrox Tables. The 'x' axis shows the percentage of oxygen in the mix in 1% increments starting with air (21%). The 'y' axis shows the depth in 3 metre intervals starting at 3 metres and aligns with the BSAC '88 and Nitrox tables.

The following example is used to illustrate the advantages of a table versus mathematical calculations.

What is the maximum MOD for nitrox 32%?

Identify 32% on the 'x' axis. To calculate MOD, the diver should not exceed a PO_2 of 1.4 bar. Move down the column looking for the number 1.40. The table stops at 1.38 bar, the next incremental depth increment of 3 metres would cause the PO_2 to exceed the maximum allowable of 1.40 bar. Moving across until the 'y' axis is intercepted, the following answer is obtained.

Answer: 33 metres

The calculated answer from the previous slide was 33.8 metres for an exact PO_2 of 1.40 bar. The table rounds down introducing a further safety factor, but above all keeps the process simple and less prone to mathematical errors. Using the waterproof 'BSAC Nitrox Tables' at a dive site, allows the diver to

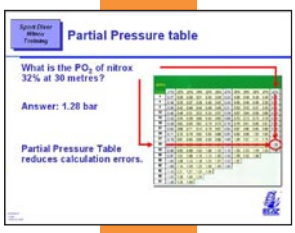
simply and quickly look up the MOD on the day.

For no-stop dives only:

If performing a no-stop dive on Nitrox 32, the divers are able to plan to a deeper maximum operating depth of 35 metres.

Max depth is 35 metres

Remind the students that a Nitrox 36 has a maximum operating depth of 30 metres for a no stop dive.



Partial Pressure table

This second example explains how the diver can obtain the partial pressure of oxygen at the target depth for a given mix from the partial pressure table.

What is the PO_2 of nitrox 32% at 30 metres?

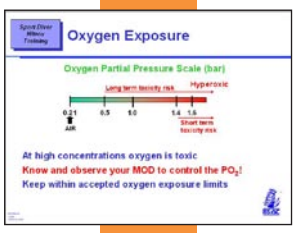
Along the 'x' axis, locate the 32% oxygen fraction column. On the 'y' axis, locate the depth of 30 metres. Locate in the table where the two columns intersect. This provides us with the required PO_2 in bar.

Answer: 1.28 bar

This answer is identical to the previously calculated value obtained.

Partial Pressure Table reduces calculation errors.

Overall, this is a very good way of finding PO_2. Knowing the PO_2 at the target depth beforehand prevents the diver accidentally exceeding the critical limit of 1.40 bar for the dive gas.



Oxygen Exposure

Oxygen has been discussed as being toxic in general terms. The topic will now be addressed in more detail highlighting just how much oxygen is too much.

Oxygen Toxicity is the main concern when nitrox diving and is the limiting factor for achievable depth.

Oxygen Partial Pressure Scale (bar)

The bar moves from normoxic oxygen levels to hyperoxic conditions. Hyperoxic conditions can be fatal.

At high concentrations oxygen is toxic

For safe diving the PO_2 is limited to 1.40 bar avoiding the more extreme exposures.

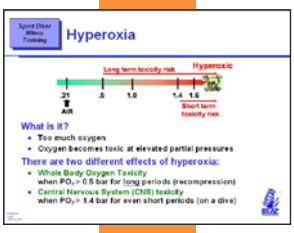
Know and observe your MOD to control the PO_2!

Exceeding the limits of human tolerance of oxygen can be life threatening. By planning properly and not exceeding the MOD the risk of oxygen toxicity can be managed. Divers need to understand what actions to take should they approach or exceed limits.

Keep within accepted oxygen exposure limits

Some consequences of elevated PO_2 are time dependent. Oxygen exposure tracking is therefore as important as planning decompression. Tolerance to CNS toxicity varies from individual to individual, and from day to day for the same person.

It is essential that divers measure the uptake of oxygen into the body, ensuring that they never exceed a PO_2 of 1.40 bar. Stay within the acceptable exposure times; these can be found in the NOAA Oxygen Exposure Limits Table (see page 24 in the nitrox tables).



Hyperoxia

The workshop will now focus on hyperoxia and specifically the practical situations that could lead to it when diving.

What is it?

- **Too much oxygen**

  Although any gas mixture containing a PO_2 in excess of 0.21 bar could be termed a hyperoxic mix, the effects do not become significant until the PO_2 approaches 0.5 bar.

- **Oxygen becomes toxic at elevated partial pressures**

  Basically, you can have too much of a good thing. The richer the mix the shallower the depth at which it becomes toxic.

  It is essential therefore that the increase in exposure of the body to oxygen is monitored, since above a certain PO_2 level; or after a certain time at a given PO_2 level, oxygen becomes toxic to the human body.

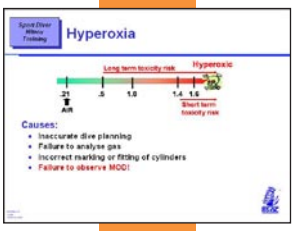
There are two different effects of hyperoxia:

- **Whole Body Oxygen Toxicity when PO_2 > 0.5 bar for <u>long</u> periods (recompression)**

  Whole body oxygen toxicity is also known as 'pulmonary toxicity dose' as it affects the lungs before other body parts. This is the long term effect of oxygen toxicity and the extent of exposure required for whole body toxicity to appear is longer than would be experienced during Sports Diving.

- **Central Nervous System (CNS) toxicity can occur when PO_2 > 1.4 bar for even short periods (on a dive)**

  Divers will be at a high risk of experiencing CNS toxicity if they exceed the Safe Diving recommendation of 1.40 bar. The maximum safe depth limit is considerably shallower than for air (21% O_2), and falls within the depth range of Sports Divers.



Hyperoxia

There following is a list of reasons why divers might breathe a hyperoxic mixture.

Causes:

- **Inaccurate dive planning**

  Safe diving should always start with accurate dive planning. Nitrox only

slightly increases the complexity of the dive plan, by requiring the diver to choose a suitable dive gas for the proposed dive; and then to work out the decompression requirements.

- **Failure to analyse gas**

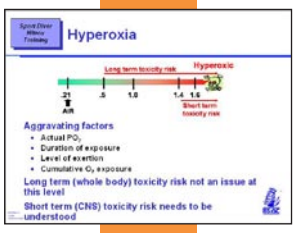
  There are many examples where the gas blender has failed to blend the gas accurately. One documented incident resulted in a diver entering the water with a pure oxygen mix. It is essential that divers witness an analysis of their own cylinder gas content.

- **Incorrect marking or fitting of cylinders**

  Divers can be very lazy and trust to memory or others that they have chosen or labelled a cylinder correctly. On many occasions, divers have dived on the wrong mixture or used inappropriate regulators. If unsure, perform or ask for an analysis and then correctly mark on the cylinder its contents and MOD.

- **Failure to observe MOD!**

  The MOD is there to protect the diver. Failure to observe the MOD could lead to CNS toxicity and a potential fatality.



Hyperoxia

Aggravating factors

- **Actual PO_2**

  The higher the PO_2, the greater the effect.

- **Duration of exposure**

  The longer the exposure, the more likely the onset of symptoms.

- **Level of exertion**

  The greater the diver's level of exertion, and hence carbon dioxide (CO_2) production, the greater the impact of a high PO_2. Evidence shows that a high PCO_2 predisposes towards oxygen toxicity.

- **Cumulative O_2 exposure**

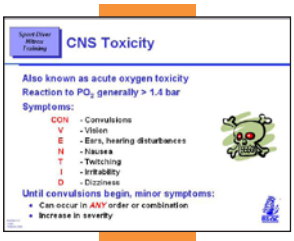
  The oxygen exposure from any dive will be additive to any residual exposure from previous dives.

Long term (whole body) toxicity risk not an issue at this level

The short dive durations experienced by Sports Divers preclude this from being a significant risk.

Short term (CNS) toxicity risk needs to be understood

The effects and how to practically manage CNS toxicity need to be fully understood by the Sports Diver.



CNS Toxicity

Also known as acute oxygen toxicity

CNS toxicity is also known as acute oxygen toxicity.

Reaction to PO_2 generally > 1.4 bar

While a PO_2 of 1.4 bar is generally accepted as a level below which the effects of CNS toxicity are unlikely to be experienced, as with many physiological effects of diving, it is not a precise threshold. An individual's tolerance will also vary day to day.

Symptoms:

The following is a useful mnemonic to remember the symptoms of CNS toxicity.

CON - Convulsions

V - Vision

E - Ears, hearing disturbances

N - Nausea

T - Twitching

I - Irritability

D - Dizziness

Stress that:

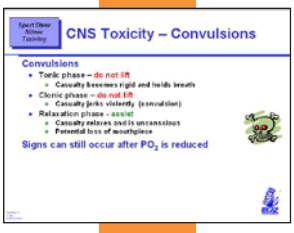
Until convulsions begin, minor symptoms:

There is no set progression through the more minor symptoms. They:

- **Can occur in *ANY* order or combination**
- **Increase in severity**

These minor symptoms are ones that only the diver affected may notice and some are similar to those experienced with other diving related conditions (e.g., narcosis). If a diver feels that something is wrong, then it could be! The dive should be aborted: it may save their life! Particular symptoms which have alerted some divers to a potential oxygen toxicity attack are narrow / tunnel vision and bright coloured spots appearing before the eyes. Facial twitching, particularly around the lips, is the one sign that buddies may observe.

Once convulsions begin however, a more recognisable pattern is seen.



CNS Toxicity – Convulsions

CNS convulsions are experienced at high partial pressures generally greater than 1.4 bar; but evidence has shown episodes to occur as low as 1.28 bar; and they can be experienced after long exposure to elevated partial pressure. Although the cause in human physiology is not fully understood the effects have been categorized as shown below:

Three phases *may* be apparent:

- **Tonic phase – do not lift**
    - **Casualty becomes rigid and holds breath**

      As the casualty will be holding their breath, an ascent could cause lung damage.

- **Clonic phase – do not lift**
    - **Casualty jerks violently (convulsion)**

      The casualty's movements can be extremely violent, therefore rescuers should, if practicable, remain clear of the casualty to avoid prejudicing their own safety.

- **Relaxation phase - assist**
    - **Casualty relaxes and is unconscious**

      Once the casualty has entered this phase is the time to act and bring them to the surface, as rescuers can assist without prejudicing their own safety or risking injury to the casualty during the ascent.
    - **Note: loss of regulator**

      As the casualty is unconscious there is a high probability that he/she will lose their mouthpiece.

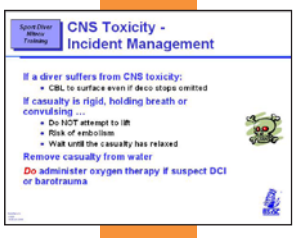
While the above description gives the 'classic' progression of signs and symptoms, the reality is that not all phases may be observed by a buddy or subsequently remembered by the casualty. Underwater, even if they do occur, the first phase may go unnoticed by buddies.

Evidence indicates that once they begin, convulsions progress through the above sequence of phases, which is subsequently repeated with increasing frequency.

Signs can still occur after PO_2 is reduced

Sometimes convulsions can continue after the casualty has been removed from breathing a high PO_2. This may be due to the casualty having been brought to the surface or after a dive, recognising the more minor symptoms, has bailed out to a lower PO_2 on open circuit.

The mechanism is not understood but divers, particularly rescuers, need to be aware that it can happen and be prepared to deal with it.



CNS Toxicity - Incident Management

If a diver suffers from CNS toxicity:

Provided the casualty is in the relaxation phase, perform a

- **CBL to surface even if deco stops omitted**

  Missing a few minutes has a low risk of DCI, especially when diving on nitrox. Discuss options during the planning phase, if the rescuer does not wish to lift the diver directly to the surface.

If casualty is rigid, holding breath or convulsing ...

If the casualty is in either the tonic or clonic phase,

- **Do NOT attempt to lift**
- **Risk of embolism**
- **Wait until the casualty has relaxed**

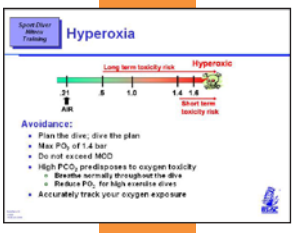
On reaching the surface,

Remove casualty from water

Use any additional resources to help with this exercise.

Do administer oxygen therapy if suspect DCI or barotrauma

If the diver convulses, remove from the oxygen source, and then reapply when the convulsion has finished.



Hyperoxia

Avoidance:

While the effects of oxygen toxicity can be quite dramatic, there are a few simple procedures that can effectively reduce the likelihood of them occurring:

- **Plan the dive; dive the plan**

  Always ensure that the fundamentals of good dive practices are performed.

- **Max PO_2 of 1.4 bar**

  Calculate the MOD using a PO_2 of 1.40 bar or less.

- **Do not exceed MOD**

  Monitor depth at all times.

- **High PCO_2 predisposes to oxygen toxicity**

  A high level of PCO_2 in the blood is known to reduce tolerance to high PO_2. Measures to counteract the impact of CO_2 are:

  - **Breathe normally throughout the dive**

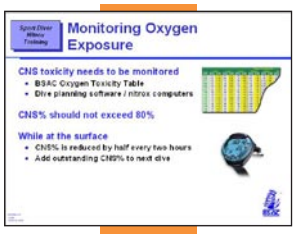
    Ensure that the lungs are properly ventilated by breathing normally at all times.

  - **Reduce PO_2 for high exercise dives**

    Where high levels of exercise are expected – such as swimming against a current – reduce depth if possible.

- **Accurately track your oxygen exposure**

  Monitor your CNS exposures for each dive and take them into account when planning the next dive.



Monitoring Oxygen Exposure

CNS toxicity needs to be monitored

During dive planning, use the NOAA Oxygen Exposure Limits table in the BSAC Nitrox Decompression Tables to check the Maximum Single Exposure, and Maximum 24 hour exposure. Oxygen uptake is measured, by the minute, at the maximum PO_2 the diver experiences.

A number of different systems are available to calculate the uptake of CNS:

- **BSAC Oxygen Toxicity Table**

  The BSAC Oxygen Toxicity Table provides data for the tracking of CNS toxicity uptake.

- **Dive planning software / nitrox computers**

  Computer based dive planning software will normally automatically compute CNS for each dive and, where appropriate, take account of previous dives.

CNS% should not exceed 80%

If a planned dive's CNS% reaches 80%, then a two hour break breathing air on the surface should be conducted.

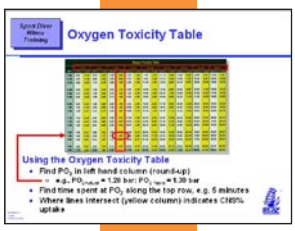
While at the surface

- **CNS% is reduced by half every two hours**

  For every two hours spent at the surface breathing air there is a reduction in the previous dive's CNS total of 50%.

- **Add outstanding CNS% to next dive**

  Residual CNS% is cumulative. The CNS% from the last dive should be added to the next dive taking into account the two hour decay model, unless 24 hours has elapsed between the dives.



Oxygen Toxicity Table

Using the Oxygen Toxicity Table

The oxygen toxicity table is a simple look-up table for calculating total CNS% for a dive.

- **Find PO_2 in left hand column (round-up)**

  Identify the PO_2 or the closest higher value from the left hand column.

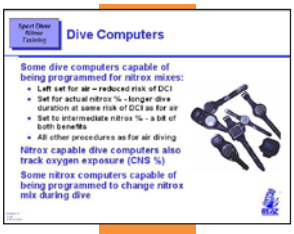
  - **e.g., $PO_{2Actual}$ = 1.28 bar; PO_2 Table = 1.30 bar**

- **Find time spent at PO_2 along the top row, e.g. 5 minutes**

  For exposure times not shown in the table, split the exposure into unit times shown above and add the indicated doses to find the total dose.

- **Where lines intersect (yellow column) indicates CNS% uptake**

  In this example, the CNS% value of 2.80% should be identified.



Dive Computers

Some dive computers capable of being programmed for nitrox mixes:

Many of the new dive computers or wrist watches can be programmed for up to 10 nitrox gas switches. Before using the nitrox functions, it is essential that the user has practiced and become familiar with the use of their own dive computer.

- **Left set for air – reduced risk of DCI**

  As per the Ocean Diver course, leaving the dive computer configured with an air mathematical model minimises the risk of the diver experiencing DCI.

- **Set for actual nitrox % - longer dive duration at same risk of DCI as for air**

  Programming the dive computer for the exact nitrox percentage enables the computer to adapt to the actual percentage of nitrogen in the mix. This extends the no-stop times over an air mathematical model, but if the diver extends their dive time beyond the no-stop time of the air mathematical model, they are placing themselves at a similar risk of DCI.

- **Set to intermediate nitrox % - a bit of both benefits**

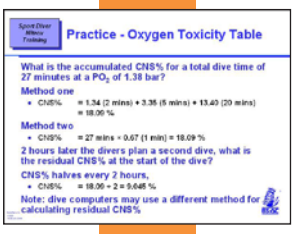
  Half way house. The user is reducing the probability of DCI while benefiting slightly from extended no-stop dive times over an air mathematical model.

- **All other procedures as for air diving**

  Other than programming for nitrox, the computer will still behave operationally and functionally as when it is configured to use an air mathematical model. Dive planning based on the computer should produce the adjusted times for nitrox. All other dive parameters and processes will remain unchanged.

Nitrox capable dive computers also track oxygen exposure (CNS %)

During the dive, the majority of nitrox enabled computers will display the actual CNS%.



Some nitrox computers capable of being programmed to change nitrox mix during dive

As new computers and updated models enter the sport diving market, new features are being added, including the facility for multiple gas switches. This is beyond the scope of this workshop.

Practice - Oxygen Toxicity Table

The following example is included to allow the students to have a practice at working with the BSAC Oxygen Toxicity Table.

What is the accumulated CNS% for a total dive time of 27 minutes at a PO_2 of 1.38 bar?

Ensure that the students have access to the oxygen toxicity table. Allow the students a few minutes to answer the question.

The slide demonstrates two different methods of using the table:

Method one

Using the oxygen toxicity table, split the total dive time of 27 minutes into manageable portions, for example, 2, 5 and 20 minutes then add together the resultant CNS% values.

- **CNS% = 1.34 (2 mins) + 3.35 (5 mins) + 13.40 (20 mins)**

  = 18.09 %

Method two

Identify 1 minute of CNS% at a PO_2 of 1.38 bar (rounding up to 1.4 bar) and then multiply by the total time.

- **CNS% = 27 mins × 0.67 (1 min) = 18.09 %**

Continuing the dive plan,

2 hours later the divers plan a second dive, what is the residual CNS% at the start of the dive?

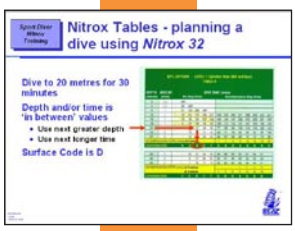
CNS% halves every 2 hours,

- **CNS% = 18.09 ÷ 2 = 9.045 %**

This value should then be added to the calculated CNS% for the next dive.

Note: dive computers may use a different method for calculating residual CNS%

The CNS% calculation varies depending on how the mathematical model has been implemented, so divers should observe subtle discrepancies in the calculated CNS%.



Nitrox Tables - planning a dive using *Nitrox* 32

The rules, procedures and definitions utilised in the BSAC NITROX decompression tables are identical to those used for the BSAC '88 Tables or vice versa, i.e.,

- No-stop diving.
- Decompression diving.
- Ascent rates.
- Dive profiles.
- Table procedures and usage.
- Altitude diving above level 1 is not catered for in the BSAC Nitrox Tables. However, the considerations regarding decompression and flying in aircraft before or after a dive remain the same.
- Recommended safe diving.

Establish that everyone in the class understands the basic definitions prior to working through the following example.

Dive to 20 metres for 30 minutes

Set the scene for the dive. The dive is to be performed on Nitrox 32. No previous dive history in the past 24 hours.

Depth and/or time is 'in between' values

Making use of the graphic, explain that the table increments in 3 metre intervals. For a depth of 20 metres, when planning dives, the diver should always err on the side of caution:

- **Use next greater depth**

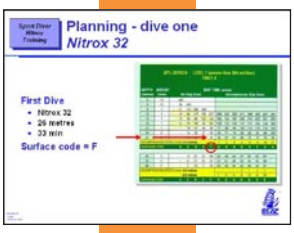
  21 metres is identified as the closest incremental depth for dive planning purposes.

- **Use next longer time**

  41 minutes is the closest and safest option to the dive plan of 30 minutes.

Surface Code is D

The intersection of 21 metres at 41 minutes then identifies the surfacing code as D.



Planning - dive one *Nitrox 32*

Using the BSAC Nitrox tables, work through the following example inviting student participation.

First Dive

Emphasise that there is no previous dive history in the past 24 hours.

- **Nitrox 32**

  The divers preferred nitrox mix.

- **26 metres**

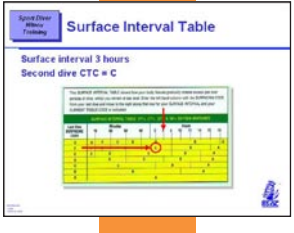
  On the graphic identify that the principle of next greater depth of 27 metres applies.

- **33 min**

  The next longest time of 34 minutes needs to be applied to identify the correct surfacing code.

Surface code = F

Allow the students an opportunity to find the surfacing code from their own copy of the dive tables.



Surface Interval Table

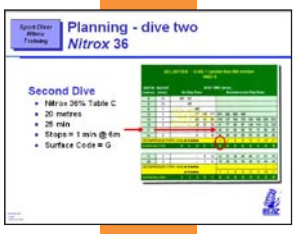
The example continues. Step through the processes involved to look up the correct surfacing code.

Surface interval 3 hours

Follow on from the first dive, where the divers had a surfacing code of F. Using the Surface Interval Table, highlight how to find the new surface code in preparation for dive two.

Second dive CTC = C

Allow the students an opportunity to find the new current tissue code from their own copy of the dive tables.



Planning - dive two *Nitrox* 36

Dive two in the sequence is planned to be executed on Nitrox 36.

Second Dive

- **Nitrox 36% Table C**

  The students should turn to 36% Oxygen – Level 1Table C in the nitrox tables.

- **20 metres**

  This is the maximum operating depth for the second dive.

- **25 min**

  This is the maximum dive time for the second dive.

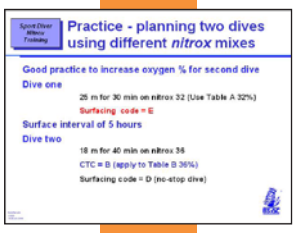
- **Stops = 1 min @ 6m**

  This is identified as a decompression dive requiring a mandatory decompression stop of 1 minute at 6 metres.

- **Surface Code = G**

  Allow the students an opportunity to find the surfacing code from their own copy of the dive tables.

The higher the percentage of oxygen in the nitrox mix, the lower the probability of a diver experiencing a DCI incident.



Practice - planning two dives using different *nitrox* mixes

Good practice to increase oxygen % for second dive

It is good practice to increase the oxygen in the mix for subsequent dives as this will help to reduce the risk of DCI:

- by minimising the cumulative effect of nitrogen diffusing into the already preloaded tissues
- and by maximising the pressure differential between the lungs and alveoli thereby increasing the rate of nitrogen off-gassing during the ascent phase.

Dive one

Emphasise that there is no previous dive history in the past 24 hours.

- **25 m for 30 min on nitrox 32 (Use Table A 32%)**

  Invite the students to identify the surfacing code for dive one. Once the group have achieved a consensus, reveal the answer.

- **Surfacing code = E**

  Check that all the students are all in agreement with the answer.

Surface interval of 5 hours

Invite the students to obtain the new surface code from the 'Surface Interval Table' as they will require this for dive two.

Dive two

- **18 m for 40 min on nitrox 36**

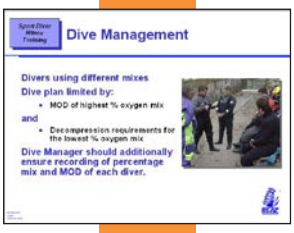
  The second dive requires the students to change nitrox tables and use the 36% Oxygen tables.

- **CTC = B (apply to Table B 36%)**

  Check that all the students agree with the answer and invite them to identify the new surface code for dive two.

- **Surfacing code = D (no-stop dive)**

  Check that all the students are all in agreement with the answer. Be prepared to work through an additional example.



Dive Management

Divers using different mixes

In an ideal world, the Dive Manager (formerly 'Dive Marshal') would pair divers using similar gas mixes. When this is inconvenient or impractical then the divers and Dive Manager need to consider the following:

Dive plan limited by:

- **MOD of highest % oxygen mix**

  The diver with the shallower MOD dictates the maximum depth of the dive.

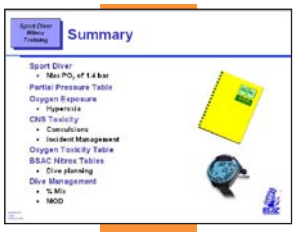
and

- **Decompression requirements for the lowest % oxygen mix**

  The diver with the most nitrogen in their cylinder mix drives the overall decompression plan. This diver has a higher susceptibility to DCI.

Dive Manager should additionally ensure recording of percentage mix and MOD of each diver.

Dive Manager on the day is responsible for the percentage mix and MOD being recorded on the Dive Manager's Slate. The diver should be pre-prepared to provide these specific details in addition to the agreed dive plan.



Summary

Reiterate the key points of the workshop using the Summary interactively as a means to check that the students have understood them.

Sports Diver

- **Max PO_2 of 1.4 bar**

Partial Pressure Table

Oxygen Exposure

- **Hyperoxia**

CNS Toxicity

- **Convulsions**
- **Incident Management**

Oxygen Toxicity Table

BSAC Nitrox Tables

- **Dive planning**

Dive Management

- **% Mix**
- **MOD**

Allow time for the students to ask questions.