3.7 Trimix Cave Diver: Open Circuit or Closed Circuit Rebreather Course

The purpose of the Trimix Cave Diver course is to provide the Cave Diver training for the safe planning and execution of mixed gas diving in caves to depths not exceeding 90 m/300 ft. The diver will be introduced to the proper and safe use of helium as a breathing gas, along with oxygen and nitrox for staged decompression. This course will emphasize precision and accuracy in all aspects of the dive beginning with advanced pre-dive planning. Safety will be a primary focus of this course due to the depths to which dives will be made.

3.7.1 Course Duration

Course duration shall be a minimum of four days.

3.7.2 Prerequisites

A. Minimum of 21 years of age.

B. NSS-CDS Cave Diver or the equivalent.

C. Minimum of 50 logged non-training cave dives after completion of Cave Diver.

D. Must be trimix certified from a recognized training agency or taking this course in conjunction with a trimix course.

E. Rebreather option: Must be qualified as a Normoxic Rebreather Diver, or if entering the Program based on equivalent experience, must be qualified as either open circuit Normoxic Trimix Diver or open circuit Trimix Diver or must be taking the Normoxic Rebreather Diver and Trimix Diver course on an approved Rebreather for mixed gas diving, with all dives other than confined water made on Trimix or Heliox. Note all Rebreather Trimix Divers must have completed the Normoxic Rebreather knowledge development program and skills.

F. Rebreather option: 50 hours of dive time, post rebreather certification is required on the specific Rebreather for which the diver is being trained.

3.7.3 Knowledge Development

Class presentation with a field exercises and pre-dive planning and briefing including the following topics:

A. Physics review

B. Physiology, including:

   1. Equivalent Narcosis Depth
   2. Hypoxia
   3. Hyperoxia

4. Pulmonary (Whole Body) and Central Nervous System Toxicity
5. Anoxia
6. Narcosis (nitrogen, oxygen and helium)
7. Decompression Sickness
8. Nitrogen and helium absorption and elimination
9. Helium and nitrogen "bends"
10. Carbon dioxide
11. Sources, effects and prevention
12. Contributing factor to DCS, oxygen toxicity and nitrogen narcosis
13. Carbon monoxide- sources and effects
14. Helium
15. Properties
16. HPNS
17. Effects on respiration
18. Effectiveness as an insulator/alternatives
19. Inert gas isobaric counter-diffusion
20. Comparative rate of absorption and elimination
21. Purpose of use
22. Gas consumption while breathing helium based gas mixtures
23. Hyperthermia
24. Hypothermia

C. Psychological aspects

D. Decompression gas options
   1. Oxygen
   2. Nitrox
   3. Air
   4. Helium

E. Equipment considerations
   1. Equipment marking
   2. Gas analyzers
   3. Travel gas

4. Regulator performance and helium mixes
5. Suit inflation options
6. Dual buoyancy requirements
7. Rigging/configuration
8. Redundancy

F. Dive computers, tables and available software

G. Dive planning
1. Dive plan
2. Contingency planning
3. Gas analysis and labeling
4. Gas requirements
5. Gas switches
6. Oxygen and decompression cylinder placement
7. Stage cylinder use, including gas contingency planning
8. Oxygen limits
9. Inert gas limits

H. Emergency procedures
1. Omitted decompression/DCS
2. Regulator and other equipment failure
3. Loss of gas
4. Nitrogen narcosis
5. Oxygen toxicity
6. Psychological aspects

I. Accident Analysis

J. Specific hazards of deep cave diving

K. Mixing and Blending (Optional)
1. Optimal mixes
2. Trimix, heliair and heliox
3. Hypoxic, normoxic and hyperoxic gas mixes
4. Blending options
5. Stratification

6. Gas boosting with oxygen and/or helium
7. Gas analysis
8. Cylinder top-offs and calculations

L. Rebreather option: For those who are already O/C Trimix Divers this class must include a confined water session and a minimum of 150 minutes of in water training time, using Trimix or Heliox, completed within at least two open-water or overhead- environment dives.

3.7.4 Land/Open Water Drills

Minimum of one open water dive during which designated drills will be conducted.

Prior to the execution of any cave dive, the student shall satisfactorily complete the following open water drills:

A. Swim a measured line for ten minutes in full equipment- including staged decompression and oxygen cylinders.

B. Execute a series of decompression and oxygen cylinder drops and retrievals along a measured line. This drill shall be performed both in good visibility conditions and in simulated zero visibility by use of a blacked out mask or other technique.

C. Initiate a gas share and swim a measured line in full equipment for a period of ten minutes.

D. Simulate an out of gas ascent from a depth of no greater than 18 m/60 ft with simulated decompression stops. Under no circumstance shall this drill be performed at a point that any diver in the team has accumulated required decompression.

E. Perform a timed valve shutdown. The diver should have the ability to complete this exercise in no more than 60 seconds.

3.7.5 Cave Dives and Skills

Minimum of one shallow (less than 40 m/130 ft) cave dive during which SAC and foot per minute travel rates are measured, cylinder drops and retrievals are executed and a gas share procedure is executed.

Minimum of three deep caves dives at a minimum of. All dives must have a minimum depth of 55 m/180 ft and a maximum depth of 90 m/300 ft. Each member of the dive team shall:

A. Prepare and precisely execute a dive plan.

B. Participate in a complete detailed pre-dive briefing.

C. Properly analyze and label all cylinders to be used for the dive.

D. Properly calculate gas turns based on pressure and volume of all team members.

E. Execute full and complete in-water pre-dive safety checks.

F. Demonstrate the ability to safely and efficiently execute oxygen and decompression cylinder drops and retrievals.

G. If stage cylinders are utilized, proper gas planning, cylinder drops and retrievals and contingency planning for cylinder placement for depths greater than the MOD of stage cylinder gas and gas use at higher than expected rates.

H. Demonstrate the ability to safely and efficiently execute required gas switches.

I. During the dive, demonstrate above-average execution of cave trim, technique and awareness.

J. At the conclusion of each dive, convey to the instructor a level of awareness and confidence consistent with the advanced nature of the dive.

No emergency drills shall be conducted at any time during the course of a deep cave dive and no equipment removal shall occur except for oxygen and decompression cylinders.

3.7.6 Equipment Requirements

In addition to all equipment required as a Cave Diver, the following:

A. Properly rigged and labeled decompression cylinder(s) of a minimum rated volume of 11 L/80 ft^3.

B. Properly rigged and cleaned oxygen cylinder(s) of a minimum rated volume of 5.5 L/40 ft^3.

C. Trimix computer and backup bottom timer/depth gauge and backup tables appropriate for the planned dive or two bottom timer/depth gauges and tables appropriate for the planned dive.

D. Spare mask.

E. Oxygen and helium gas analyzers (may be provided by instructor).

F. Text as prescribed by the NSS-CDS Deep Cave Diver Specialty Instructor.

G. Rebreather Option: The student being trained must own or have unlimited access to the rebreather on which they are being trained.

3.7.7 Limits of Training

A. Equivalent Narcosis Depth (END) shall not exceed 100-130 ft/ 30-39 m.

B. Pre-dive planning will provide for a PO_2 not to exceed 1.4 ATA for the working portion of the dive or 1.6 ATA for decompression purposes.

C. Minimum starting visibility shall be 6 m/20 ft.

D. Penetration shall be limited to not greater than one-third of doubles and one-third of stage cylinder(s) if used.

E. Maximum depth shall not exceed 90 m/300 ft.

F. One-third gas rule is the maximum rule for all cylinders- except for decompression cylinders- on all dives. This maximum rule may be reduced to less than one-third at the instructor's discretion. The dive plan shall provide for a 1.5 margin of reserve for decompression gas for the planned dives.

F. No equipment removal in cave except for decompression and stage cylinders.

G. No use of diver propulsion vehicles.

H. Rebreather option: (CCR) Inspired oxygen partial pressure may not exceed 1.3 PO_2 on a dive or 1.4 PO_2 on decompression. At 6 m/20 ft a flush to 1.6 may be used to check cell performance.

I. (CCR) If using a CCR dives must be conducted using an on board diluent mixture containing not more than 1.1 PO_2 .

3.7.8 Completion Requirements

A. Completion of all requirements of the NSS-CDS Deep Cave Diver course.

B. Completion of the NSS-CDS Deep Cave Diver written examination with a grade of 80% or higher.

C. During the course, demonstration of a high proficiency level in all phases of dive planning and execution.

D. Demonstration of a clear awareness and appreciation of the heightened level of risk involved in the activity of deep cave diving. A cavalier or otherwise disrespectful attitude is grounds for incompletion of this course.

E. Rebreather Option:

1. Perform Leak test
2. Perform Lost gas drill
3. Perform simulated bailout procedures with OC and buddy OC
4. Following a means of reference (pool wall, guideline, ship railing, etc.) with eyes closed, remove stage cylinders and swim a distance of at least 5 m/15 ft. Reverse direction, return to stage cylinders and replace them on correct sides, identifying each cylinder by feel.
5. Simulate the rescue of a diver. Tow the diver on the surface for a distance of at least 12 m/40 ft while simulating mouth-to-mouth resuscitation.
6. Ascend or swim laterally using bailout for at least 9 m/30 ft from a depth of at least 60 m/200 ft. Record time lapsed and gas used.
7. Perform SCR bailout for a minimum of ten minutes on at least one dive.
8. Exchange bailout cylinders or deploy long hose to a buddy on at least one dive.

Note: The NSS-CDS Deep Cave Instructor shall require rigorous precision and accuracy from the students at this level of training. Only those students who demonstrate high proficiency and awareness levels and the utmost respect for the deep cave environment will be issued a training completion card at this level.

3.7.9 Instructor Requirements

A. NSS-CDS Cave Instructor in current teaching status for a minimum of at least two years, have completed a minimum of eight (8) Cave courses, a minimum of six (6) TDI, IANTD or equivalent Advanced Trimix (or equivalent) courses and approved by the Training Chairman to teach the Deep Cave Diver Specialty Course.

B. IANTD or TDI Advanced Trimix Instructor or the equivalent.

C. Proof, either by logbook, referral by a current teaching status NSS-CDS Deep Cave Diver Instructor or approval on review of the Training Director, of a minimum of 50 cave dives to depths exceeding 60 m/200 ft, 20 of which shall have been to depths greater than 75 m/250 ft.

D. Final approval by the Training Director to teach this course based on approved Standards and Procedures requirements.

E. Maximum student to instructor ratios:

   1. Classroom: 6:1
   2. Open Water: 6:1
   3. Shallow cave drills: 3:1
   4. Deep cave dives: 3:1

F. When emergency drills are conducted, the instructor shall be within easy and manageable swimming distance of the students.

G. Instructor shall use cave configured equipment with double tanks and dual outlet manifold mandatory. Unless the rebreather option is being used. The instructor's gas supply- both as to quantity and content- in all cylinders, including decompression and stage cylinders, shall be consistent with that used by the students.

H. Instructor shall have a first aid kit and oxygen available for surface support.

I. Refer to Section 4 of Standards and Procedures for general procedures and requirements regarding NSS-CDS Specialty Instructor ratings.

J. Rebreather option: A Trimix Instructor or higher may teach this course.

To teach Rebreather Trimix, the Instructor must be a Trimix Rebreather Instructor or higher. The instructor may teach only the category Rebreather CCR, SCR, or PSCR their Trimix rebreather instructor qualification is on. Once qualified as a Rebreather Trimix Instructor, the instructor may use any rebreather they are at least diver-qualified on to teach Trimix Rebreather Diver programs. For example: A Rebreather Trimix Instructor who trained as a Rebreather Trimix Instructor on a CCR O_2ptima may teach a Trimix Diver-level course while using any other CCR that the instructor, at minimum, is diver- qualified on. The Rebreather Trimix Instructor may teach students on all rebreathers the Instructor is diver-qualified on, provided they are a Rebreather Trimix Instructor in that category; CCR, SCR.