32. Mixed Gas Closed Circuit Rebreather Diver, Unit Specific

*** Discovery MK VI / SE7EN / Se7en must be equipped with full 60 M upgrades, including 60M-emodule and counterlungs with manual addition valves**.

32.1 Introduction

This is the intermediate level certification course for divers wishing to utilize a closed circuit rebreather (CCR) for mixed gas diving. The objective of the course is to train divers in the benefits, hazards and proper procedures for mixed gas diving on the unit specific CCR, utilizing a mixed gas diluent containing 16 percent or greater oxygen, and to develop intermediate CCR diving skills appropriate to technical diving to a maximum depth of 60 metres / 200 feet.

32.2 Qualifications of Graduates

Upon successful completion of this course, graduates may engage in technical diving activities utilizing the unit specific CCR to a maximum of 60 metres / 200 feet, utilizing a mixed gas diluent containing 16 percent or greater oxygen provided:

1. The diving activities approximate those of training
2. The areas of activities approximate those of training
3. Environmental conditions approximate those of training

Upon successful completion of this course, graduates are qualified to enroll in:

1. TDI Advanced Mixed Gas Closed Circuit Rebreather Diver, unit specific.

32.3 Who May Teach

An active TDI Closed Circuit Rebreather Instructor, with a unit specific TDI Mixed Gas Instructor rating.

32.4 Student to Instructor Ratio

Academic

1. Unlimited, so long as adequate facility, supplies and time are provided to ensure comprehensive and complete training of subject matter

Confined Water (swimming pool-like conditions)

1. A maximum of 3 students per active TDI Instructor is allowed or 4 with a certified assistant

Open Water (ocean, lake, quarry, spring, river or estuary)

1. A maximum of 3 students per active TDI Instructor is allowed or 4 with a certified assistant
2. The ratio should be reduced as appropriate due to environmental or operational constraints

Special note; A certified assistant is a TDI Divemaster or equivalent from agencies recognized by TDI, with a mixed gas CCR user qualification and a minimum of 50 hours logged diving on the CCR being taught.

32.5 Student Prerequisites

1. Minimum age 18
2. Provide a verified log of a minimum of 50 rebreather hours distributed over a minimum of 50 dives on the specific rebreather. Valid logged dives must be deeper than 9 metres / 20 feet, half of which must be deeper than 20 metres / 66 feet. If the diver has 50 hours on another CCR unit recognized by TDI, only 25 hours are required to be on the specific unit
3. Have completed and qualified the TDI Air Diluent Decompression Procedures Rebreather/TDI CCR Helitrox Diluent Decompression Procedures Diver course or equivalent from agencies recognized by TDI

32.6 Course Structure and Duration

Open Water Execution

1. Minimum of 360 minutes open water training to be completed over a minimum of 6 dives including 1 equipment configuration and drills practice air diluent dive to a maximum 40 metres / 130 feet
2. All subsequent dives to build incrementally in no greater than 10 metres / 33 feet steps
3. A minimum of 5 dives must be conducted on mixed gas diluent.
4. All mixed gas dives are to be deeper than 40 metres / 130 feet, utilizing a mixed gas diluent containing 16 percent or greater oxygen, to a maximum depth of 60 metres/200 feet
5. A minimum of four dives must be decompression dives
6. In addition to meeting the course prerequisites, if the student is also qualified as a TDI Mixed Gas CCR Diver (any unit) or equivalent from agencies recognized by TDI then a minimum of 240 minutes open water training is required over a minimum of 4 mixed gas decompression dives to build incrementally in no greater than 15 metres / 50 feet steps.
7. In addition to meeting the course prerequisites, if the student is also qualified as a TDI Trimix Diver or equivalent from agencies recognized by TDI then a minimum of 240 minutes open water training is required over a minimum of 4 mixed gas decompression dives to build incrementally in no greater than 15 metres / 50 feet steps

Course Structure

1. TDI allows instructors to structure courses according to the number of students participating and their skill level
2. Oral examinations are permitted if the exam is not available in a language the student understands

Duration

1. Minimum of 6 hours for academic development and a further 2 hours for equipment configuration workshop

32.7 Administrative Requirements

The following is the administrative tasks:

1. Collect the course fees from all the students
2. Ensure that the students have the required equipment
3. Communicate the training schedule to the students
4. Have the students complete the:
    a. *TDI Liability Release and Express Assumption of Risk* Form
    b. *TDI Medical Statement* Form

Upon successful completion of the course the instructor must:

1. Issue the appropriate TDI certification by submitting the TDI Diver Registration Form to TDI Headquarters/Regional Office or registering the students online through member's area of the TDI website

32.8 Required Equipment

The following are required for this course:

1. TDI Diving Rebreathers Student Manual
2. *TDI CCR Preflight Checklist*
3. *TDI Diving Rebreathers* PowerPoint Presentation
4. Unit specific rebreather manual
5. Unit specific rebreather examination if required by the manufacturer
6. Manufacturer's Build Checklist
7. Manufacturer's manual and updates

The following equipment is required for each student:

1. A complete closed circuit rebreather configured within the manufacturers recommendations; this should be the student's personal unit
2. Minimum of 2 bottom timers and depth gauges or; 1 CCR mixed gas computer and 1 bottom timer and depth gauge
3. Bailout gas supply in a minimum of 2 separate off-board cylinders; calculated at 45.30 litres /1.06 cubic feet per minute usage to cover stress situations
4. Two open circuit regulators and gauges fitted to the configuration
5. Mask, fins and a suitable line-cutting device
6. Slate and pencil
7. Reel with a minimum of 60 metres / 200 feet of line
8. Reel with a minimum of 30 metres / 100 feet of line
9. Two lift bags / delayed surface marker buoys (DSMB's) with a minimum of 12 kg / 25 lbs lift
10. Exposure suit adequate for the open water environment where training will be conducted
11. Access to an oxygen analyzer
12. Access to a helium analyzer
13. Adequate weight

32.9 Required Subject Areas

The *TDI Diving Rebreathers* Student Manual is required for use as a review/recap document. The instructor may use any additional text or materials they feel will represent the topic in an educational manner. The following topics must be covered during the course:

1. Gas Physiology
    a. Oxygen (O_2) toxicity
    b. Hypoxia
    c. Nitrogen absorption
    d. Helium absorption
    e. HPNS
    f. Carbon dioxide (CO_2) toxicity
    g. Gas consumption
    h. Gas mixing
2. Formula Work
    a. Oxygen (O_2) metabolizing calculations
    b. Manually controlled closed circuit rebreathers
    c. Equivalent narcosis depth theory
    d. Central nervous system (CNS) tracking
    e. Oxygen tracking units (OTU)
    f. Gas management
3. Dive Tables.
    a. Creation of custom dive tables appropriate to dive depths
    b. Creation of lower percentage of oxygen (PO_2) diluent to support loop flushing and bailout at depth
4. Dive Computers.
    a. Mix adjustable
    b. Constant partial pressure of oxygen (PPO_2)
    c. Oxygen (O_2) integrated
5. Dive Planning
    a. Operational planning
        i. Gas requirements including bailout scenarios
        ii. Decompression on a CCR
        iii. Oxygen limitations
        iv. Nitrogen limitations
        v. Helium limitations
6. Equipment Maintenance
    a. Fuel cell management
        i. Date stamps
        ii. Replacement
    b. Loop configurations

c. Additional fitted equipment and modifications
    i. Auto diluent addition
    ii. Dual mode mouthpieces
    iii. Heads up display
    iv. Additional manual injectors
    v. Integrating oxygen monitors for dive computers

32.10 Required Skill Performance and Graduation Requirements

The following open water skills must be completed by the student during open water dives with the following course limits:

1. No dives deeper than 60 metres / 200 feet
2. No dives shallower than 40 meters / 130 feet, other than the 1 air diluent configuration dive are credited toward the dive requirements. Subsequent training dives in shallow water are permitted if necessary during the course.
3. Equivalent narcosis depth not to exceed 30 metres / 100 feet
4. Calculate all off-board gas at 45.30 litres /1.06 cubic feet per minute usage to cover stress situations
5. PO_2 not to exceed manufacturer recommendation or a working limit of 1.3 bar during the bottom phase of the dive and 1.4 bar during the decompression phase of the dive.
6. Diluent PO2 should not exceed 1.2 at maximum depth
7. All dives to be completed within appropriate fixed PO_2 decompression tables or decompression planning software
8. All dives to be completed within CNS percentage limits with a recommend maximum of 80 percent of the total PO_2 CNS limit
9. The student is only certified for CCR mixed gas diving on the rebreather being used

Land Drills

1. Build unit based on manufacturer's specifications using manufacturer's manual/build checklist
2. Demonstrate familiarity with basic and intermediate hand signals
3. Select and prepare equipment suitable for soft overhead environment with long decompression obligations
4. Conduct team oriented drills for lift bag deployment and bailout procedures
5. Drills for buddy rescue
6. Properly analyze all gas mixtures to be used
7. Demonstrate adequate pre-dive planning
    a. Limits based on system performance
    b. Limits based on bailout gas requirements
    c. Limits based on oxygen exposures at chosen PPO_2 levels
    d. Limits based on manually controlled closed circuit rebreathers
    e. Limits based on nitrogen absorption at planned depth and PPO_2 (set-point) level
    f. Limits based on helium absorption

g. Correct narcotic depth planning and diluent selection to allow cell flushing at target depth (diluent should not exceed a PO2 of 1.2 at maximum planned depth)

Pre-dive Drills

1. Conduct pre-dive checks using TDI Pre-flight checklist
2. Use START* before every dive
3. Stress analysis and mitigation

Open Water Skills:

1. Show good awareness of buddy and other team members through communications, proximity and team oriented dive practices
2. Demonstrate buoyancy control; ability to hover at fixed position in water column without moving hands or feet
3. Properly execute a recovery from a system failure and conclude the dive and decompression on open circuit gases carried
4. Properly execute a recovery from system failure and conclude the dive and decompression with the unit in manual mode
5. Gas shutdowns and loss of gas, correct choice and switching to off board gases
6. Broken hoses, catastrophic failure scenarios
7. Flooded absorbent canister
8. Cell errors
9. SCR drill (minimum of 10 minutes)
10. Oxygen rebreather mode in depths less than 6 metres / 20 feet
11. Stop at 3 to 6 metres / 10 to 20 feet on descent for leak bubble check
12. Demonstrate competence managing 2 bailout cylinders, including drop and recovery while maintaining position in the water column
13. Deployment of a lift bag / delayed surface marker buoy (DSMB) at depth and mid water
14. Simulate failed lift bag / DSMB deployment
15. On 2 of the dives, demonstrate an ascent with ascent reel and lift bag and perform staged decompression
16. Electronics systems monitoring for PPO_2 levels
17. Proper execution of the dive within all pre-determined dive limits
18. Demonstration of decompression stops at pre-determined depths
19. Demonstrate controlled ascent with toxed diver including surface tow at least 30 metres / 100 feet with equipment removal on surface, in water too deep to stand in

In order to complete the course and achieve the TDI Mixed Gas CCR rating the student must:

1. Complete to the instructors satisfaction all confined and open water skill development sessions
2. Demonstrate mature, sound judgment concerning dive planning and execution
3. Satisfactorily complete a written examination with a minimum score of 80 percent
4. Course must be completed within 6 weeks from the starting date
5. Complete a refresher course following a period of inactivity greater than 6 months following the course
6. course