



21. Mixed Gas Closed Circuit Rebreather Diver, Unit Specific- Inspiration / Evolution, KISS, Optima, Megalodon

21.1 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.

21.2 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.

21.3 Who May Teach

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

21.4 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 2 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 2 students per active TDI Instructor is allowed or 4 with a certified assistant
2. The ratio should be reduced as required 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.

21.5 Student Pre-Requisites

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; 50 percent deeper than 20 metres / 66 feet. All must be deeper than 9 metres / 20 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 course or equivalent from agencies recognized by TDI

21.6 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. Only 1 dive is on air diluent all others are to be mixed gas dives
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
5. Four dives must be decompression dives

Course Structure

1. TDI allows instructors to structure courses according to the number of students participating and their skill level
2. The final exam may be given orally if 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

Special note: If the diver is already open circuit trimix certified, 6 dives and 360 minutes is still required.

21.7 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 or registering the students online through member's area of the TDI website

21.8 Required Equipment

The following are required for this course:



1. *TDI Diving Rebreathers* Student Manual
2. Unit specific rebreather manual
3. *TDI Diving Rebreathers* PowerPoint Presentation
4. Manufacturer's manual and updates

The following equipment is required for each student:

1. A closed circuit rebreather; 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 oxygen clean 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

21.9 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 (O₂) toxicity
 - b. Hypoxia
 - c. Nitrogen absorption
 - d. Helium absorption
 - e. HPNS
 - f. Carbon dioxide (CO₂) toxicity
 - g. Gas consumption
 - h. Gas mixing
2. Formula Work
 - a. Oxygen (O₂) 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 (PO₂) diluent to support loop flushing and bailout at depth
- 4. Dive Computers.
 - a. Mix adjustable
 - b. Constant partial pressure of oxygen (PPO₂)
 - c. Oxygen (O₂) 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

Special note: If the TDI Trimix course is taught in conjunction all subject matter from both courses must be covered.

21.10 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
- 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. PO₂ 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. All dives to be completed within appropriate fixed PO₂ decompression tables
7. All dives to be completed within CNS percentage limits with a recommend maximum of 80 percent of the total PO₂ CNS limit
8. The student is only certified for CCR mixed gas diving on the rebreather being used

Open Water Skills:

1. Verify diluent and O₂ cylinder contents using O₂ analyzer where appropriate
2. Demonstrate correct pre dive planning procedures including:
 - a. Limits based on system performance
 - b. Limits based on oxygen exposures at chosen PPO₂ levels
 - c. Limits based on manually controlled closed circuit rebreathers
 - d. Limits based on nitrogen absorption at planned depth and PPO₂ (setpoint) level
 - e. Limits based on helium absorption
 - f. Correct narcotic depth planning and diluent selection to allow cell flushing at target depth
3. Properly execute a recovery from a system failure and conclude the dive and decompression on open circuit gases carried
4. Gas shutdowns and loss of gas, correct choice and switching to off board gases
5. Broken hoses, disaster scenarios
6. Flooded absorbent canister
7. Oxygen rebreather mode in depths less than 6 metres / 20 feet
8. Controlled use of BCD/suit for buoyancy control
9. Pre dive checks
10. Stop at 3 to 6 metres / 10 to 20 feet on descent for leak bubble check
11. Remove and replace side mounted stage cylinders under water
12. Deployment of a lift bag / delayed surface marker buoy (DSMB) at depth and mid water
13. Electronics systems monitoring for PPO₂ levels
14. Proper execution of the dive within all pre-determined dive limits
15. Demonstration of decompression stops at pre-determined depths
16. Post dive clean of unit to avoid contamination and spread of disease

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