



33. Advanced Mixed Gas Closed Circuit Rebreather Diver, Unit Specific

33.1 Introduction

This is the highest level certification course for divers wishing to utilize the unit specific closed circuit rebreather (CCR) for advanced mixed gas diving. The objective of the course is to train divers in the benefits, hazards and proper procedures for advanced mixed gas diving on a CCR and to develop advanced CCR diving skills appropriate to technical diving to a maximum depth of 100 metres / 330 feet.

*** Poseidon SE7EN must be equipped with full 100M upgrades, including 100M-emodule and counter-lungs with manual addition valves.**

33.2 Qualifications of Graduates

Upon successful completion of this course, graduates may engage in technical diving activities utilizing the unit specific CCR to a maximum depth of 100 metres / 330 feet utilizing any mixed gas diluent appropriate to the dive plan.

33.3 Who May Teach

An active TDI Instructor with a TDI unit specific advanced mixed gas CCR instructor rating

33.4 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 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 advanced mixed gas CCR user qualification and a minimum of 120 hours logged diving on the CCR being taught.

33.5 Student Prerequisites

1. Minimum age of 18
2. Certified TDI CCR Mixed Gas Diluent diver, or equivalent from agencies recognized by TDI

3. Have a verified log of a minimum of 100 hours as a certified CCR diver over a minimum of 100 dives; a minimum of 50 hours and 50 dives must be on the unit specific CCR. Fifty percent of these dives must be deeper than 30 metres / 100 feet All dives to be deeper than 9 metres / 20 feet

33.6 Course Structure and Duration

Open Water Execution:

1. Minimum of 420 minutes open water training to be completed over a minimum of 7 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 6 dives must be conducted on mixed gas diluent
4. All mixed gas dives are to be deeper than 40 metres / 130 feet
5. Five of the mixed gas dives must be decompression dives
6. In addition to meeting the course prerequisites, if the student is also qualified as a TDI Advanced Mixed Gas CCR Diver (any unit) or equivalent from agencies recognized by TDI then a minimum of only 240 minutes open water training is required over a minimum of 4 mixed gas decompression dives to build incrementally in no greater than 10 metres / 33 feet steps. Two dives must be deeper than 70 metres/ 230 feet
7. In addition to meeting the course prerequisites, if the student is also qualified as a TDI Advanced Trimix Diver or equivalent from agencies recognized by TDI then a minimum of only 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. The 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: The maximum depth when teaching this course in the UK or Ireland is 75 metres / 245 feet due to H.S.E. requirements.

33.7 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

33.8 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
5. Manufacturer's Build Checklist
6. *TDI CCR Preflight Checklist*

The following equipment is required for each student:

1. A complete unit specific CCR; 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 100 metres / 330 feet of line
8. Reel with a minimum of 50 metres / 165 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

33.9 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

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- 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 (out)
 - f. Gas management
3. Dive Tables
- a. Creation of custom dive tables appropriate to dive depths
 - b. Creation of lower percentage 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. Oxygen limitations
 - iii. Nitrogen limitations
 - iv. 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

33.10 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 100 metres / 330 feet
2. No dives shallower than 40 metres / 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 litres 45.30 / 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. Diluent PO₂ should not exceed 1.2 at maximum depth
7. All dives to be completed within appropriate fixed PO₂ 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 PO₂ CNS limit
9. The student is only certified for CCR mixed gas diving on the rebreather being used

Pre-dive Drills

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

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 gas switching procedure
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 PPO₂ levels
 - d. Limits based on manually controlled closed circuit rebreathers
 - e. Limits based on nitrogen absorption at planned depth and PPO₂ (setpoint) 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)

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 a 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



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6. Broken hoses, disaster 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. Manually control CCR Unit for one full dive including all decompression stops
 12. Demonstrate competence managing 3 bailout cylinders, including drop and recovery while maintaining position in the water column
 13. Demonstrate proper understanding and implementation of team bailout procedures and conduct a team bailout from a depth greater than 40 metres/130ft
 14. Demonstrate ability as a team to plug in and share off-board gas, including team sharing/swapping of off-board bailouts
 15. On 2 of the dives, demonstrate an ascent with ascent reel and lift bag and perform staged decompression
 16. Proper execution of the dive within all pre-determined dive limits
 17. Ability to manage multiple failures in adverse conditions
 18. Demonstrate of surface support/support divers in dealing with bailout scenarios

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

1. Complete to the instructor's 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