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

34.1 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 (or shallower if mandated by local law).

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

34.2 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.

34.3 Who May Teach

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

34.4 Student to Instructor Ratio

Academic:

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

Confined Water (swimming pool-like conditions):

1. N/A.

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

1. A maximum of 3 students per active TDI Instructor is allowed.
2. The ratio should be reduced as required due to environmental or operational constraints.

34.5 Student Prerequisites

1. Minimum age of 18.
2. Certified TDI CCR Mixed Gas Diluent diver, or equivalent from agencies recognized by TDI.
3. Provide proof of a minimum of 100 rebreather hours over a minimum of 100 dives; a minimum of 50 hours and 50 dives must be on the unit specific CCR. A minimum of 30 dives must be deeper than 30 Metres/100 Feet and a minimum of 10 logged mixed gas CCR dives, after mixed gas diver training, must be deeper than 50 metres/165 feet requiring staged decompression.

34.6 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 20 Metres/ 66 Feet.
2. A minimum of 6 dives must be conducted on mixed gas diluent.
3. All mixed gas dives are to be deeper than 40 Metres/130 Feet, two dives must be deeper than 75 Metres/245 Feet and one dive must be to at least 85 Metres/280 Feet.Five of the mixed gas dives must be decompression dives. Planned decompression obligation must not exceed 120 minutes. No more than 3 in-water sessions per day and no more than 2 mandatory decompression dives per day.

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.

Crossover:

1. If a student already qualified as a TDI Advanced Mixed Gas CCR Diver or equivalent wishes to qualify on another CCR recognized by TDI, the student must:
    a. Meet all crossover requirements for Air Diluent Deco or Helitrox Deco CCR.

b. All crossover requirements for Mixed Gas Diluent CCR.

c. Follow all unit specific course standards.

d. Meet all skill performance requirements.

2. The only changes during the unit crossover are:

   a. Minimum of 120 minutes open water training to be completed over a minimum of 2 dives to between 60 Metres/200 ft and 100 Metres/330 Feet (unless a shallower depth is required by local law).

   b. Must demonstrate proficiency in all required skills at the Advanced Mixed Gas diluent level.

34.7 Administrative Requirements

Administrative Tasks:

1. Collect the course fees from all the students.
2. Ensure that the students have the required equipment.
3. Communicate the 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. Download and retain student's dive logs of all training dives.
2. 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.

34.8 Training Material

Required Material:

1. *TDI Diving Rebreathers* Student Manual and Knowledge Quest or eLearning.
2. *TDI Advanced Trimix* student manual or eLearning.
3. *TDI Diving Rebreathers* PowerPoint presentation.
4. *TDI Advanced Trimix* Instructor Guide.
5. Unit specific rebreather manual and updates.

6.

7. Manufacturer's Build Checklist.
8. *TDI CCR Preflight* Checklist.

34.9 Required Equipment

The following equipment is required for each student:

1. A complete unit specific CCR; this should be the student's personal unit. Any modifications must be approved by the manufacturer.
2. Minimum of 1 CCR mixed gas computer and 1 backup OC/CCR computer for bailout in the event of a system failure.
3. Bailout gas cylinders (minimum 3) with the appropriate capacity for the planned dive, each equipped with a first and second stage and SPG.
4. Mask, backup mask, fins and a suitable line-cutting device.
5. Slate and pencil.
6. Reel or spool with a minimum of 100 Metres/330 Feet of line.
7. Reel with a minimum of 50 Metres/165 Feet of line.
8. Two lift bags/delayed surface marker buoys (DSMB's) with adequate lift and size for the dive environment.
9. Exposure suit adequate for the open water environment where training will be conducted.
10. Access to an oxygen analyzer.
11. Access to a helium analyzer.
12. Adequate weight.

Note: Instructor and students must all be on the same rebreather type (eCCR or mCCR) and no more than 3 different units of the same type on a given training dive.

34.10 Required Subject Areas

The TDI Diving Rebreathers Student Manual or eLearning 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.
i. Gas Density

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 (out).
    f. Gas management.
3. Dive Tables:
    a. Creation of custom dive tables appropriate to dive depths.
    b. Creation of lower percentage 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. Decompression conservatism/Gradient factor selection.
    d. Oxygen (O_2) integrated.
5. Dive Planning:
    a. Operational planning.
    b. Scrubber duration.
    c. Gas requirements including bailout scenarios, gas management and gas consumption.

   d. Diving in mixed teams.
6. Decompression on a CCR:
   a. Oxygen limitations.
   b. Nitrogen limitations.
   c. Helium limitations.
7. 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 /bail out valves.
      iii. Heads up display.
      iv. Additional manual injectors.
      v. Integrating oxygen monitors for dive computers.
8. Team Diving Considerations:
   a. Purpose of dive
   b. Use of pre-dive checklists
   c. Buddy checks
   d. Dive planning and setpoints
   e. Bailout scenarios

34.11 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. Calculate bailout gas at 50 litres /1.8 cubic Feet per minute usage for bottom mix and ascent phase including the first 10 minutes of decompression, and at 25 litres/0.9 cubic Feet per minute for decompression gas(ses) after the end of the first decompression stop.
4. Breathing gas limits:
    a. Maximum planned PO2 setpoint not to exceed 1.3 bar.
    b. Maximum breathing loop PO2 of 1.4 bar except at 6m/20 ft or less for a maximum of two minutes
    c. Open circuit bailout not to exceed a PO2 of 1.6 bar at the maximum depth of the dive, and a minimum of 5% oxygen.
    d. Onboard diluent not to exceed a PO2 of 1.1 bar at the maximum depth of the dive.
    e. Equivalent narcotic depth not to exceed 30 metres/100 ft.
    f. Breathing gas density of less than 6.3 g/l.
5. All dives to be completed within appropriate fixed PO_2 decompression tables or decompression planning software.
6. All dives to be completed within CNS percentage limits with a recommend maximum of 80 percent of the total PO_2 CNS limit.
7. Students to log all dives at the end of each diving day.

Pre-dive Drills:

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

* START is S-drill (OOA drill and Bubble Check), Team (buddy equipment checks), Air (gas matching), Route (entry/exit and planned path underwater), Tables (depth, duration, waypoints, and schedule).

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 and scrubber duration.
    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 (setpoint) level.
    f. Limits based on helium absorption.
    g. Appropriate selection of decompression conservatism/gradient factors for the planned dive.
    h. Correct narcotic depth planning and diluent selection to allow cell flushing at target depth (diluent should not exceed a PO_2 of 1.1 at maximum planned depth).

Open Water Skills

1. All skills must be demonstrated by the instructor on the unit specific CCR.
2. Show good awareness of buddy and other team members through communications, proximity, and team-oriented dive practices.
3. Demonstrate buoyancy control; ability to hover at fixed position (±1m/3ft) in water column for at least 90 seconds without moving hands or feet.
4. Mask removal and replacement/deploy backup mask while maintaining neutral buoyancy.
5. Properly execute a recovery from a system failure and conclude the dive and decompression on open circuit gases carried.
6. Properly execute a recovery from a system failure and conclude the dive and decompression with the unit in manual mode.
7. Gas shutdowns and loss of gas, correct choice and switching to off board gases.
8. Broken hoses, disaster scenarios.

9. Flooded absorbent canister.
10. Cell errors.
11. SCR drill (minimum of 10 minutes).
12. Oxygen rebreather mode in depths less than 6 Metres/20 Feet.
13. Manually control CCR Unit for one full dive including all decompression stops.
14. Demonstrate competence managing 3 bailout cylinders, including drop and recovery while maintaining position in the water column.
15. Demonstrate proper understanding and implementation of team bailout procedures and conduct a team bailout from a depth greater than 40 Metres/130ft.
16. Demonstrate ability as a team to plug in and share off-board gas, including team sharing/swapping of off-board bailouts.
17. On 2 of the dives, demonstrate an ascent with ascent reel and lift bag and perform staged decompression.
18. Cell validation checks with appropriate use of diluent and oxygen.
19. Proper execution of the dive within all pre-determined dive limits.
20. Ability to manage multiple failures in adverse conditions.
21. Demonstrate use of surface support/support divers in dealing with bailout scenarios.

Demonstrate simulated rescue of a non-responsive rebreather diver to the surface from a depth of at least 6 metres/20 feet.

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 the TDI Advanced Trimix written examination with a minimum score of 80 percent.
4. Complete a refresher course following a period of inactivity greater than 6 months following the course.