

## 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 facility, 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. 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 and a minimum of 20 logged CCR dives requiring staged decompression. All dives to be deeper than 9 metres / 20 feet

### 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 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, and two dives should be deeper than 70 metres/230 feet.
5. Five of the mixed gas dives must be decompression dives. Planned decompression obligation for the first three decompression dives must not exceed 30 minutes and for subsequent decompression dives must not exceed 60 minutes. At least one dive must have a total run time longer than 60 minutes.

#### 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 TDI Advanced Mixed Gas Diluent CCR Diver or equivalent from agencies recognized by TDI and wishes to qualify on another CCR recognized by TDI, the student must meet all crossover requirements for Air Diluent Deco or Helitrox Deco CCR as well as all crossover requirements for Mixed Gas Diluent CCR and follow all unit specific course standards with the exception of:
  - a. Minimum of 120 minutes open water training to be completed over a minimum of 2 dives to a maximum of 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****The following are 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. 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 Required Equipment****The following are required for this course:**

1. *TDI Diving Rebreathers* Student Manual or eLearning
2. *TDI Advanced Trimix* student manual or eLearning
3. *TDI Diving Rebreathers* Instructor Guide
4. *TDI Advanced Trimix* Instructor Guide
5. Unit specific rebreather manual
6. *TDI Diving Rebreathers* PowerPoint Presentation
7. Manufacturer's manual and updates
8. Manufacturer's Build Checklist
9. *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. 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

### 34.9 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<sub>2</sub>) toxicity
  - b. Hypoxia
  - c. Nitrogen absorption
  - d. Helium absorption
  - e. HPNS
  - f. Carbon dioxide (CO<sub>2</sub>) toxicity
  - g. Gas consumption
  - h. Gas mixing
2. Formula Work
  - a. Oxygen (O<sub>2</sub>) 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<sub>2</sub>) diluent to support loop flushing and bailout at depth
4. Dive Computers
  - a. Mix adjustable
  - b. Constant partial pressure of oxygen (PPO<sub>2</sub>)
  - c. Decompression conservatism/Gradient factor selection
  - d. Oxygen (O<sub>2</sub>) integrated
5. Dive Planning
  - a. Operational planning.
  - b. Scrubber duration
  - c. Gas requirements including bailout scenarios , gas management and gas consumption
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

### 34.10 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 bailout gas at 45 litres /1.6 cubic feet per minute usage for bottom mix and at 30 liters/1.1 cubic feet per minute for decompression gas(es)
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  $PO_2$  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

### 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 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 1.2 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 in water column without moving hands or feet
4. Properly execute a recovery from a system failure and conclude the dive and decompression on open circuit gases carried
5. Properly execute a recovery from a system failure and conclude the dive and decompression with the unit in manual mode
6. Gas shutdowns and loss of gas, correct choice and switching to off board gases
7. Broken hoses, disaster scenarios
8. Flooded absorbent canister
9. Cell errors
10. SCR drill (minimum of 10 minutes)
11. Oxygen rebreather mode in depths less than 6 metres / 20 feet
12. Manually control CCR Unit for one full dive including all decompression stops
13. Demonstrate competence managing 3 bailout cylinders, including drop and recovery while maintaining position in the water column
14. Demonstrate proper understanding and implementation of team bailout procedures and conduct a team bailout from a depth greater than 40 metres/130ft
15. Demonstrate ability as a team to plug in and share off-board gas, including team sharing/swapping of off-board bailouts
16. On 2 of the dives, demonstrate an ascent with ascent reel and lift bag and perform staged decompression
17. Cell validation checks with appropriate use of diluent and oxygen
18. Proper execution of the dive within all pre-determined dive limits
19. Ability to manage multiple failures in adverse conditions
20. Demonstrate use of surface support/support divers in dealing with bailout scenarios
21. Demonstrate controlled ascent with simulated toxed diver including surface tow at least 50 metres / 165 feet with equipment removal on surface, in water too deep to stand in

**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. 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