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## **19. TDI – Advanced Mixed Gas Closed Circuit Rebreather, Unit Specific- Inspiration / Evolution, Optima, Megalodon**

### **19.1 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 of three hundred thirty (330) fsw / one hundred (100) msw.

### **19.2 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 three hundred thirty (330) fsw / one hundred (100) msw utilizing any mixed gas diluent appropriate to the dive plan.

### **19.3 Who May Teach**

Who may teach this course:

1. An active TDI Instructor with a TDI unit specific Advanced Mixed Gas CCR Instructor rating.
2. A “certified assistant” is a SDI 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.

### **19.4 Student – Instructor Ratio**

Academic:

1. Unlimited, so long as adequate facility, supplies and time are provided to insure comprehensive and complete training.

Confined Water (Swimming pool-like conditions):

1. A maximum of two (2) students per active TDI Instructor is allowed or four (4) with a certified assistant (see above; who may teach).

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

1. A maximum of two (2) students per active TDI Instructor is allowed or four (4) with a certified assistant (see above; who may teach).
2. The ratio should be reduced as required due to environmental or operational constraints



## **19.5 Student Pre-Requisites**

The student must:

1. Be a minimum age of eighteen (18).
2. Have a verified log of a minimum of one hundred (100) CCR hours distributed over a minimum of one hundred (100) dives on the unit specific CCR. Fifty (50) % of these dives must be deeper than one hundred (100) fsw / thirty (30) msw. All to be deeper than twenty (30) fsw / nine (9) msw. If the diver has one hundred (100) hours on another CCR unit recognized by TDI, only fifty (50) hours are required to be on the Inspiration / Evolution.
3. Have completed and qualified the TDI Air Diluent CCR Course or equivalent from agencies recognized by TDI.

## **19.6 Course Structure and Duration**

Open Water Execution:

1. Minimum of four hundred twenty (420) minutes open water training to be completed over a minimum of seven (7) dives including one (1) equipment configuration and drills practice air diluent dive to a maximum one hundred thirty (130) fsw / forty (40) msw.
2. All subsequent dives to build incrementally in no greater than thirty three (33) fsw / ten (10) msw steps.
3. Only one (1) dive is on air diluent all others are to be mixed gas dives.
4. All mixed gas dives are to be deeper than one hundred thirty (130) fsw / forty (40) msw.
5. Five (5) of the mixed gas dives must be decompression dives.
6. If the student is qualified as a TDI Mixed Gas CCR Diver or equivalent from agencies recognized by TDI then a minimum of two hundred forty (240) minutes open water training is to be completed over a minimum of four (4) mixed gas decompression dives to build incrementally in no greater than thirty three (33) fsw / ten (10) msw steps two dives must be deeper than seventy (70) msw / two hundred thirty (230) fsw.
7. Or if the student is qualified as a TDI Advanced Trimix Diver or equivalent from agencies recognized by TDI then a minimum of two hundred forty (240) minutes open water training is to be completed over a minimum of four (4) mixed gas decompression dives to build incrementally in no greater than fifty (50) fsw / fifteen (15) msw 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 six (6) hours for academic development and a further two (2) hours for equipment configuration workshop.

**Special note;** The maximum depth when teaching this course in the UK or Ireland is seventy five (75) msw due to H.S.E. requirements.



## **19.7 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 Liability Release and Medical history forms.
5. The Instructor must review the Liability Release and Medical Forms before starting on the course.

Upon successful completion of the course the Instructor must:

1. Complete the Student Registration Form and send the Registration Form to TDI HQ.
2. Award card and certificate.

## **19.8 Required Equipment**

The following are required for this course:

1. TDI unit specific Rebreather Manual.
2. TDI Slide Set.
3. Manufactures' Manual & Updates.

The following equipment is required for each student:

1. A complete unit specific CCR. This should be the students own unit.
2. Minimum of two (2) bottom timers and depth gauges or one (1) CCR mixed gas computer & one (1) bottom timer and depth gauge.
3. Bailout gas supply in a minimum of two (2) separate off-board oxygen clean cylinders. Calculated at 30 litres (1.06 cubic feet) per minute usage to cover stress situations.
4. Two (2) open circuit regulators and gauges fitted to the configuration.
5. Mask, fins & a suitable line-cutting device.
6. Slate & pencil.
7. Reel with a minimum of three hundred thirty (330) fsw / one hundred (100) msw of line.
8. Reel with a minimum of one hundred sixty five (165) fsw / fifty (50) msw of line.
9. Two (2) Lift Bags / Delayed Surface Marker Buoys (DSMB's) with a minimum of twenty five (25) lb / twelve (12) kg 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.

## **19.9 Required Subject Areas**

The TDI Rebreather 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 toxicity.



- B. Hypoxia
  - C. Nitrogen absorption.
  - D. Helium absorption.
  - E. HPNS
  - F. CO<sub>2</sub> toxicity.
  - G. Gas consumption.
  - H. Gas mixing.
2. Formula Work.
- A. O<sub>2</sub> metabolizing calculations.
  - B. Manually controlled closed circuit rebreathers
  - C. Equivalent Narcosis Depth theory.
  - D. CNS tracking.
  - E. OTU Tracking.
  - F. Gas management.
3. Dive Tables.
- A. Creation of custom dive tables appropriate to dive depths.
  - B. Creation of lower PO<sub>2</sub> diluent to support loop flushing and bailout at depth.
4. Dive Computers.
- A. Mix adjustable.
  - B. Constant PPO<sub>2</sub>.
  - C. O<sub>2</sub> 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. Head Up Display.
    - IV. Additional Manual Injectors.
    - V. Integrating Oxygen Monitors for Dive Computers.

## **19.10 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 one hundred (100) msw
- 2. No dives shallower than one hundred thirty one (131) fsw / forty (40) msw other than the one (1) air diluent configuration dive.



3. Equivalent narcosis depth not to exceed one hundred (100) fsw / thirty (30) msw.
4. Calculate all off-board gas at 30 litres (1.06 cubic feet) per minute usage to cover stress situations.
5. PO<sub>2</sub> 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 PO<sub>2</sub> decompression tables.
7. All dives to be completed within CNS% limits with a recommend maximum of eighty (80) % of the total PO<sub>2</sub> 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 O<sub>2</sub> cylinder contents using O<sub>2</sub> 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 PPO<sub>2</sub> levels.
  - C. Limits based on manually controlled closed circuit rebreathers
  - D. Limits based on nitrogen absorption at planned depth and PPO<sub>2</sub> (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 shallower than twenty (20) fsw / six (6) msw.
8. Controlled use of BC/suit for buoyancy control.
9. Pre dive checks.
10. Stop at ten to twenty (10 – 20) fsw / three to six (3-6) msw 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 PPO<sub>2</sub> 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 unit specific TDI Advanced 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 pass mark of greater than eighty (80) %.
4. Course must be completed within six (6) weeks from the starting date.
5. Complete a refresher course following a period of inactivity greater than six (6) months following the course.