

30. Air Diluent Closed Circuit Rebreather Diver, Unit Specific

30.1 Introduction

This is the entry level certification course for divers wishing to utilize a closed circuit rebreather (CCR) for air diving. The objective of the course is to train divers in the benefits, hazards and proper procedures for diving a CCR and to develop basic CCR diving skills to a maximum depth of 30 metres / 100 feet, using air as a diluent. No decompression diving is allowed on this course

30.2 Qualifications of Graduates

Upon successful completion of this course, graduates may:

1. Engage in diving activities utilizing the CCR to a maximum depth of 30 metres / 100 feet, utilizing air as a diluent

30.3 Who May Teach

1. An active TDI Instructor with a TDI Air Diluent CCR Instructor rating on the specific unit being used

30.4 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, One additional student may be added if they are doing a refresher or unit crossover.

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

1. A maximum of 3 students per active TDI Instructor. One additional student may be added if they are doing a refresher or unit crossover.
2. The ratio should be reduced as required due to environmental or operational constraints

Note: A certified assistant is an SDI and/or TDI Divemaster or equivalent from agencies recognized by TDI, with an air diluent CCR user qualification and a minimum of 30 hours logged diving on the CCR being taught

30.5 Student Prerequisites

1. Minimum age 18
2. Provide proof of 20 logged open water dives. If completing a unit crossover, provide proof of 10 logged CCR dives in the last 12 months.
3. Provide proof as a TDI Nitrox Diver or equivalent from agencies recognized by TDI*
4. If the rebreather is a TDI approved sidemount rebreather, the student must hold the TDI Sidemount Diver certification or equivalent, provide proof of 10 logged sidemount dives, and any additional requirements the sidemount rebreather manufacturer may have.

Note: Nitrox diver and/or Advanced Nitrox diver may be combined with this course

30.6 Course Structure and Duration

Confined Water Execution:

1. Minimum of 60 minutes confined water training to a maximum of 9 metres / 30 feet

Open Water Execution

1. Equipment configuration session, confined water session, and 50 metre fully-equipped CCR diver surface tow must be completed prior to open water training dives
2. Minimum of 420 minutes open water training to be completed over a minimum of 7 dives with a gradual increase in depth each day to a maximum of 30 metres/100 feet

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 academic development and 2 hours equipment maintenance workshop
2. The duration of the entire course must take a minimum of 5 days

Crossover: If a student already qualified as a TDI Air Diluent CCR Diver or equivalent wishes to qualify on another CCR recognized by TDI, the student must follow all unit specific course standards and meet all skill performance requirements. The only changes during the unit crossover are:

1. Minimum of 60 minutes confined water training to a maximum of 9 metres / 30 feet
2. Minimum of 240 minutes open water training to be completed over a minimum of 4 dives to a maximum depth of 30 metres / 100 feet
3. If a student already is qualified as a Kiss Spirit air diluent diver and is crossing over to the Sidewinder, the student must complete an academic session covering unit build, hose routing, donning and doffing, and a minimum of 180 minutes open water training over a minimum of 3 dives.

30.7 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 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

30.8 Training Materials

The following are required for this course:

1. *TDI Diving Rebreathers Student Manual*
2. *TDI Diving Rebreathers Instructor Guide*
3. *TDI Diving Rebreathers PowerPoint Presentation*
4. Manufacturer's manual and updates
5. Manufacturer's Build Checklist
6. *TDI CCR Preflight Checklist*
7. *Rebreather course evaluation form* (see appendix)
8. Manufacturer's minimum training standards and any additional course forms required by the manufacturer

Optional

Mel Clark- *Rebreathers Simplified*

30.9 Required Equipment

The following equipment is required for each student:

1. A complete closed circuit rebreather . Any modifications to the unit must be approved by the manufacturer
2. Minimum of 1 CCR dive computer, or bottom timer and depth gauge
3. Mask, fins and a suitable line-cutting device
4. Slate and pencil
5. Reel with a minimum of 40 metres / 130 feet of line
6. Lift-bag / delayed surface marker buoy (DSMB) with adequate lift and size for the dive environment
7. Exposure suit appropriate for the open water environment where training will be conducted
8. Access to an oxygen analyzer
9. Appropriate weight
10. Bailout gas supply (and an externally carried redundant air source).

Note: The instructor and any certified assistant must also carry a bailout gas supply for the student(s) during all open water sessions. This redundant gas source must be greater than the instructor and any certified assistant's rebreather requirement

30.10 Required Subject Areas

The *TDI Diving Rebreathers Student Manual* or eLearning and the manufacturer's manual are mandatory for use during this course but instructors may use any additional text or materials that they feel help present these topics. The following topics must be covered during the course:

1. History and Evolution of Rebreathers
2. Comparison of Open Circuit, Closed Circuit and Semi Closed Circuit Rebreather Systems and the Benefits/Problems with Each
3. Practical Mechanics of the System
 - a. Assembly and disassembly of the CCR
 - b. Layout and design of the unit
 - c. Absorbent canister design and maintenance
 - d. Breathing loop de-contamination procedures
 - e. Manufacturer supported additional items:bailout valve, automatic diluent valve, etc
 - f. Loop volume – minimum/optimum
4. Gas Physiology
 - a. Oxygen (O₂) risks: Hyperoxia, Toxicity, Hypoxia
 - b. Nitrogen absorption
 - c. Carbon dioxide (CO₂) toxicity, Hypercapnia

5. Proper Scrubber Packing; in accordance with manufacturer's recommendation
 - a. Gas consumption
6. Electronic or Manual Systems Design and Maintenance
 - a. Oxygen (O₂) metabolizing calculations
 - b. Fuel cells
 - c. System electronics functionality and calibration procedures
7. Dive Tables
 - a. Constant partial pressure of oxygen (PPO₂) theory
 - b. Central nervous system (CNS) and awareness of oxygen tracking units (OTU) tracking
8. Dive Computers
 - a. Mix adjustable
 - b. Constant PO₂
 - c. Oxygen (O₂) integrated
 - d. Decompression conservatism/Gradient factor selection
9. Dive Planning
 - a. Operational planning
 - b. Gas requirements including bailout scenarios
 - c. Scrubber duration
 - d. Oxygen limitations
 - e. Nitrogen limitations
10. Emergency Procedures
 - a. Use of B.A.D.- D.A.S. – Bail out, Anxiety breaths, Decide – Diluent flush, Always know your PO₂, Skills to overcome problem
 - b. Three H's problems
 - c. Flooded loop
 - d. Cell warnings
 - e. Battery warnings and electronic failures

30.11 Required Skill Performance and Graduation Requirements

All standards set by both TDI and the rebreather manufacturer must be met, while maximum limits of neither may be exceeded.

The following open water skills must be completed by the student during open-water dives with the following course limits:

1. All skills must be demonstrated by the instructor on the unit-specific CCR
2. All open water dives must be between 9 metres / 30 feet and 30 metres / 100 feet
3. Two dives must be deeper than 20 metres / 60 feet and one dive must be deeper than 27 metres / 90 feet
4. Satisfactorily complete any additional skills required by the unit specific manufacturer.
5. PO₂ not to exceed manufacturer recommendation or a working limit of 1.3 bar
6. All dives to be completed within CNS percentage limits with a recommend maximum of 80 percent of the total PO₂ CNS limit
7. Safety stops to be conducted with a minimum 3 minutes at 6 metres / 20 feet
8. Where the user opts for an automatic diluent valve (ADV) fitted by the manufacturer additional skills such as regular diluent gauge monitoring and addition control must be emphasized

Open Water Skills:

1. Pre-dive checks
 - a. Unit buildup
 - b. Scrubber canister check
 - c. Breathing loop check
 - d. Positive and negative check
2. Verify diluent and oxygen (O₂) cylinder contents using O₂ analyzer where appropriate
3. 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 nitrogen absorption at planned depth and PO₂ setpoint
 - d. Appropriate selection of decompression conservatism/gradient factors for planned dive
 - e. Thermal constraints

4. Emergency procedures
 - a. Mouthpiece familiarity drills
 - b. Bailout drills
 - c. Gas shutdowns and loss of gas
 - d. Broken hoses
 - e. Flooded absorbent canister
 - f. Carbon dioxide (CO₂) breakthrough
 - g. Low oxygen drills
 - h. High oxygen drills
 - i. Flooding loop
 - j. Electronics and battery failure
 - k. Properly execute the ascent procedures for an incapacitated CCR diver and tow the diver a minimum of 50 metres at the surface with both rescuer and victim wearing complete CCR diving system and bailout system
5. Use of BCD/suit and effective management of loop breathing volume for buoyancy control
6. Stop at 3-6 metres / 10 – 20 feet on descent for leak bubble check
7. Electronics systems monitoring for PO₂ levels (SETPOINT) and switching setpoints
8. Manual control of setpoint if electronically controlled CCR is not used
9. Use and adjustment of Heads Up Displays and computers
10. Mask removal and replacement
11. Use of lift bag / delayed surface marker buoy and reel (where relevant and applicable)
12. Proper execution of the dive within all pre-determined dive limits
13. Demonstration of safety stops at pre-determined depths
14. Constant loop volume management
15. Cell validation checks with appropriate use of diluent and oxygen
16. Post dive clean of unit
 - a. Mouth piece and hoses
 - b. Clean and disinfect unit
 - c. Inspect components of unit
17. Diver maintenance of unit
 - a. Cell remove and replace
 - b. Mouthpiece strip and rebuild
 - c. Replacing/recharging batteries

In order to complete the course and achieve the TDI Air Diluent CCR rating the student must:

1. Satisfactorily complete the written examination with a minimum score of 80 percent
2. Complete to the instructor's satisfaction, all confined and open water skill development sessions
3. Demonstrate mature, sound judgment concerning dive planning and execution
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

The following articles and books are recommended reading and allow wider understanding.

1. Richard Pyle - *A Learners Guide to Closed Circuit Rebreather Operations*
2. Kenneth Donald - *Oxygen & the Diver*
3. John Lamb - *Oxygen Measurement for Divers*
4. Barsky, Thurlow & Ward - *The Simple Guide to Rebreather Diving*
5. Bob Cole - *Rebreather Diving*
6. Jeffrey Bozanic - *Mastering Rebreathers*