

30. Air Diluent Closed Circuit Rebreather Decompression Procedures Diver, Unit Specific-

30.1 Introduction

This is the second 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 45 metres / 150 feet using an air diluent for formal decompression diving.

30.2 Qualifications of Graduates

Upon successful completion of this course, graduates may engage in decompression diving activities utilizing a CCR without direct supervision provided:

1. The diving activities approximate those of training
2. The areas of activities approximate those of training
3. Environmental conditions approximate those of training

Upon successful completion of this course, graduates are qualified to enroll in:

1. TDI Mixed Gas CCR unit specific course
2. TDI Advanced Wreck Course

30.3 Who May Teach

An active TDI Instructor with a TDI Air Diluent CCR Decompression Procedures Instructor rating for 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 4 students per active TDI Instructor is allowed

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

1. A maximum of 4 students per active TDI Instructor is allowed
2. The ratio should be reduced as required due to environmental or operational constraints

30.5 Student Prerequisites

1. Minimum age 18



2. Provide proof of 50 logged dives
3. Provide proof of TDI Advanced Nitrox Diver and Deco Procedures 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 and provide proof of 10 logged sidemount dives.

OR

1. Minimum age 18
2. TDI Air Diluent CCR Diver certified or equivalent
3. 30 hours on the CCR unit
4. Six months CCR diving experience

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. 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 45 metres / 150 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

1. If a student already qualified as TDI CCR Air Diluent Deco Diver or equivalent from an agency recognized by TDI and wishes to qualify on another CCR recognized by TDI, the student must follow all unit specific course standards with the exception of:
 - a. Minimum of 60 minutes confined water training to a maximum of 9 metres / 30 feet
 - b. Minimum of 180 minutes open water training to be completed over a minimum of 3 dives to a maximum of 45 metres / 150 feet

Upgrades

1. If a student has the entry level 1 certification and wishes to do the decompression part of this course, only 240 minutes in open water is required
2. The student must have a minimum of 30 logged hours over 30 dives before enrolment on the deco course
3. Six months CCR diving experience

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. 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

Required materials:

1. *TDI Diving Rebreathers* Student Manual
2. Manufacturer's manual and updates
3. *TDI Decompression Procedures* Student Manual
4. *TDI Advanced Nitrox* Student Manual
5. Manufacturer's Build Checklist
6. *TDI CCR Preflight Checklist*
7. Rebreather course evaluation form (see appendix)
8. Mel Clark- *Rebreathers Simplified* (required for JJ-CCR only)

Optional:

1. *TDI Diving Rebreathers* PowerPoint Presentation
2. Mel Clark- *Rebreathers Simplified*
3. Skills prompt slates

30.9 Required Equipment

The following equipment is required:

1. A complete closed circuit rebreather
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 50 metres / 165 feet of line
6. Lift bag / delayed surface marker buoy (DSMB) with a minimum of 12 kg / 25 lb lift
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 cylinder with a minimum capacity of 5.7 litres / 40 cu ft air or nitrox may be used

Note: The instructor and any certified assistant will also carry a bailout gas supply during all open water sessions. This redundant gas source must be greater than the instructor and any certified assistant's bailout requirements.

30.10 Required Subject Areas

The *TDI Diving Rebreathers Student Manual* 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 unit
 - b. Layout and design of the unit
 - c. Absorbent canister design and maintenance
 - d. Proper packing of canister, in accordance with manufacturer's recommendations
 - e. Breathing loop de-contamination procedures
 - f. Manufacturer supported additional items (Automatic Diluent Valve, etc)
4. Gas Physiology
 - a. Oxygen (O₂) toxicity
 - b. Nitrogen absorption
 - c. Carbon dioxide (CO₂) toxicity
 - d. Gas consumption
5. Electronic and Manual Systems Design and Maintenance
 - a. Oxygen (O₂) metabolizing calculations
 - b. Fuel cells
 - i. Maintenance
 - ii. Replacement
 - iii. Manufacturing date
 - c. System electronics functionality and calibration procedures
6. Dive Tables
 - a. Constant partial pressure of oxygen (PPO₂) theory
 - b. Central nervous system (CNS) and awareness of oxygen tracking units (OTU)
7. Dive Computers
 - a. Mix adjustable
 - b. Constant percentage of oxygen (PO₂)
 - c. Oxygen (O₂) integrated

8. Dive Planning
 - a. Operational planning
 - b. Gas requirements including bailout scenarios
 - c. Oxygen limitations
 - d. Nitrogen limitations
9. Emergency Procedures
 - a. Use of B.A.D.D.A.S.S
 - b. Three H's problems
 - c. Flooded loop
 - d. Cell warnings
 - e. Battery warnings
 - f. Bailout gas requirements

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 open water dives must be between 9 metres / 30 feet to 45 metres / 150 feet
2. Two dives must be deeper than 20 metres / 66 feet and one dive must be deeper than 30metres / 100 feet
3. PO₂ not to exceed manufacturer's recommendation or a working limit of 1.3 bar
4. All dives to be completed within CNS percent limits with a recommend maximum of 80 percent of the total PO₂ CNS limit
5. Safety stops to be conducted with a minimum 3 minutes at 6 metres / 20 feet
6. When 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
7. Calculate all off board gas at 45.30 litres / 1.6 cubic feet per minute usage to cover stress situations
8. All dives to be completed within appropriate constant PO₂ decompression tables
9. Student is only certified for decompression diving on the specific CCR unit
10. Students must do one bailout from depth on open circuit to include simulated decompression

Open Water Skills:

1. Pre dive checks
 - a. Unit build-up
 - b. Scrubber packing
 - c. Positive and negative checks
2. Verify diluent and 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. Thermal constraints
4. Emergency procedures
 - a. Mouthpiece familiarity drills
 - b. Gas shutdowns and loss of gas
 - c. Broken hoses
 - d. Flooded absorbent canister
 - e. Carbon dioxide (CO₂) breakthrough
 - f. Semi-closed mode
 - 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
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 of lift bag / delayed surface marker buoy and reel
10. Proper execution of the dive within all pre-determined dive limits
 - a. Constant loop volume management
11. Post dive clean of unit to avoid contamination and spread of disease

If this is the first CCR course taken the following must be included:

1. Post dive clean of unit
 - a. Mouth piece and hoses
 - b. Clean and disinfect unit
 - c. Inspect components of unit
2. Dive maintenance of unit
 - a. Cell remove and replace
 - b. Mouth piece strip and rebuild
 - c. Replacing batteries

Decompression related in water skills:

1. Demonstrate comfort swimming on surface and at depth carrying 1 bailout/decompression cylinder
2. Demonstrate ability to drop and retrieve 1 bailout/decompression cylinder while maintaining position in the water column
3. Demonstrate ability to deploy SMB or lift-bag solo and as a member of a team
4. Demonstrate appropriate reaction to gas hemorrhage from manifold or first stage, SPG and primary regulator
5. Demonstrate appropriate reaction to simulated free-flowing deco regulator
6. Buddy breathing deco gas for at least 1 minute
7. Oxygen rebreather mode at less than 6 metres / 20 foot stop



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8. Complete 1 bailout scenario at depth to include decompression obligation on open circuit

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

1. Satisfactorily complete the written examination with a minimum score of 80 percent and 100% remediation
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

Recommended Additional Reading and Support Material

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*