# 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 or nitrox 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*

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 facilities, 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.

## *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 sessionand confined water session 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.
3. No more than 3 in-water sessions per day

**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 be a minimum of 5 days.

**Crossover**:

If a student is 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:
    a. Complete an academic session covering unit build, hose routing, donning, and doffing.
    b. 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. 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 and Knowledge Quest or eLearning.
2. *TDI Diving Rebreathers* PowerPoint Presentation
3. Manufacturer's manual and updates.
4. Manufacturer's Build Checklist.

5. *TDI CCR* Preflight Checklist.
6. Manufacturer's minimum training standards and any additional course forms required by the manufacturer.

**Optional**

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

## *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**: Instructor and students must all be on the same unit for all portions of the course. 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. The 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 ($CO_2$) toxicity, Hypercapnia.
    d. Gas density.
5. Proper Scrubber Packing; in accordance with manufacturer's recommendation:
    a. Gas consumption.
6. Electronic or Manual Systems Design and Maintenance:
    a. Oxygen ($O_2$) metabolizing calculations.
    b. Fuel cells.
    c. System electronics functionality and calibration procedures.
7. Dive Tables:
    a. Constant partial pressure of oxygen ($PPO_2$) theory.
    b. Central nervous system (CNS) and awareness of oxygen tracking units (OTU) tracking.

8. Dive Computers:
    a. Mix adjustable.
    b. Constant $PO_2$.
    c. Oxygen ($O_2$) 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.
    f. Diving in mixed teams.
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.
11. Team Diving Considerations:
    a. Purpose of dive
    b. Use of pre-dive checklists
    c. Buddy checks
    d. Dive planning and setpoints
    e. Bailout scenarios

## *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 6 Metres/20 Feet and 30 Metres/100 Feet.
3. Two dives must be at least 24 Metres/79 Feet deep.
4. Satisfactorily complete any additional skills required by the unit specific manufacturer.
5. 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.
    d. Onboard diluent not to exceed a PO2 of 1.1 bar at the maximum depth of the dive.
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. 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.
9. Students to log all dives at the end of each diving day.

**Open Water Skills:**

1. Pre-dive checks:
    a. Unit buildup using manufacturer's unit build checklist.
    b. Scrubber canister check.
    c. Breathing loop check.
    d. Positive and negative check.
2. Verify diluent and oxygen ($O_2$) cylinder contents using $O_2$ 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 $PPO_2$ levels.

   c. Limits based on nitrogen absorption at planned depth and $PO_2$ 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 ($CO_2$) breakthrough.
   g. Low oxygen drills.
   h. High oxygen drills.
   i. Flooding loop.
   j. Electronics and battery failure.
   k. Demonstrate simulated rescue of a non-responsive rebreather diver to the surface from a depth of at least 5 metres/16 feet.
   l. Oral inflation of BCD at the surface
5. Use of BCD/suit and effective management of loop breathing volume for buoyancy control. Demonstrate ability to hover at fixed position (±1m/3ft) in water column for at least 90 seconds without moving hands or feet.
6. Stop at 3-6 Metres/10 – 20 Feet on descent for leak bubble check.
7. Electronics systems monitoring for $PO_2$ 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.
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. Mouthpiece 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. Complete a refresher course following a period of inactivity greater than 6 months following the course.