

27. Semi-Closed Circuit Rebreather Diver, Unit Specific- DOLPHIN, RAY, Atlantis, SUBMATIX ST100 & AZIMUTH

27.1 Introduction

This is the entry-level certification course for recreational divers wishing to utilize one of the following semi-closed circuit rebreathers: Dolphin, Ray, Submatix ST100 or Azimuth. The objective of this course is to train recreational divers in the benefits, hazards and proper procedures for using SCR rebreathers.

27.2 Qualifications of Graduates

Upon successful completion of this course, graduates may engage in no decompression diving activities utilizing the Dolphin, Ray, Submatix ST100 or Azimuth to a maximum depth of 40 metres / 130 feet, without decompression; utilizing nitrox mixes not exceeding their level of certification.

27.3 Who May Teach

Any active TDI Rebreather Instructor may teach this course. Specific instructor certification required for each specific rebreather.

27.4 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 6 students per instructor for the Draeger units, maximum of 4 students per instructor for the Azimuth and Submatix units; it is the instructor's discretion to reduce this number as conditions dictate

27.5 Student Prerequisites

1. Minimum age 18, 15 with parental consent
2. Minimum certification of TDI Nitrox Diver, may be combined in program, or equivalent at the discretion of the instructor

27.6 Course Structure and Duration

Open Water Execution

1. A minimum of 4 dives with a minimum of 100 accumulated minutes for the Drager units
2. A minimum of 5 dives with a minimum of 125 accumulated minutes for the Submatix ST100
3. A minimum of 6 dives with a minimum of 150 accumulated minutes for the Azimuth

Course Structure

1. TDI allows instructors to structure courses according to the number of students participating and their skill level

Duration

1. The minimum number of classroom and briefing hours is 6

27.7 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. 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

27.8 Training Material

Required material

1. *TDI Diving Rebreathers* Student Manual or eLearning
2. Specific manufacturer manual for the rebreather being dived

Optional Material

1. TDI plastic EAD and PO₂ tables
2. *TDI Diving Rebreathers* PowerPoint Presentation
3. Nitrox and rebreather equations software

27.9 Required Equipment

The following equipment is required for each student:

1. Rebreather specific to the training being conducted
2. Integrated PO₂ monitoring device for inhaled PO₂ for each rebreather
(See item 17.13 if unit is equipped)
3. Mask and fins
4. Exposure suit appropriate for the open water environment
5. Access to oxygen analyzer, instructor may supply
6. Weight / weight system
7. Bailout cylinder, minimum size 1.9 litres / 13 cubic feet
8. Flow meter, instructor may supply

27.10 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 this course:

1. History and Evolution of Rebreathers
2. Comparison of Open Circuit, Closed Circuit, and Semi-closed Circuit
3. Practical Mechanics of the System
 - a. Assembly and disassembly of the rebreather
 - b. Layout and design
 - c. Scrubber recharge
 - d. System maintenance
 - e. Breathing loop decontamination procedures
4. Review of Nitrox
 - a. Dalton's Law (triangle)
 - b. Optimum nitrox mix
 - c. Oxygen tracking
 - d. Gas preparation
 - e. Dive planning examples

5. Gas Physiology
 - a. Oxygen (O₂) toxicity
 - b. Hyperoxia
 - c. Hypoxia
 - d. Asphyxia
 - e. Hypercapnia
 - f. Nitrogen absorption
 - g. Carbon dioxide (CO₂) toxicity
 - h. Gas consumption
 - i. Cylinder sizes
 - ii. Depth and workload
6. Formula Work / Metabolic Consumption
 - a. Oxygen (O₂) metabolizing calculations
 - b. Inspired oxygen (O₂) calculations (rebreather equation)
 - c. Equivalent air depth (EAD)
7. Dive Tables
 - a. Inspired oxygen (O₂) table
 - b. Equivalent air depth
8. Dive Computers
 - a. Mix adjustable
 - b. Oxygen (O₂) integrated
 - c. PO₂ monitoring devices
9. Problem Solving
 - a. Canister flooding
 - b. Mouthpiece loss
 - c. Scrubber exhaustion
 - d. Battery or sensor loss
 - e. Breathing bag rupture
 - f. Open circuit bailout system
 - i. On board gas
 - ii. Off board gas
 - g. Hyperoxia scenario
 - h. Hypoxia scenario
 - i. Hypercapnia scenario
 - j. Post problem maintenance of equipment
10. Dive Planning
 - a. Operational planning
 - i. Gas requirements
 - ii. Oxygen limitations
 - iii. Nitrogen limitations

27.11 Required Skill Performance and Graduation Requirements

The dive depth shall not exceed 1.6 ATM PO₂. The following skills must be completed by the student during open water dives:

1. Properly analyze gas mixture
2. Perform all pre dive checks, positive, negative, flow rate, by-pass regulator operation, relief valve pressure, a minimum of 6 times
3. Demonstrate a leak check and repair scenario
4. Demonstration of integrity of exhale counter-lung for Submatix ST100
5. Properly packing a scrubber canister a minimum of 2 times; if using the ExtendAir cartridge one packing must be with granular material
6. Properly execute set-up and breakdown; a minimum of 6 times for Azimuth or 4 times for Draeger and Submatix ST100 rebreathers
7. Demonstrate adequate pre-dive planning
 - a. Limits based on system performance
 - b. Limits based upon oxygen exposures at planned depth with mix
 - c. Limits based upon nitrogen absorption at planned depth with mix
8. Properly execute the planned dives within all pre-determined limits
9. Properly execute a recovery from a system failure and switch to bail-out stationary a minimum of 2 times
10. Properly execute a recovery from a system failure and switch to bail-out hovering a minimum of 2 times, one of the bail-out scenarios the diver must switch to open circuit and complete dive and safety stop on open circuit; direct ascent must begin when diver switches to open circuit, this scenario should be conducted no deeper than 20 metres / 60 feet
11. Properly demonstrate hose clearing technique after each bail-out scenario
12. Perform block switch a minimum of 2 times, Azimuth only
13. Proper PO₂ monitoring on all dives, if unit is equipped with PO₂ monitoring device
14. Properly execute a mask clearing exercise with emphasis on minimal gas loss
15. Safely and properly execute a buddy out of air scenario, it is preferable the buddy is on a SCR unit also
16. Diver will demonstrate actual safety stops at pre-determined depths
17. Properly execute cleaning and maintenance of the rebreather, including breathing loop decontamination

In order to complete this course, students must:

1. Satisfactorily complete the TDI Diving Rebreathers Course written examination
2. Complete all open water requirements safely and efficiently
3. Demonstrate mature, sound judgment concerning dive planning and execution