rEvo air diluent course procedures

Minimum requirements for air diluent course

(if any training agency requirement exceeds the rEvo requirements, then this agency requirement prevails)

V1.5 21/07/2015 Paul Raymaekers
(*Changes in italic*)

General:

- Successfull completion of the air diluent course allows the diver to dive to a depth of 40m max, as the CE-type approval of the rEvo using air as diluent is limited to 40m.
- In case agencies allow helium based mixtures on the first CCR course a student follows, the oxygen fraction shall be 21% (+/-1 %), and the max depth is limited to 40m.
- Max decompression allowance depends on the previous certification of the diver, and agency standards, but can never be more than the current OC/CCR decompression limits the diver had before the course.
- Only rEvo approved instructors can teach this course: rEvo instructors are listed on the rEvo website *(Please check before you start a course: if an instructor is not listed on the rEvo website, he/she is not a real/approved rEvo instructor!)*
- The instructor dives a rEvo during the course
- Only rEvo students take part of the course (no other units)
- Student / instructor ratio:
- * theory: no limit as long as practically possible
- * all the rest: practical work, confined water and open water: max 2 students / instructor (the number can be increased to 3 if minimum one of the students is a cross over candidate) (instructor candidates are not considered ‘students’ in this case)
- Student pre-requisites: minimum 18 years / 50 open water dives / advanced nitrox or equivalent. (advanced nitrox or equivalent can be co-taught with the rEvo course)
- Total course duration: minimum 5 full days
- Total in-water time minimum 480 minutes
- Confined water: minimum 1 dive, in-water time minimum 60 minutes
- Open water: minimum 6 dives, in-water time minimum 360 minutes
- Total number of dives: minimum 8, 4 at depth > 10m, and 2 > 30m (this means either minimum 1 confined water and 7 open waters, or minimum 2 confined and 6 open waters)
- The open water dives must be spread over minimum 3 days, and the maximum number of dives per day is 2. (3 dives in one day can only be seen as an exception in case weather/circumstances did not allow a second dive on the previous day)
- Students carry 1 stage/bail-out on all dives: confined water and open water (recommended minimum 5 liter / 40cuft or more if required by OC deco bail-out plan)
- Use of check-lists during the course is mandatory

Crossover rules:

In order for a diver to participate in a rEvo Rebreather crossover course, he or she must meet or exceed **ALL** of the following criteria:

- *Minimum certification - Air Diluent Closed Circuit Rebreather certification by a recognized technical training agency to a minimum dive depth of 30 Meters. . (Cross over is not allowed for certifications on SCR or PSCR, nor for CCR certifications that only allow a lesser dive depth: in all these cases a full course is mandatory).*
- *Initial CCR certification earned within the past thirty (30) days or, if previous CCR certification was earned longer than thirty (30) days ago, diver must show proof of ten (10) logged dives beyond initial CCR certification within the past six (6) months.*
- *Diver must be able to plan CCR dives and appropriate amount of bailout gas to safely get out of the water in an emergency.*
- *Have a general understanding of physics, physiology, oxygen toxicity, carbon dioxide, nitrogen narcosis, decompression sickness, rebreather components and maintenance.*
- *Diver must be able to perform basic CCR skills during the first pool session of the cross over, to show that he or she masters basic CCR diving: these skills include, but are not limited to: changing to OC bail out and back to CCR, mask removal and replacement, no mask swim, switch to bailout and back to CCR without a mask, handling bail-out tank, boom drills, recognizing basic CCR problems and solving them, control buoyancy at shallow depth.*
- *The diver must show the instructor that he/she has the ability and knowledge to continue into this level of training*

If the diver does not meet the prerequisites listed above, a full rEvo CCR course is mandatory.

- Total course duration: minimum 2.5 days
- Total in-water time minimum 240 minutes
- Confined water: minimum 1 dive, in-water time minimum 60 minutes
- Open water: minimum 4 dives, in-water time minimum 180 minutes
- Total number of dives: minimum 5, 4 at depht > 10m, and 2 > 30m

Training materials:

- all agency approved material as long as it covers all items listed in the next paragraph
- rEvo III manual available from the rEvo website
- rEvodream chart available from the rEvo website
- rEvo check lists (rEvo website)
- article on Oxygene sensors (rEvo website)
- article on constant mass flow (rEvo website)
- article on how to use the rMS (optional, if fitted)
- shearwater predator manual (shearwater website) (*optional, if unit has a shearwater computer or controller)
- rEvo specific exam (multiple choice) (agency specific)
- rEvo student evaluation form: (includes evaluation of the different skills and student behavior during the training, also records the dive time and depth of each dive): this form must be sent/mailed back to the rEvo company after the training, so that the student is officially registered as certified rEvo diver. Available from the rEvo website.

Minimum theory topics/duration DURING the course (not before!) :

- General rebreather design: 2 hours
- Physiology: hypoxia, hyperoxia and hypercapnea: 1.5 hours
- How to dive rebreathers ‘when all goes as planned’: 1.5 hour
- Diving rebreathers ‘when all goes wrong’ (emergency scenario’s): 2 hours
- Dive planning and decompression calculation: 2 hours
- Oxygen sensors: 0.5 hours
- Constant mass flow theory: 0.5 hours
- rEvo scrubber rotation system and why: 0.5 hours
- rMS: how it works, how to use it: 1 hour (if fitted)

Practical work:

Build-up of the rEvo rebreather: 2.5 hours
Use of the rEvodreams: 1.5 hours (NG) 0.5 hours (P or P5)
Maintenance (disassembling/assembling) of the DSV (* if the DSV does not have greasing holes): 0.5 hours
Use of the shearwater computer/controller: 1.5 hours (*: optional)
Changing batteries in rEvodream, controller battery (*), shearwater computer (*) 0.5 hours

Exam:

for both the full course and the crossover, the exam must be administered like a classic exam at the end of the course, after all the theory has been taught, and the students have completed all of the practical work on the rEvo: the exam is NOT an open book exam. After the students have completed the answer sheet, the instructor has to correct and discuss all of the answers with the students.

Practical diving:

For all dives:

- Before dive: build up of the unit, briefing of the dive, full check before water entry including full 5 minutes prebreathing.
- End of dive: cleaning/rinsing, debriefing of all skills, fill in the student evaluation form
- All dives, except the last 2 (on the last day) are done completely in mCCR mode. For hybrid/electronic rebreathers, when diving in mCCR mode, the low set-point is set at *0.5*, and the unit is dived manually at the target setpoint
- On all open water dives: during the ascent the target set-point is maintained till at least the 6 meter stop, between 6 and 3m > 1.0 and less then 3m >0.7 bar. All students do an oxygen flush between 6 and 3 meter when there is no risk of accidentally descending again (on line, SMB, rope, slope..). Once on the surface, the students do another oxygen flush.

CW1 (confined water dive 1) (*see note 1*)

mCCR: target setpoint always > 0.7, except during CMF test
hCCR: unit all the time on low set-point *0.5*, but manually always > 0.7

- get used to lung volume, minimum lung volume
- dump by nose, mouth, leaking side of lips
- flush using manual add / ADV
- full flush: go vertical and flush continouesly while gas freeflows out of mouth
- oxygen addition in small bursts / breathing the gas throug the loop
- breathing head up/down, sideways: feel the hydrostatic differences
- mask clearing
- DSV removal and going back to DSV
- DSV removal, breath from bail-out, check PPO2, back to DSV
- Controlled ascent / descent
- Touring in pool on CCR
- Touring in pool on bail-out
- Take off bail-out tank (static) and clip back on
- CMF test (starting at PPO2 0.5 bar)
- BOOM drill: close tanks in < 3 seconds, check, analyze (evaluate the situation), find solution,… open tanks again

CW2 (confined water dive 2) (*see note 1*)

mCCR: target setpoint always > 0.7
hCCR: unit all the time on low set-point *0.5*, but manually always > 0.7
for every 'emergency drill', at the end of the drill the student signals his buddy what happened and why he took action

- Concentrate on minimum lung volume
- Exercise full vertical flush on both oxygen and diluent: in less then 3 seconds pure oxygen or diluent must be in the loop
- oxygen addition in small bursts / breathing the gas throug the loop
- mask switching on CCR with buddy
- remove mask, switch from CCR to bail-out, switch to CCR again (static) (*note 2*)
- Controlled ascent / descent
- Touring in pool on buddy's bail-out
- Touring in pool on CCR without mask (*note 2*)
- Take off bail-out tank (dynamic) and clip back on
- BOOM drill: close tanks in < 3 seconds, check, open tanks again
- Hypoxic drill: full diluent flush first, then bail-out to OC
- Hyperoxic drill: bail-out
- Hypercapnea drill: full diluent flush, open loop breathing on CCR for 1 minute, then bail-out
- 3 barrel rolls (* optional if there is enough depth)
- controlled ascent without mask (*optional if there is enough depth) (*note 2*)
- water removal from breathing hoses
- repeat all drills of CW1 and CW2 till comfortable

- take off the rebreather in the water, clean-up (tidy up straps and hoses), swim to side where some-one else pulls it out of the water (simulation for rib-diving) (For shallow pools where the diver can stand on the bottom this can be done in open water if conditions allow)

OW1 (open water dive 1)

mCCR: target setpoint always 1.0
hCCR: unit all the time on low set-point *0.5*, but manually always 1.0
max depth 10m

- on descent at 3-6m: bubble-check, buddy configuration check, bail-out check
- at target depth: signal to buddy: set-point switch to target set-point (manually!)
- 15 minutes free swim to get accustomed
- repeat all drills from CW1 and 2, except CMF: booms, 3 x H,
- if not done already: barrel roll
- during ascent: concentrate on minimum loop volume

OW2 (open water dive 2)

mCCR: target setpoint always 1.0
hCCR: unit all the time on low set-point *0.5*, but manually always 1.0
max depth 15m

- on descent at 3-6m: bubble-check, buddy configuration check, bail-out check
- at 6-7m check oxygen sensors for current limiting, then flush down the PPO2 before further descent
- at target depth: signal to buddy: set-point switch to target set-point (manually!)
- swim on CCR without mask for > 25 meters
- simulate loss of dil: breath from bail-out and exhale into CCR/wing
- RMV matching/determination: swim for 10 minutes on bail-out at constant depth, note the pressure drop for later calculations
- !!! before going on CCR again: check PPO2, if not clear: flush with diluent before breathing from the loop (go from OC to CCR, set DSV on CCR, vertical diluent flush until PPO2 is breathable, breath on loop while adding oxygen in small bursts till target PPO2 is reached)
- all emergency drills: booms, 3 x H..
- shoot bag / SMB
- ascent on CCR
- flush with pure oxygen between 6 and 3m
- flush pure oxygen when on surface

OW3 (open water dive 3)

mCCR: target setpoint always 1.3
hCCR: unit all the time on low set-point *0.5*, but manually always 1.3

min depth 10m max depth 20m

- on descent at 3-6m: bubble-check, buddy configuration check, bail-out check
- at target depth: signal to buddy: set-point switch to target set-point (manually!)
- repeat all emergency drills: booms, 3 x H..
- SCR drill for minimum 5 minutes
- Practice frog kick
- Swim 15m without breathing: change to bail-out, hold regulator in your hand in front of you while swimming for 15m, at the end breath from bail-out, go back to CCR but check PPO2 before breathing on CCR
- Switch bail-out tanks with buddy (dynamic)
- shoot bag / SMB
- ascent slowly on CCR, safety stop at 6 and 3 meters for 3 minutes each
- flush with pure oxygen between 6 and 3m
- flush pure oxygen when on surface

OW4 (open water dive 4)

mCCR: target setpoint always 1.3
hCCR: unit all the time on low set-point *0.7*, but manually always 1.3
min depth 10m max depth 25m

- on descent at 3-6m: bubble-check, buddy configuration check, bail-out check
- at target depth: signal to buddy: set-point switch to target set-point (manually!)
- repeat all emergency drills: booms, 3 x H..
- practice frog kick
- during the dive when possible, whilst breathing off the bail-out regulator demonstrate the opening of the loop to control buoyancy
- Out of gas on CCR and OC: breath from buddy's bail-out (dynamic)
- Practice OC bail-out ascent for h/eCCR: bail out to OC regulator, switch your controller to low set-point, then switch computer to OC
- shoot bag / SMB
- note the pressure of your bail-out tank
- ascent on OC, simulate stops at 9m, 6m, 3m
- practice open circuit stage swapping on ascent whilst breathing off the bail-out cylinder
- at surface: note the pressure of the bail-out tank again

OW5 (open water dive 5)

mCCR: target setpoint always 1.3
hCCR: unit is dived in electronic mode with the solenoid working: low set-point 0.7 till target depth, then high set-point 1.3
min depth 30m max depth 40m

- on descent at 3-6m: bubble-check, buddy configuration check, bail-out check
- at 6-7m flush oxygen for general unit check, then flush down the PPO2 before further descent
- at target depth: signal to buddy: set-point switch to target set-point (automatic mode for h/eCCR)
- repeat all emergency drills: booms, 3 x H..
- switch bail-out tanks with buddy
- demonstrate and practice stage swapping whilst breathing off the bail-out stage
- signal drills with cards: feeling funny, high breathing resistance, urge to breath fast, weakness in legs, muscle twitching, funny cell readings, ….
- practice water removal from breathing hoses
- shoot bag / SMB
- ascent on CCR, but keep the set-point high until the end of the 6m stop. Switch to .7 when leaving 6m but manually add Oxygen until the surface (so diver feels the difficulty if not switching to low set-point at the start of the ascent)
- mandatory decompression on CCR, max 10 minutes (* compulsary if certification allows decompression diving after course, if not: simulate stops at 9m, 6m, 3m)
- at 6-7m check oxygen sensors for current limiting
- flush oxygen between 6 and 3 meter, and at surface

OW6 (open water dive 6)

mCCR: target setpoint always 1.3
hCCR: unit is dived in electronic mode with the solenoid working: low set-point 0.7 till target depth, then high set-point 1.3
min depth 30m max depth 40m

- on descent at 3-6m: bubble-check, buddy configuration check, bail-out check
- at target depth: signal to buddy: set-point switch to target set-point (automatic mode for h/eCCR)
- repeat all emergency drills: booms, 3 x H, flooded canister..
- unconscious diver lift and tow (Rescue)..
- signal drills with cards: feeling funny, high breathing resistance, urge to breath fast, weakness in legs, muscle twitching, funny cell readings, ….
- shoot bag / SMB
- ascent on OC, (for h/eCCR switch to low set-point before changing controller to OC)
- mandatory decompression on bail-out, max 15 minutes (*compulsary if certification allows decompression diving after course, if not: simulate stops at 9m, 6m, 3m)
- flush oxygen at surface

Note:

1: confined water is defined as: you must be able go into the water, with no special effort, and be able to stand up in max one meter of water, have a stable ground under your fins and then have a gradual increase of depth until completely submerged (this means that it can both be pool conditions, and ‘confined open water’, like a lake or beach where you can simply walk into)
2: for open water dives, in water temp less then 15°C, all drills that require mask removal for prolonged time, may be changed into ‘after the primary mask is removed, deploy back-up mask and continue the exercise’