

## 3.2.6 Closed-Circuit Rebreather Fundamentals

### 3.2.6.1 Course Outcomes

GUE's Closed-Circuit Rebreather Fundamentals course is an entry-level, closed-circuit rebreather course designed to educate GUE divers in basic rebreather technologies and to cultivate diver proficiency in the use of GUE-approved closed-circuit rebreather configurations.

### 3.2.6.2 Prerequisites

Applicants for a CCR-F Diver course must abide by [Training Prerequisites \(2.1.4.1\)](#), plus:

- a. Be a minimum of 18 years of age. Documented parental or legal guardian consent must be submitted to GUE HQ when the participant is a minor.
- b. Hold a GUE Technical Fundamentals certification<sup>1</sup>.
- c. Have conducted at least 150 non-training dives.
- d. If using a drysuit during the course, have conducted at least 25 non-training dives in a drysuit or have conducted 15 non-training dives utilizing a drysuit following completion of GUE Drysuit Primer certification.

### 3.2.6.3 Course Content

The Closed-Circuit Rebreather Fundamentals course is normally conducted over five days. It requires a minimum of six dive sessions and at least forty hours of instruction, encompassing lectures, land drills, and at least eight hours of dive time.

### 3.2.6.4 Closed-Circuit Rebreather Fundamentals Specific Training Standards

- a. Student-to-instructor ratio is not to exceed 3:1.
- b. Maximum depth of 100 ft/30 m.
- c. Minimum 6 ft<sup>3</sup>/180 L of oxygen and 30 ft<sup>3</sup>/825 L of bailout/diluent are required to begin a CCR-F dive.
- d. The oxygen supply valve must never be closed completely during drills.
- e. All dives must be within minimum decompression limits (MDLs), i.e., no required stops.
- f. No overhead diving.
- g. Students must complete GUE Rescue Primer or equivalent from a recognized training agency prior to certification.

### 3.2.6.5 Required Training Materials

GUE training materials and recommended study as determined by the course study packet available online or via download after GUE course registration.

### 3.2.6.6 Academic Topics

- a. Introduction: GUE organization and course overview (objectives, limits, expectations)
- b. Anatomy of rebreathers, common components and how they function
- c. Benefits and disadvantages of using closed-circuit rebreathers

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<sup>1</sup> Including GUE Fundamentals with Technical rating issued under past versions of Standards.

- d. Inherent risks of using closed-circuit rebreathers
- e. Closed-circuit rebreather operation, alarms, and warnings
- f. Breathing gas dynamics, hyperoxia, hypoxia, hypercapnia, and gas density
- g. Absorbent material: properties and canister endurance
- h. Gas management: consumption, use, requirements, and reserves
- i. Decompression considerations while using closed-circuit rebreathers
- j. Diver safety and responsibilities

### 3.2.6.7 Land Drills and Topics

- a. Rebreather assembly and set-up
- b. Rebreather pre-dive checklist
- c. Rebreather on-site checklist
- d. CHAOS critical control checks and 5-minute pre-breathe
- e. Dry land experience dive, including basic operations such as: switching to and off the loop (DSV open/close); achieving a proper seal around the mouthpiece; preventing nose exhalation; testing for, achieving, and maintaining optimal loop volume; pO<sub>2</sub> awareness using HUD and handset; communicating own pO<sub>2</sub> and current setpoint; requesting pO<sub>2</sub> and setpoint information from team
- f. Electronically controlled setpoint and switches
- g. Manually controlled setpoint and switches
- h. Diluent flush techniques, including two-handed, one-handed, and exhalation-triggered ADV diluent gas addition
- i. Basic failure management
- j. Bailout and out-of-gas procedures
- k. Maintenance and repair of closed-circuit rebreathers

### 3.2.6.8 Required Dive Skills and Drills

Students must demonstrate competence in the following skills to attain GUE Closed-Circuit Rebreather Fundamentals certification:

- a. Must be able to swim at least 300 yds/275 m in less than 14 minutes without stopping. This test should be conducted in a swimsuit and, where necessary, appropriate thermal protection.
- b. Must be able to swim a distance of at least 50 ft/15 m on a breath hold while submerged.
- c. Demonstrate a safe and responsible demeanor throughout all training.
- d. Demonstrate basic equipment proficiency and an understanding of the GUE CCR equipment configuration.
- e. Demonstrate proficiency in safe diving procedures, including assembly and setup; rebreather pre-dive checklist; rebreather on-site checklist; CHAOS critical control checks and 5-minute pre-breathe; GUE EDGE; flow check; in-water activity; and post-dive assessment, breakdown, and maintenance.
- f. Demonstrate awareness of team members' closed-circuit rebreather function and an overall concern for safety, responding quickly to visual or audible indications and dive partner needs during diving and failures.

- g. Demonstrate proficiency in underwater communication.
- h. Demonstrate proficiency with the use of the closed-circuit rebreather during ascents, descents, and bottom phase of the dive.
- i. Demonstrate good buoyancy and trim, i.e., approximate reference is a maximum of 20 degrees off horizontal while remaining within a range of 3 ft/1.0 m from target depth.
- j. Demonstrate the ability to manage a flooded closed-circuit rebreather by bailing out and returning to the surface.
- k. Demonstrate the ability to diagnose and bailout in response to simple simulated closed-circuit rebreather problems.
- l. Demonstrate the ability to switch and maintain desired  $pO_2$  setpoints electronically throughout a dive.
- m. Demonstrate the ability to switch and maintain desired  $pO_2$  setpoints manually throughout a dive.
- n. Demonstrate effective valve management.
- o. Efficiently and comfortably demonstrate how to donate gas to an out-of-gas diver while using the closed-circuit rebreather.

### 3.2.6.9 Equipment Requirements

GUE CCR configuration as outlined in Appendix A, except:

- a. CCR-F students may use smaller bailout configurations than are appropriate for CCR-T1 and CCR-T2 dives.

Prior to the commencement of the class, students should consult with a GUE representative to verify equipment requirements and the appropriateness of any selected equipment.

## Appendix A - GUE Equipment Configuration

The GUE base equipment configuration is comprised of:

- a. Tanks/cylinders: Students may use a single tank/cylinder with a single- or dual-outlet valve. Students may also use dual tanks/cylinders connected with a dual-outlet isolator manifold, which allows for the use of two first stages. Dual tanks/cylinders connected with a dual-outlet, non-isolator manifold can be used, but only in recreational (minimum decompression) diving, and are considered an alternative for a single tank/cylinder. Consult course-specific standards and your instructor to verify size requirements.
- b. Regulators:
  - i. Single tank: The first stage must supply a primary second stage via a 5 to 7 ft/1.5 to 2 m hose. A backup second stage must be necklaced and supplied via a short hose. The first stage must also supply an analog pressure gauge, inflation for the buoyancy compensator (BC), and (when applicable) inflation for a drysuit.
  - ii. Double tank: One first stage must supply a primary second stage via a 5 to 7 ft/1.5 to 2 m hose (7 ft/2 m hose is required for all cave classes), and inflation for the buoyancy compensator (BC). The other first stage must supply a necklaced

backup second stage via a short hose, an analog pressure gauge, and (when applicable) inflation for a drysuit.

- c. Backplate system:
  - i. Is held to the diver by one continuous piece of webbing. This webbing is adjustable and uses a buckle to secure the system at the waist.
  - ii. A crotch strap is attached and looped through the waistband to prevent the system from riding up a diver's back.
  - iii. The continuous webbing must support five D-rings;
    - 1. The first placed at the left hip
    - 2. The second placed in line with a diver's right collarbone
    - 3. The third placed in line with the diver's left collarbone
    - 4. The fourth and fifth are placed on the front and back of the crotch strap when divers plan to use advanced equipment such as DPVs.
  - iv. The harness below the diver's arms has small restrictive bands to allow for the placement of backup lights. The webbing and system retains a minimalist approach.
- d. Buoyancy compensation device (BC):
  - i. A diver's BC is back-mounted and minimalist in nature.
  - ii. It is free of extraneous strings, tabs, or other material.
  - iii. There are no restrictive bands or restrictive elastic affixed to the buoyancy cell.
  - iv. Wing size and shape is appropriate to the cylinder size(s) employed for training.
- e. At least one time/depth measuring device
- f. Wrist-mounted compass
- g. Mask and fins: Mask is low-volume; fins are rigid, non-split.
- h. Backup mask
- i. At least one cutting device
- j. Wetnotes with at least one pencil
- k. Exposure suit appropriate for the duration of exposure
- l. Surface marker buoy (SMB) with spool: Where required, the SMB should be appropriate for environmental conditions and deployed using a spool with at least 100 ft/30 m of line.

**The GUE PSCR configuration is comprised of:**

- a. GUE base equipment configuration (except Tanks/Cylinder)
- b. One primary and two backup lights
- c. A GUE-approved passive semi-closed circuit rebreather
- d. Modified tank configuration as appropriate for use with a GUE-approved passive semi-closed circuit rebreather
- e. Modified regulator configuration as appropriate for use with a GUE-approved passive semi-closed circuit rebreather

**The GUE CCR configuration is comprised of:**

- a. GUE base equipment configuration (except Tanks/Cylinder)
- b. One primary and two backup lights
- c. A GUE-approved closed-circuit rebreather

- i. Where required, students must own a GUE-approved closed-circuit rebreather before attending the course; they can, however, use a rented or borrowed unit during the course.
- ii. The closed-circuit rebreather used by the student, with all associated components, must be fully functional (pass all tests on the rebreather pre-dive checklist) and serviced according to manufacturer specifications.
- iii. All oxygen sensors must be less than one year from manufacturing date.
- iv. Both the rebreather controller and SOLO board must be updated with the latest software and firmware versions published by the manufacturer.
- d. Modified tank configuration as appropriate for use with a GUE-approved closed-circuit rebreather
- e. Modified regulator configuration as appropriate for use with a GUE-approved closed-circuit rebreather
- f. Spare parts and consumables, including one set of controller, HUD, and solenoid batteries; one oxygen sensor; and one DSV/BOV mouthpiece.
- g. If using a drysuit inflation cylinder attached to the backplate, extended inflation cylinder straps need to be used to ensure that it does not interfere with or restrict the counterlung's function.

**The GUE Sidemount configuration is comprised of:**

- a. GUE base equipment configuration (except Tank/cylinders, Regulators, Backplate, BC)
- b. One primary and two backup lights
- c. Tanks/cylinders: Students are required to use independent cylinders with single valves and without manifolds, which allow for the use of one first stage each. Stage cylinders with [proper cylinder marking \(2.2, e\)](#) will also be utilized.
- d. Regulators: One of the second stages must be on a 7 ft/2 m hose. Both first stages must supply a pressure gauge and provide inflation for a drysuit (where applicable) and a wing.
- e. Sidemount harness: A diver's sidemount setup should be back-mounted and minimalist in nature. Wing size and shape should be appropriate to the cylinder size(s) employed for training.

**Additional Course-Specific Equipment**

- a. Where required, back gas and stage cylinders with [proper cylinder marking \(2.2, e\)](#) will also be utilized in accordance with the GUE General Training Standards, Policies, and Procedures document and configured in line with GUE protocols.
- b. When drysuit inflation systems are applicable, they should be sized appropriately for the environment; small tanks are placed on the left side of the backplate with larger supplies affixed to the diver's left back gas tank.
- c. Underwater lights:
  - i. When required, backup lights should be powered by alkaline batteries (not rechargeable) and stowed on the D-rings at a diver's chest (except when diving sidemount).
  - ii. Backup lights should have a minimal amount of protrusions and a single attachment at the rear.
  - iii. Backup lights should feature a twist-on/off switch for operation

- iv. The primary light should consist of a rechargeable battery pack and be fitted with a Goodman-style light handle.
- v. When burn time requirements create the need for an external battery pack, it should reside in a canister mounted on the diver's right hip.
- d. Guideline devices, as required during cave diving activities:
  - i. A primary reel is required for all cave diving and provides a minimalist form factor with a handle designed to support a Goodman or "hands free" handle operation. The primary reel must contain at least 150 ft/45 m of line.
  - ii. A safety spool is required for each diver while cave diving and must contain at least 150 ft/45 m of line.
  - iii. A jump or gap spool is required during Cave 2 diving and must contain at least 75 ft/23 m of line.
- e. Where required, GUE-approved DPV must:
  - i. Be a tow-behind style with adjustable speed and clutch mechanism.
  - ii. Include an attached cord at the back with bolt snap to be clipped on the front crotch strap D-ring.
  - i. Include a leash attached to the front to be used for towing.