

## 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)

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

- b. Anatomy of rebreathers, common components and how they function
- c. Benefits and disadvantages of using closed-circuit rebreathers
- 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 (for applicable configurations), 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 configuration for which they are seeking certification.
- 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<sub>2</sub> setpoints electronically throughout a dive.
- m. Demonstrate the ability to switch and maintain desired pO<sub>2</sub> 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 configurations are comprised of:**

- a. GUE base equipment configuration (except Tanks/Cylinder, where relevant)
- 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 analog oxygen sensors must be less than one year from manufacturing date.
  - iv. All electronic components, including but not limited to the rebreather controller unit and monitoring systems, 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 appropriate 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.
  - iii. Include a leash attached to the front to be used for towing.