

CCR Liberty

USER MANUAL

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Obrázky CAD

HUD v novém provedení

HS Tilting podobně, jako je v manuálu Freedomu

Fotky udělat

Seřízení postroje – tři prsty pod popruhem

Seřízení postroje – zavěšení palců do D-kroužků

Dopsat

3.1.1 Sorbent replacement – doplnit radiální sklepaní

Introduction

Use of this manual

This user manual is part of the CCR Liberty documentation.

The CCR Liberty is intended for use exclusively by a trained person who is capable of fully understanding the instructions contained in this manual or is in the process of training with the CCR Liberty in a course accredited by the manufacturer. The initial requirements of such a training course include qualification for diving with trimix recognized by a training agency and sufficient experience with technical diving.

Responsibility of the CCR Liberty user

Strong emphasis was placed on reliability during the development of the CCR Liberty. Individual internal parts are separated in order to minimize the impact that failure of a given part may have on the rebreather's basic functionality. A number of systems have multiple backups. The logic of the CCR Liberty's control never prohibits the start of a dive even in the event that malfunctions are detected; it only indicates the status if able to do so in light of the damage. When cave diving, the inability to submerge can mean not being able to return from a dive; therefore, the CCR Liberty does not impede submersion.

The user must always decide responsibly whether he/she switches to a backup apparatus or even starts a dive with a partially malfunctioning rebreather.

A CCR Liberty user must accept the fact that diving involves risk. Following everything that the user has learned in the CCR Liberty's technical documentation and in training on diving with this rebreather can reduce the risk but cannot eliminate it. Safety when diving is further improved by regular training, methodical education and following good diving practices. Diving with a rebreather requires a far higher degree of carefulness and discipline than diving with an open-circuit apparatus.

If you do not accept the risk and you are not a trained, careful and disciplined diver, do not dive with the CCR Liberty.

The manufacturer does not bear any responsibility for use of the CCR Liberty if the apparatus has been modified in any way that is not stated in this manual or in the technical guidelines issued by the manufacturer.

System of documentation

Version

The technical documentation is subjected to a process of continual development and improvement. Therefore, please regularly check the website at www.CCRLiberty.com for updates.

This manual provides operating instructions for the hardware and software (firmware) version of the CCR Liberty written on the title page.

Technical guidelines

The manufacturer can issue technical guidelines. It is strongly recommended that the user regularly checks www.CCRLiberty.com for new guidelines. Registered users will receive notifications by e-mail.

Update of printed documentation

The electronic form of the manual is always available in its complete, updated form.

The electronic and printed forms of the manual may not be completely identical. In case of insignificant changes (correction of minor typing errors, for example), only the electronic version is updated.

User support

Registered users are entitled to technical support. The extent of free support can be limited.

The technical support department at Liberty Systems s.r.o. will provide limited support for potential and unregistered users. Prior to submitting a question, please familiarize yourself with the general principles of rebreather diving with trimix and the freely available CCR Liberty technical documentation.

Technical data

Depth limits

The maximum depth for which The CCR Liberty meets the requirements of the Harmonized Standard EN 14143:2013 is 100 m.

Diluent	Max. depth
Air	40 m
tmx 21/35	66 m
tmx 18/45	78 m
tmx (heliox) 10/90	> 78 m

Additional limitation of depth depends on the used diluent, see 3.1.5 [Tank filling - Diluent](#).

All components are tested in overpressure 6 MPa (depth 600 m). The depth gauge is checked and calibrated in overpressure 3.5 MPa (depth 350 m). EC Type-examination was performed to a 100 m simulated depth.

Water temperature limits

The CCR Liberty is intended for use in water temperatures above 4 °C and below 34 °C according to the requirements of EN 14143:2013 (Article 5.1).

The minimal temperature is determined through CO₂ scrubber duration tests, which are done at 4 °C.

CO₂ scrubber duration limit

The maximum safe operating period of the sorbent is 168 min, determined by a test in accordance to EN 14143:2013 (Article 6.6.2). During the test 1.6 l/min of CO₂ were added to the breathing loop with ventilation of 40 l/min in water with temperature 4 °C, exhaled gas with temperature 32±4 °C, 40 m depth and limit at pCO₂ 5 mBar.

The sorbent's actual maximum operating period can differ depending on the sorbent, temperature, depth and the divers physical effort.

In normal conditions scrubber duration is considered to range from 4 h in deep cold water with moderate work to 6 hours for an easy dive. For details see 3.1.1 [Sorbent service life](#)

Weight

The total weight of The CCR Liberty, readied for a dive, including fillings, is approx. 37 kg.

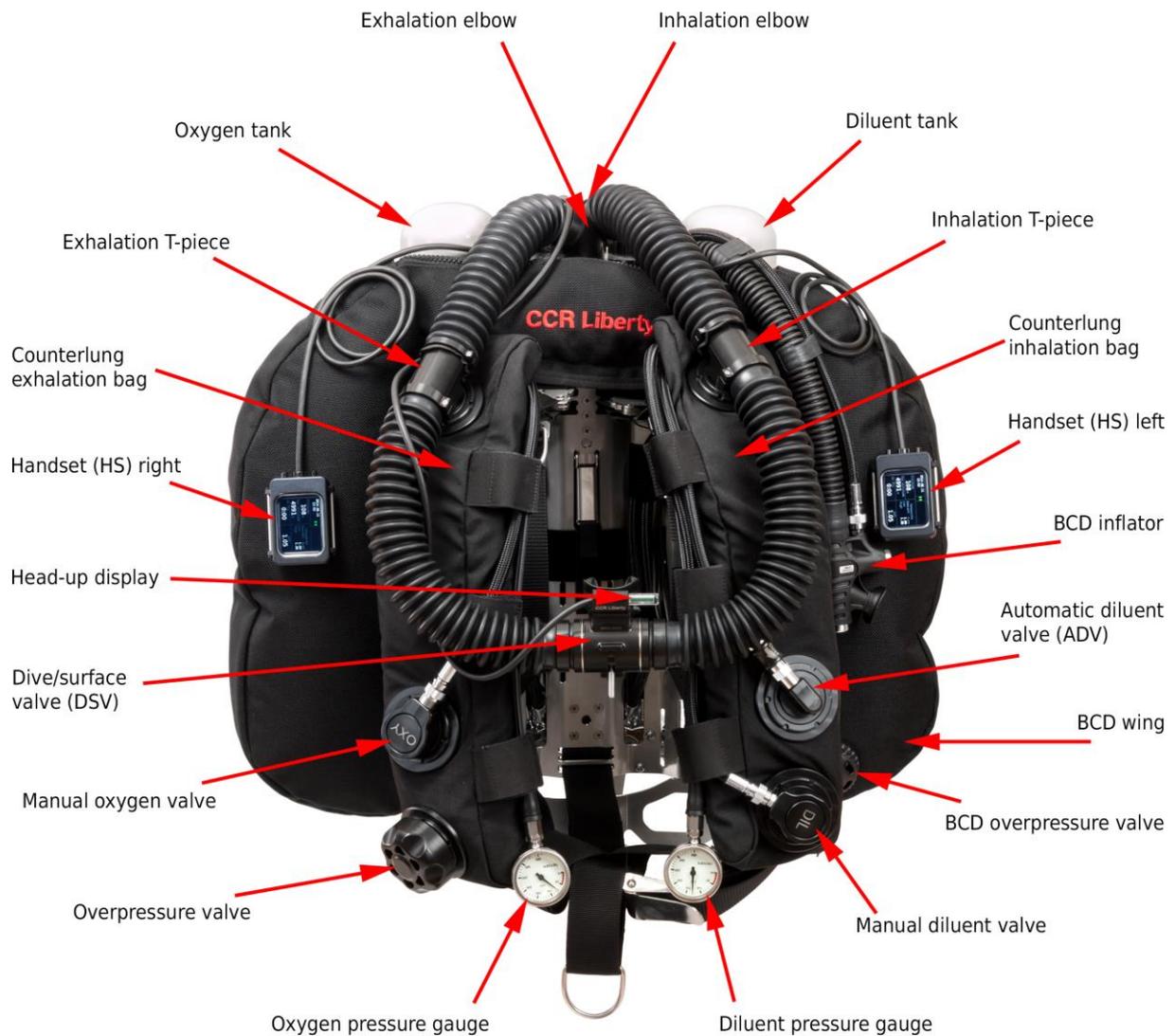
For details see 1.15 [Weights of individual parts](#)

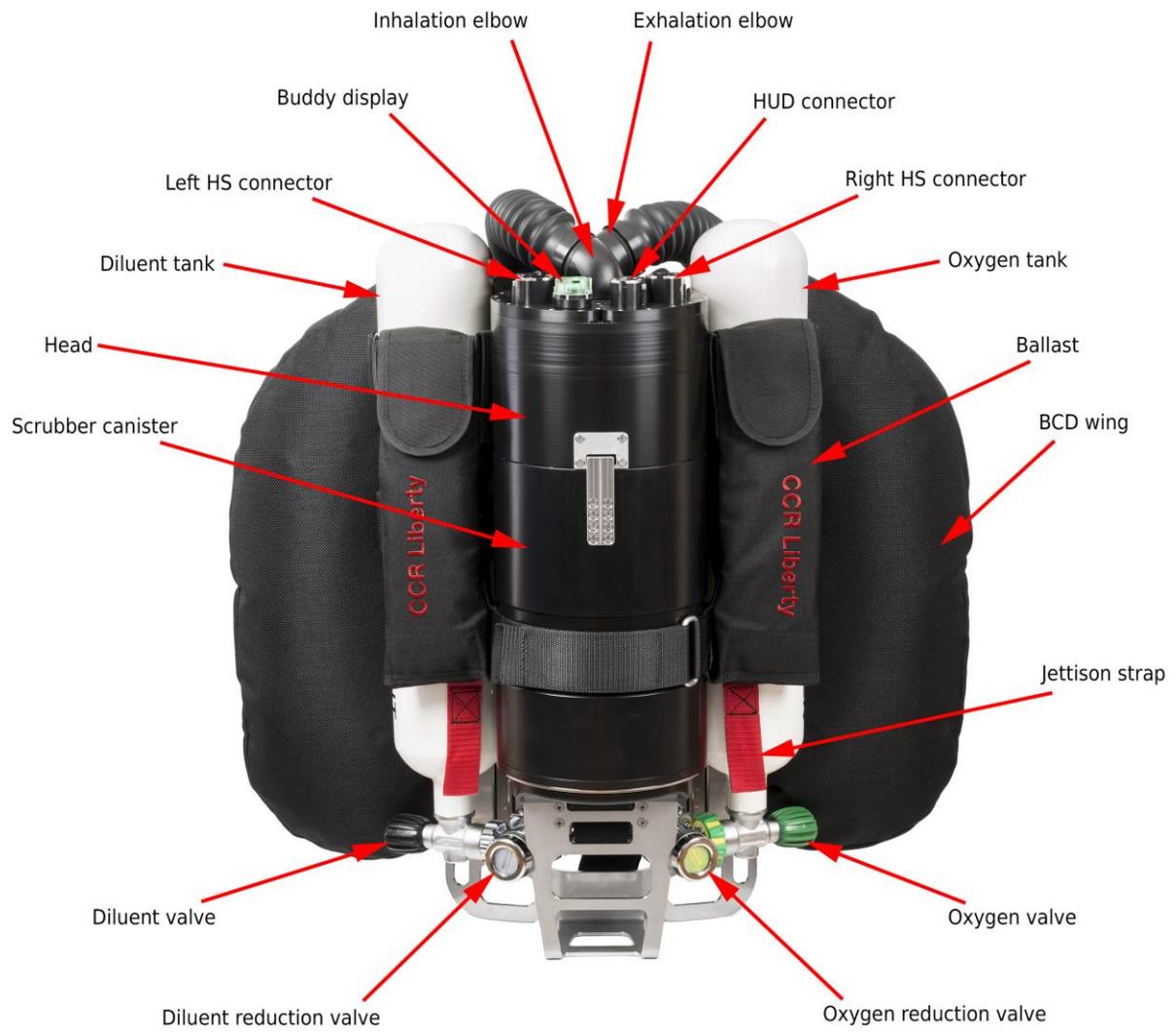
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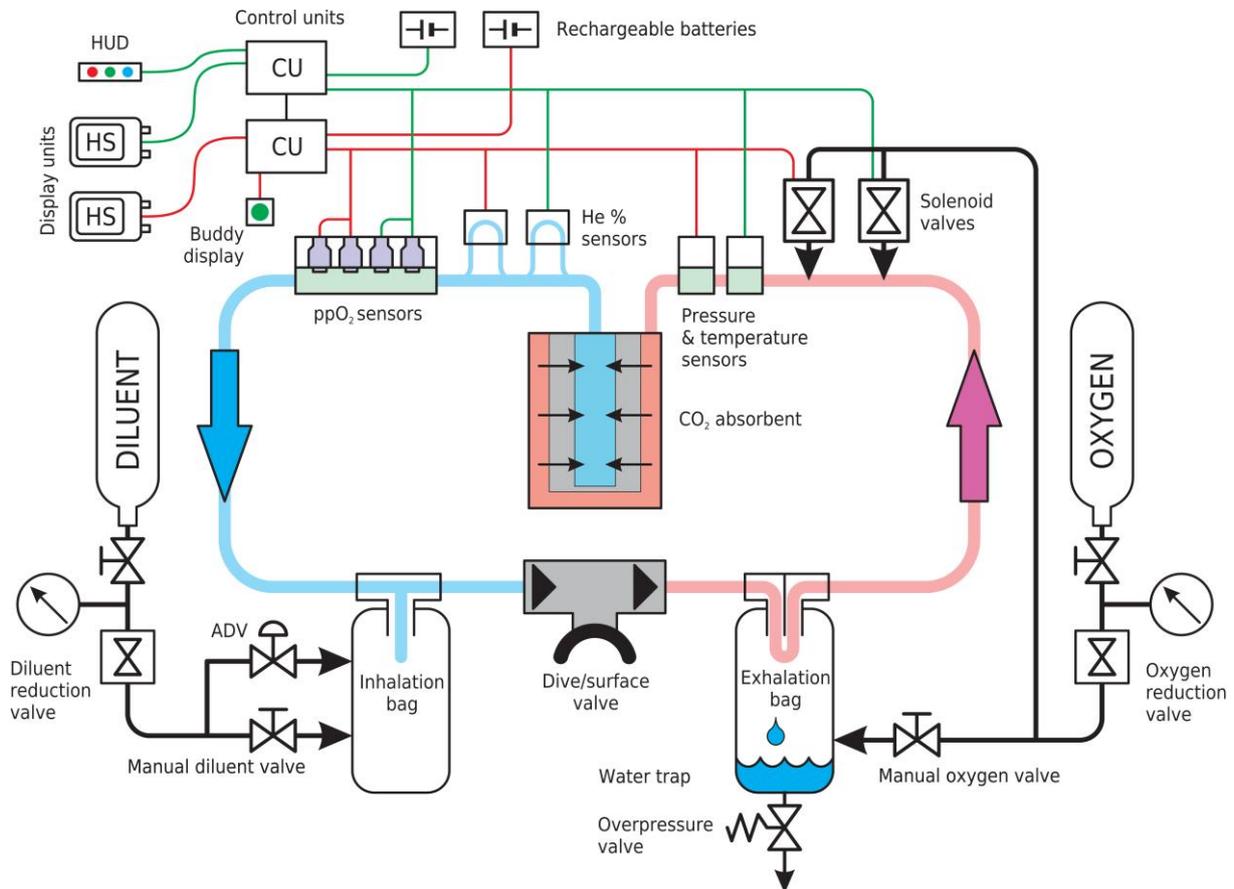
Section 1: Technical design





1.1 Basic schematic

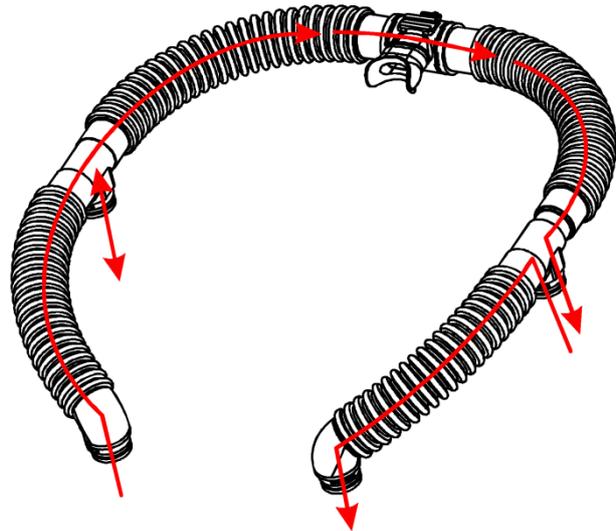
The principle of the rebreather consists in recycling the breathing mixture. Carbon dioxide is removed from the exhaled mixture and is again prepared for the next inhalation after replenishment with oxygen. The composition of the breathing mixture changes continuously.



1.2 Dive/surface valve

The breathing mixture is delivered to the dive/surface valve (DSV) through the corrugated hose from the left. When inhaling, the mixture passes through the inhalation valve to the mouthpiece and then into the diver's respiratory tract. When exhaling, it passes through the exhalation valve into the corrugated hose on the right.

The direction of the mixture's flow is indicated on the DSV.



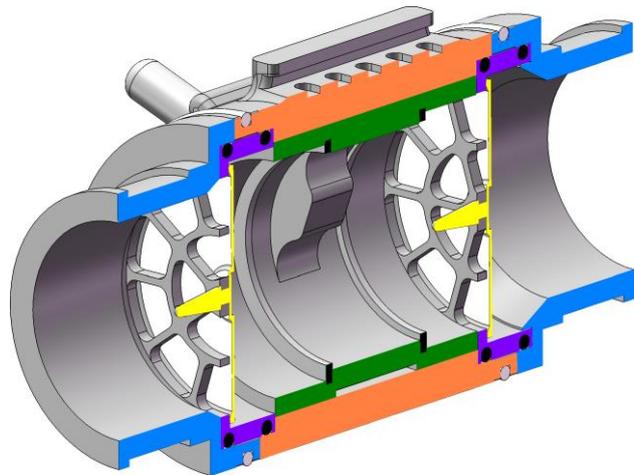
1.2.1 Inhalation valve

The inhalation valve ensures that the exhaled mixture cannot directly return to the inhalation bag and is not repeatedly inhaled by the diver without the removal of carbon dioxide and the addition of oxygen.

The inhalation valve is situated within the connection of the left corrugated hose.

A similar mushroom valve can be found in, for example, the exhalation valve of the second stage of the regulator of an open-circuit apparatus.

This is one of the most critical parts of the rebreather. It is difficult to detect a malfunction in this part during a dive, and such a malfunction can lead to loss of consciousness.



1.2.2 Exhalation valve

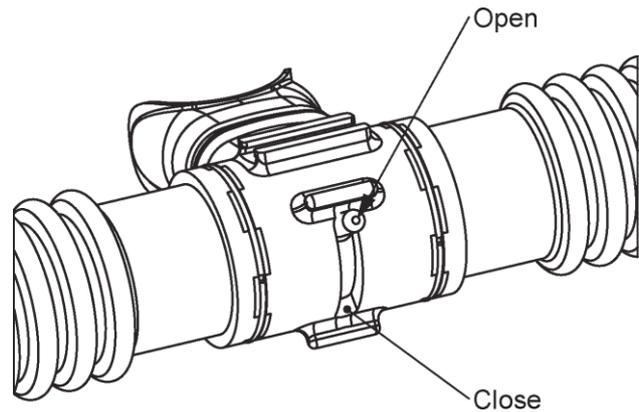
The exhalation valve directs the exhaled mixture via the corrugated hose to the exhalation bag. It ensures that the diver does not directly re-inhale the exhaled mixture.

The exhalation valve is situated within the connection of the right corrugated hose.

Closing the dive/surface valve

If the diver is in the water and not using the DSV, the DSV must be closed. Otherwise, the circuit will be flooded with water.

Closing the DSV is done by using the gate handle in the front part of the DSV. In the open position, the handle is put up; in the closed position, it is down.



1.2.3 Mouthpiece

Tightly sealed mouthpiece in the diver's mouth prevents water from entering into the circuit. The DSV and corrugated hoses function with greater force than the regulator of an open-circuit apparatus. Therefore, an anatomically suitable shape of the rebreather's mouthpiece and proper clenching in the mouth are very important.

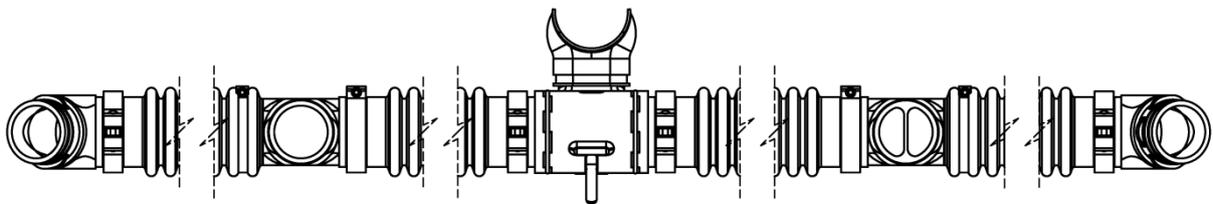
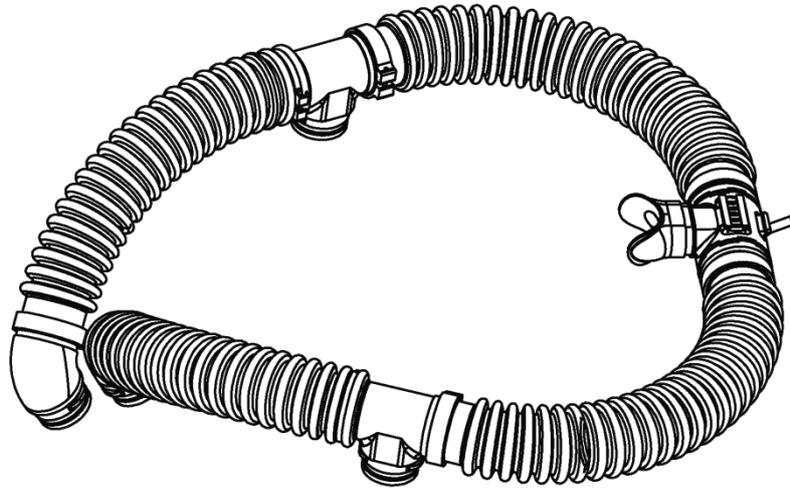
We do not recommend using a mouthpiece that can be shaped to the diver's bite after heating. This kind of mouthpiece restricts the movement of the lower jaw, which leads to unilateral stress and will rapidly exhaust the mastication muscles.

1.2.4 Usage with a full face mask

Even though the mechanical dimensions would allow the connection of the DSV to a full face mask, in a full face mask it is not possible to replace the mixture inlet from an open circuit with the inlet from a rebreather. One of the reasons for this is the necessity of defogging the visor.

Consult with the manufacturer regarding possibilities of connecting the rebreather to a full face mask. Use of such an apparatus will require procedures that deviate from this manual and from standard procedures taught in a course accredited by the rebreather's manufacturer.

1.3 Corrugated hoses and accessories



1.3.1 Hoses

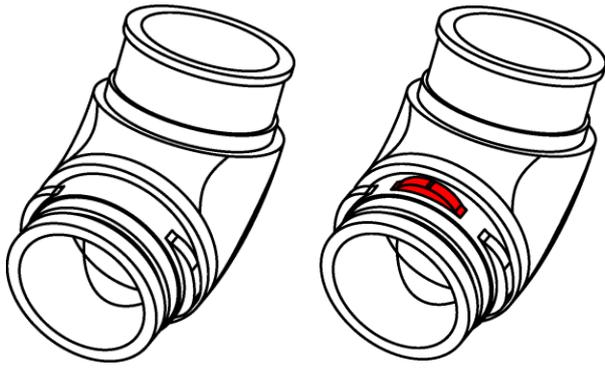
The corrugated hoses are made of EPDM rubber. Compatible chemical agents must be used for cleaning and disinfection (see Chapter 3.4.2 [Cleaning and disinfection](#)).

The corrugated hoses can be damaged if subjected to excessive stress. In particular, it is necessary to avoid perforation, cutting and excessive wear. Avoid long-term deformation of the hose, for example when storing the unit. Do not use the hoses like a handle.

The corrugated hoses are one of the least durable mechanical parts of the CCR Liberty. Pay appropriate attention to protecting them.

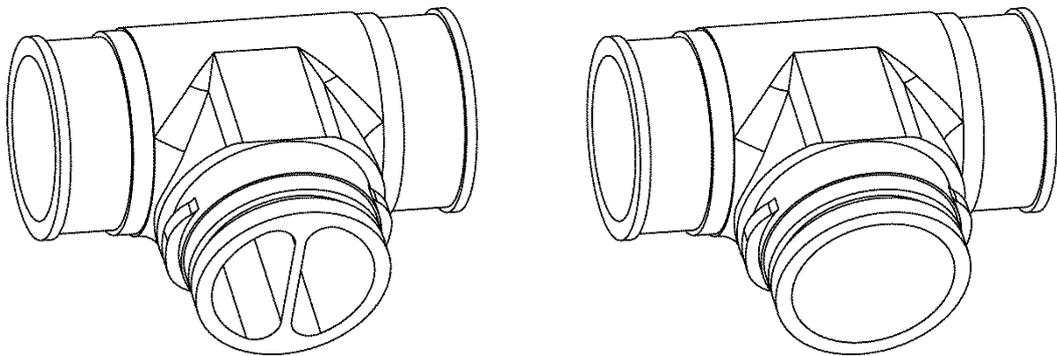
1.3.2 Attachment to the head

Unlike almost all other bayonet connectors on the CCR Liberty, the bayonet connector on the exhalation side has three protrusions. This prevents incorrect attachment of the hoses.



Elbow on the inhalation side (left) and exhalation side (right).

1.3.3 Connection to the breathing bags

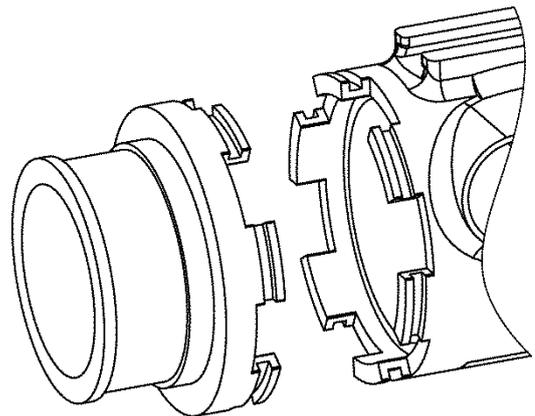


The T-pieces have standard bayonet connections. On the exhalation side, the T-piece has a partition that directs any water that has entered the DSV to the exhalation bag and improves the blending of the mixture with oxygen added using the manual bypass valve.

1.3.4 Attachment of the DSV

Attachment to the corrugated hoses is done with axial teeth that fit together and are secured with a wire retaining ring.

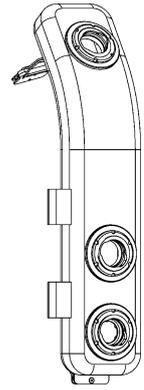
The baskets of the mushroom valves are inserted into the connector. When handling the baskets, pay attention to their correct orientation.



1.4 Inhalation bag

The inhalation bag is mounted on the left part of the harness (from the diver's perspective when wearing the CCR Liberty).

The external cover is made from a resilient textile, ensuring mechanical protection. The internal bag is made from polyurethane. It is connected to the breathing circuit with a T-piece via the upper bulkhead with a bayonet connector.



The inhalation bag is affixed to the harness with two stainless-steel buckles and with Velcro flaps. It can be easily removed for cleaning, disinfection and other handling.

See also 3.4.2 [Cleaning and disinfection](#).

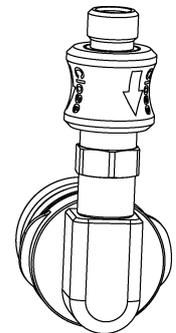
1.4.1 Automatic diluent valve

The automatic diluent valve (ADV) is mounted in the middle bulkhead with a bayonet connector.

When the volume of the inhalation bag decreases, the ADV is pressed. The ADV then automatically adds diluent to the breathing circuit.

The ADV can be closed by sliding the collar.

The sensitivity of the ADV can be decreased with an additional spring, which is included as a spare part.

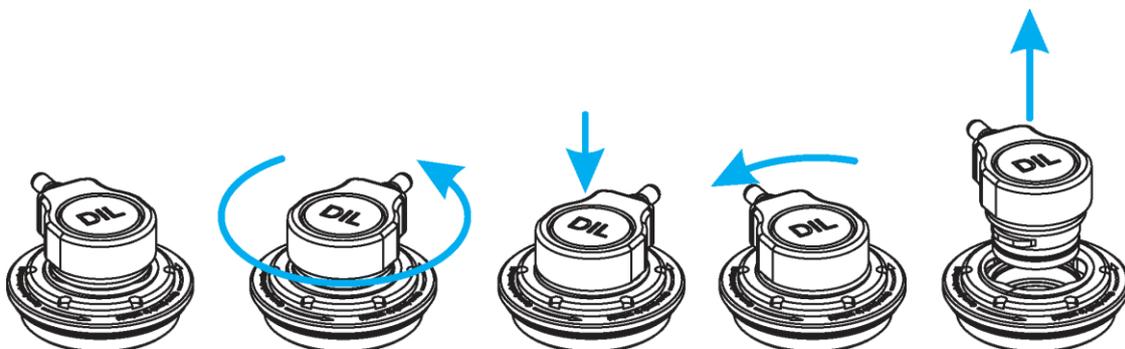


1.4.2 Manual diluent bypass valve

The manual diluent bypass valve is situated in the lower bulkhead of the inhalation bag and is equipped with a bayonet connector.

It is attached to the low pressure (LP) hose with a seatec-style quick-release connector.

It is operated by pressing the center button.



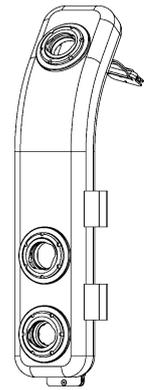
The safety lock prevents diluent valve from accidentally falling out. Follow these steps to remove.

1.5 Exhalation bag

The exhalation bag is situated on the right part of the harness (from the diver's perspective when wearing the CCR Liberty).

The design and the way it is connected to the harness and the breathing loop are similar to those of the inhalation bag.

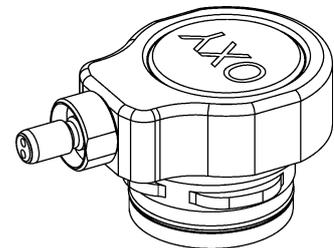
See also 3.4.2 [Cleaning and disinfection](#).



1.5.1 Manual oxygen bypass valve

The manual oxygen bypass valve is situated in the middle bulkhead of the exhalation bag and is equipped with a bayonet connector.

It is attached to the LP hose with an oxygen quick-release connector. This connector is similar to a standard seatec-style quick-release but with a shorter collar. A standard seatec-style quick-release connector cannot be connected to the oxygen quick-release connector.



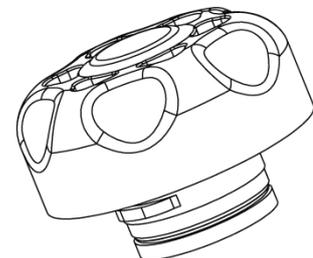
The bayonet connector on the oxygen bypass valve has three protrusions.

Use oxygen-compatible lubricant for maintenance of the oxygen bypass valve.

1.5.2 Overpressure valve

The overpressure valve (OPV) is mounted in the lower bulkhead of the exhalation bag and is equipped with a bayonet connector.

The required overpressure is regulated via rotation. When set to minimal overpressure (by turning counterclockwise), the valve is opened; only a mushroom valve ensures minimal overpressure.



A safety lock prevents the OPV from accidentally falling out. Removal is similar to the [Manual diluent bypass valve](#) (see a previous page).

1.6 Oxygen tank

1.6.1 Tank

The CCR Liberty uses a three-liter steel tank with 100 mm diameter and 200 bar filling pressure. The original 300 bar filling pressure of the bare tank was changed according to valid technical standards.

The tank is labeled OXYGEN.

The tank is situated on the right from the diver's perspective when wearing the CCR Liberty.

For more information on filling, see 3.1.4 [Oxygen](#).

1.6.2 Valve

The valve has a M26×2 200 bar outlet connection.

1.6.3 Reduction valve

The CCR Liberty uses an Apeks DST4 first-stage regulator with a specially made revolving low-pressure component, which is mounted on the backplate. This serves as the lower tank-mounting point; in the middle part, the tank is attached with a strap and Velcro.

The reduction valve is equipped with an intermediate-pressure safety overpressure valve.



1.6.4 Pressure reading

The oxygen pressure gauge is situated on the right side; the HP hose runs through an opening in the backplate.

1.7 Diluent tank

1.7.1 Tank

The CCR Liberty uses a three-liter steel tank with 100 mm diameter and 230 bar filling pressure. The original 300 bar filling pressure of the bare tank was changed because a 230 bar valve is used.

The tank is labeled DILUENT.

The tank is situated on the left from the diver's perspective when wearing the CCR Liberty.

For more information on filling, see 3.1.4 [Diluent](#).

1.7.2 Valve

The valve has a G 5/8" 230 bar outlet connection.

1.7.3 Reduction valve and pressure reading

The design is similar to that of the oxygen tank, only reversed.

1.7.4 Backup regulator (optional)

The second stage of a regulator may be connected to the output of the first stage of the diluent through LP hose of appropriate length. This regulator can be used as a backup if the diluent at a given depth is breathable (oxygen partial pressure between 0.16 and 1.6 bars).

Having the backup regulator connected to the diluent may be useful for sanity breaths and for prolonged switching to a backup apparatus.

However, it is advised to use the backup regulator only in special circumstances, for example during extreme shallow dives.

1.8 CO₂ scrubber

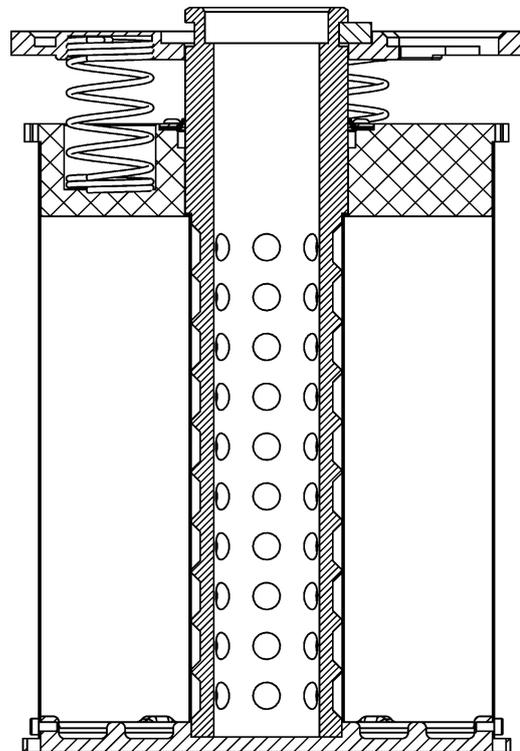
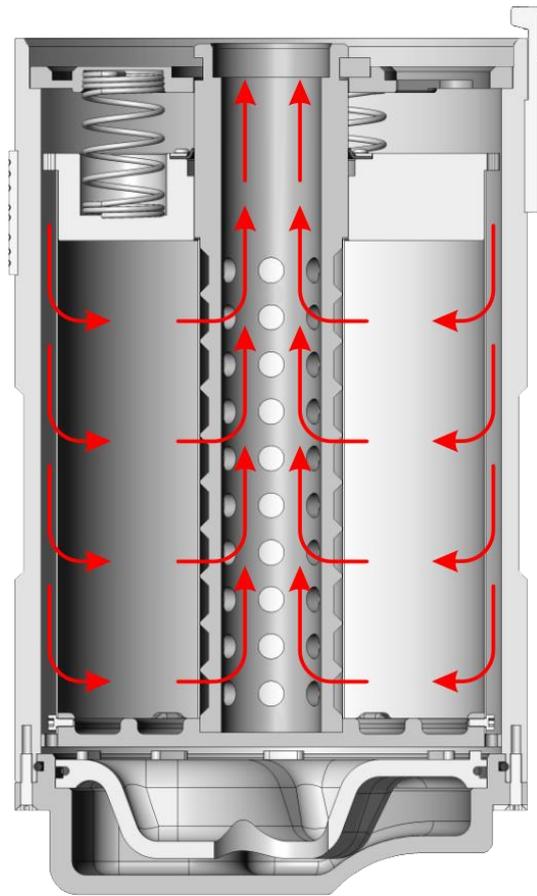
The CCR Liberty uses a radial scrubber. The breathing mixture flows from the outside to the center of the scrubber cartridge.

The scrubber consists of a scrubber cartridge inserted into a scrubber canister (external body of the CCR Liberty). A water trap is situated in the lower part of the canister.

The walls of the cartridges consist of external and internal metal mesh. A lid presses down on the scrubber cartridge by means of springs attached to the pressure plate. The pressure plate is fastened to the central tube with a retaining ring.

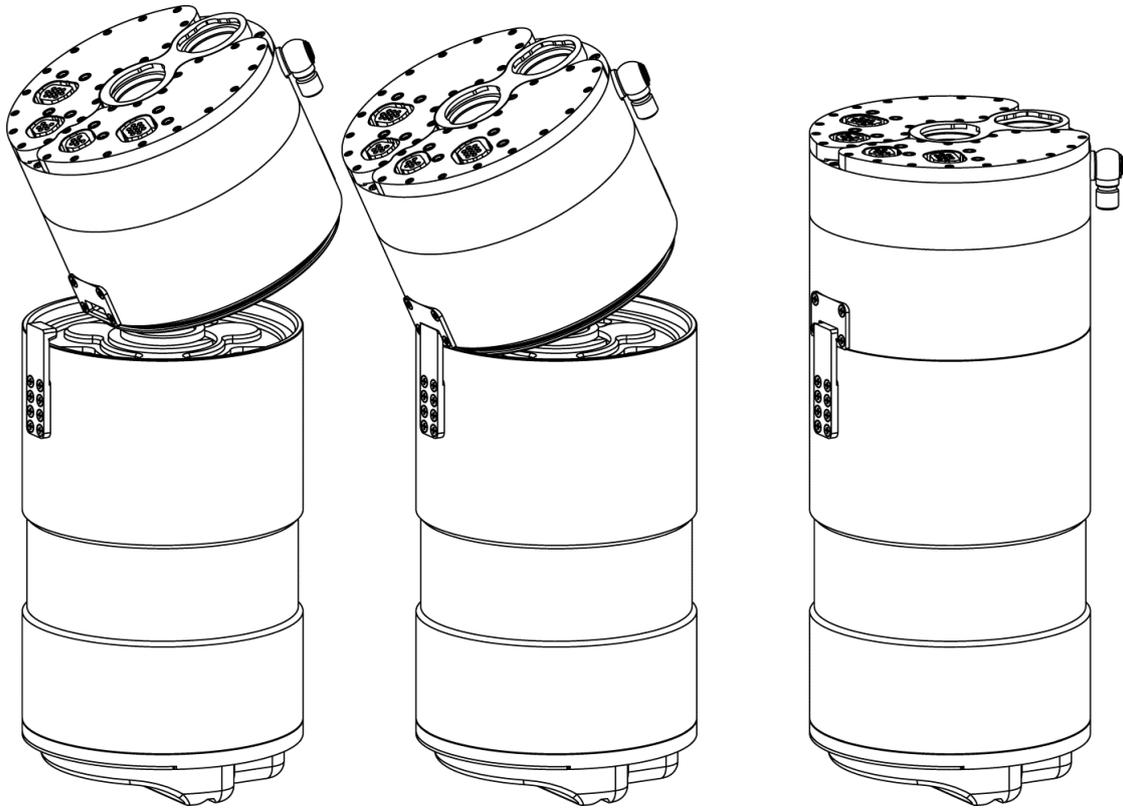
The scrubber cartridge capacity is approximately 2.5 kg of sorbent. The sorbent volume is approximately 2.82-2.99 l.

The service life and replacement of the sorbent are described in chapter 3.1.1 [Replacement of CO₂ sorbent](#).



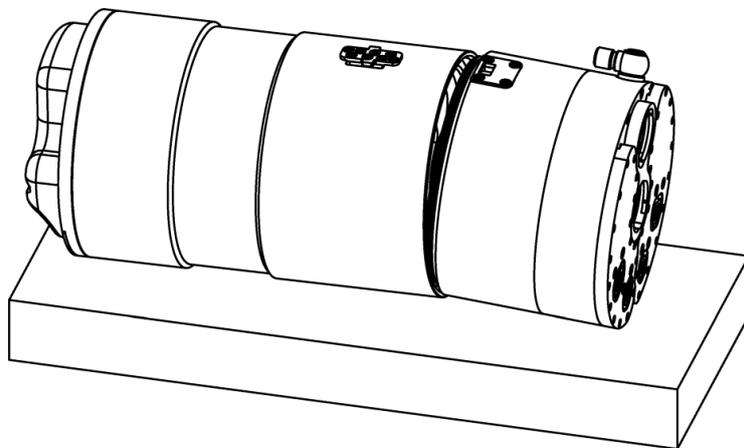
1.9 Head

The head is mounted on the CO₂ scrubber canister.



When mounting the head, push the scrubber-canister pin into the opening on the head and close the head.

The head contains the control units; solenoids; oxygen, helium and pressure sensors; and batteries.



If it is difficult to remove the head, place the rebreather on a hard surface as shown in the illustration. Press down on the head and the scrubber canister with your hands.

1.9.1 Control units

The control units (CUs) are independent. A display unit (handset – HS) is connected to each CU, which has its own power source, solenoid, temperature gauge and pressure, O₂ partial pressure and He concentration sensors.

If one control unit fails, the other control unit takes over automatically.

CUs and HSs are independent computers communicating via a bus. Each handset displays the results of both CU's activities and is used to control both CUs. Each HS is powered through the corresponding CU. In the event of a malfunction of both handsets, either CUs (or the remaining functional CU) will continue to regulate pO₂ without change according to the last adjusted setpoint.

If communication between CUs breaks down, each unit controls one solenoid. The control algorithm is sufficiently robust to ensure that deviation of pO₂ from the allowed limits will not occur during dual, parallel regulation.

Connection to a personal computer

The memory of operating protocols and content of the memory card can be read using a USB adapter connected to the handset connector as a mass storage device (like a flash drive). The connection to Windows, Mac, Linux, Android and iOS was tested, but there is no guarantee of compatibility with all operating systems and all computers.

During the time of USB connection, the control unit is powered from the USB port and, at the same time, the battery is charged (reduced current).

Each control unit is connected separately.

1.9.2 Direct measurement of pO₂

Common R22D-type electrochemical pO₂ sensors are used for measuring. Two sensors are connected to each CU. All sensors are located on the inhalation side.

The diver can manually exclude a sensor from operation and manually return an excluded sensor to averaging. The manual option has a higher priority than automatic detection of faulty sensors. If all sensors are excluded, the CCR Liberty automatically switches to the backup algorithm for calculation of the partial pressure of oxygen indirectly using measurement of the He content.

Circulation of the mixture in the breathing loop is necessary for the measurement accuracy. If the user does not breathe from the rebreather, the mixture in the vicinity of the oxygen sensors can have a different proportion of oxygen than the mixture in different parts of the breathing loop and the displayed data can thus be inaccurate.

A discrepancy can similarly occur in the event of rapid descent, when a larger amount of diluent is added. Therefore, the diluent must be breathable. See 3.1.4 [Diluent](#).

1.9.3 Measurement of He content

The helium concentration is determined by the velocity of sound in the mixture. The He concentration sensors are connected to the inhalation side.

A pressure drop caused by circulation of the mixture in the breathing loop allows the mixture to pass through the sensor. If the user does not breathe from the rebreather, this will not occur and sensor reading may be inaccurate.

If the utilized diluent contains He and its composition is known, the He-concentration measuring function can be used for reverse determination of the concentration of oxygen in the mixture based on the fact that the ratio of inert gases remains constant (process according to patent no. 303577). This principle of measuring the oxygen concentration (and its subsequent automatic conversion on the basis of the known ambient pressure to partial pressure) is used as the backup method of measuring pO_2 in case all electrochemical pO_2 sensors malfunction. This method is intended for use only in emergency situations. If possible, use the apparatus for bailout.



Do not disassemble the sensors; disassembly can result in irreparable damage.

1.9.4 Pressure and depth measurement

Each of the CCR Liberty's control units uses dual pressure sensors. The first sensor, intended for measuring low pressure, is used for determining sea level, for calibration of the pO_2 sensors, and for improving the accuracy of depth data in shallow depth.

The second sensor is intended mainly for measuring hydrostatic pressure. The maximum scope of the sensor corresponds to the depth of 300 m.

1.9.5 Temperature measurement

The temperature in the breathing circuit is measured by temperature sensors within the pressure sensors. The water temperature sensors are situated in the handsets.

Temperature data serve primarily for correction of the measuring of other quantities. The water temperature shown on the HS display is only approximate.

1.9.6 Solenoids

The control units communicate with each other and, in normal circumstances, open the solenoid valves, which supply oxygen to the breathing circuit.

1.9.7 Power supply

The minimum service life of Li-Ion batteries is six months. The typical service life of the batteries is two years.

See also 3.1.6 [Battery charging](#).

Battery compartments are pressure resistant. If overpressure is formed inside a battery compartment as a result of battery malfunction or helium diffusion, then an overpressure valve will release excess gases out of the rebreather.

1.10 Visual display units

1.10.1 Handsets

The handsets provide the CCR Liberty's user with comprehensive information on the rebreather's status and the course of the dive. All functions of the control units are controlled using the handsets.

The functionality of both handsets is identical. Each handset controls both CUs simultaneously. In the event of a malfunction of one handset, the diver simply uses the other handset. During a dive, it is possible to set a different display mode on each handset.

For more information on handset operation, see Section 2: [Control-unit operation](#).

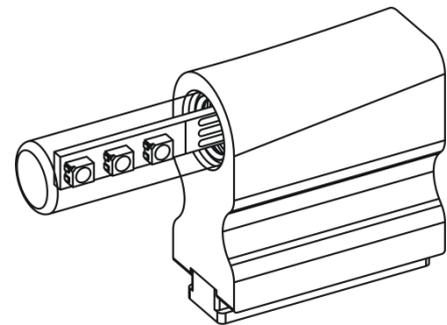
1.10.2 Head-up display

The head-up display (HUD) shows the current partial pressure or CCR error status during the dive.

Other statuses are displayed in standby mode, during charging and when the unit is connected to a computer.

If you are not entirely sure what the HUD is displaying, check the parameters on the handset display. Always check it if the HUD displays a warning (outer LED blinks red) or an alarm (all three LEDs flashes red four times).

See the following table for the various HUD signals.



1.10.3 Buddy display

The buddy display shows whether the values of the partial pressure of oxygen are within the range that is suitable for breathing or if an error situation has occurred. The displayed information is intended for the diving partner of the CCR Liberty's user.

Prior to diving, the user of the CCR Liberty must familiarize his/her diving partner with the buddy display's functionality and agree on the emergency procedure to be carried out in the event that the buddy display indicates an error situation.

See the following table for the various buddy-display signals.

HUD and buddy-display signals

Mode	Event / state	HUD signals			BD signals
		LED 1	LED 2	LED 3	
Startup	Initializing components	Binary coded service numbers			
pO ₂ in dive mode ¹ (bar; standard)	pO ₂ < 0.16	● red blinking		● red blinking	● red blinking
	0.16 ≤ pO ₂ < 0.20	● red blinking		● red blinking	● red
	0.20 ≤ pO ₂ < 0.25		● 8× blue flash		● green
	0.3		● 7× blue flash		● green
	0.4		● 6× blue flash		● green
	0.5		● 5× blue flash		● green
	0.6		● 4× blue flash		● green
	0.7		● 3× blue flash		● green
	0.8		● 2× blue flash		● green
	0.9		● 1× blue flash		● green
	1.0		● green		● green
	1.1		● 1× green flash		● green
	1.2		● 2× green flash		● green
	1.3		● 3× green flash		● green
	1.4		● 4× green flash		● green
	1.5		● 5× green flash		● green
	1.6		● 6× green flash		● green
	1.65 < pO ₂ ≤ 2.0	● red blinking		● red blinking	● red
	pO ₂ > 2.0	● red blinking		● red blinking	● red blinking
Dive mode alarm		● 4× red flash	● 4× red flash	● 4× red flash	no change
Standby (switched off from menu)	Standby		● slowly flashing		● slowly flashing
	Charging	● 1. red	● 2. red	● 3. red	● red
	Charger connected but no power supply	● red blinking			● red blinking
	Fully charged	● green	● green	● green	● green
	Charging failed	● red blinking	● red blinking	● red blinking	● red blinking
Mass storage mode (USB adaptor connected)	Reading	● green	● orange		● green
	Writing	● red	● orange		● red intensive
	No action		● orange		
Download firmware	Connected	● purple	● purple blinking	● purple	
	Downloading		● purple	● purple	

Color blind mode

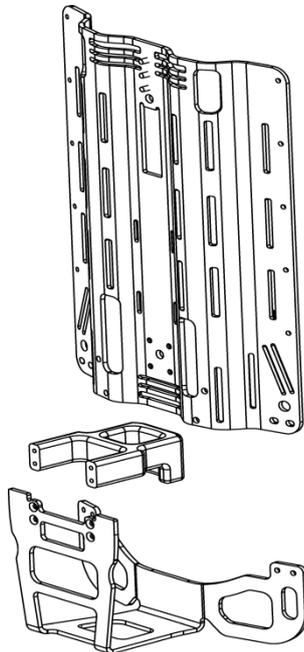
If you cannot distinguish blue and green LED lights, check “Color blind mode” in Setup → Preferences → Indication. Signals for 1.05 ≤ pO₂ ≤ 1.65 will be changed according the following table:

pO ₂ in dive mode ¹ (bar; color blind)	1.1	● 1× green flash		● 1× green flash
	1.2	● 2× green flash		● 2× green flash
	1.3	● 3× green flash		● 3× green flash
	1.4	● 4× green flash		● 4× green flash
	1.5	● 5× green flash		● 5× green flash
	1.6	● 6× green flash		● 6× green flash

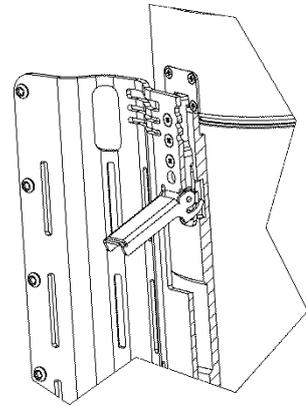
¹ Indicated pO₂ value in the range ±0.05 bar

1.11 Backplate and mounting

The method of mounting the CCR Liberty on the diver's body is based on the backplate and harness common among wing-type buoyancy compensators used in technical diving.

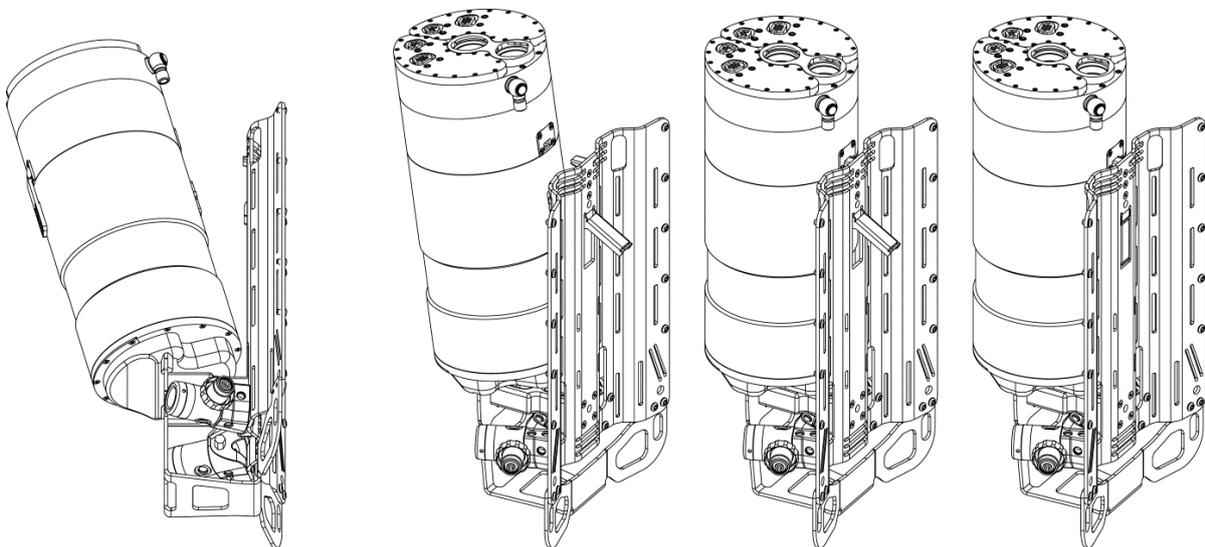


The body of the rebreather, comprised of the scrubber canister and attached head, is attached to the backplate with a cam. The cam lever cannot be released when the diver is wearing the rebreather.



The CCR Liberty's integrated stand, which serves as a lumbar support, is intended for setting the rebreather on a hard, level surface with sufficient rigidity. Always secure the standing rebreather to prevent falling.

If needed, it is possible to remove the CCR Liberty's backplate, together with the buoyancy compensator from the components specific for the rebreather and use it with the harness for open-circuit diving. It enables attachment of a twin-set (two tanks firmly connected with stainless steel bands) using bolts and wing nuts as is common in technical diving, as well as attachment of a single tank with a strap with fastener (not included with the CCR Liberty).



With the slot in the lower part, the rebreather's body fits into the protrusions of the stand.

1.12 Harness

The backplate is equipped with harness that is threaded through in a way that ensures proper system functioning. Do not change the way it is made. If you do try to take the harness out, record or remember exactly how it is threaded through in order to prevent interference with the functioning of the whole system.

It is necessary to adjust the harness so that it fits properly. Adjust the harness without the mounted scrubber canister, head, corrugated hoses and breathing bags.

Adjust the length of the shoulder straps so that it is possible to insert three fingers (index, middle and ring) under the straps at the collar-bone level without great resistance but not entirely freely.

The chest D-rings should be as low as possible, while still allowing you to cross your arms over your chest comfortably. The D-rings should be high enough for you to reach the left ring with your left thumb, and the right ring with your right thumb. The D-ring on the left side of the waist strap should be roughly on your hip.

Adjust the length of the left part of the belt strap so that it passes through the eye of the crotch strap and there is a distance of approximately 5 cm (strap width) between the ring and the eye. Adjust the right part so that the strap is slightly tight. If you shorten a strap, leave sufficient reserve for different suits and possible change of body dimensions. After shortening, it is necessary to deburr the ends of the straps by heat sealing them with a cigarette lighter or candle. Do this carefully so as not to form a hard surface on the strap ends.

Adjust the length of the crotch strap so that it passes closely to the body but does not bind. Set the position of the rear D-ring as low as possible but sufficiently high so that it does not place pressure on the buttocks when swimming. The rear D-ring should be within the diver's reach. Test the exact position of the rear D-ring in the water with the complete apparatus.

Do not shorten the straps after the first fitting. Wait until you test your gear in the water. You will be doing additional adjustments for 3 to 5 dives until the gear is fitted properly.

1.13 Buoyancy compensator

The CCR Liberty uses a wing-type buoyancy compensator (BCD) with displacement of 200 N. The compensator's design and materials are very durable and even suitable for cave and wreck diving.

The wing has a two-ply design. The internal bladder is made of high-frequency-welded Cordura 560 fabric with PU coating. The wing's external cover is made of Cordura 2000 fabric.

The wing is attached with screws along the edge of the backplate.

In order to achieve the correct position of the inflator, pass the LP hose through the rubber ring on the corrugated hose, then through the rubber ring on the shoulder strap and finally through the second rubber ring on the corrugated hose. Do not skip either of the rings on the corrugated hose; upon disconnecting the quick-release connector from the inflator, it could recede so far that it would be difficult to find it.

The buoyancy compensator is not a life preserver. It does not maintain the diver in a face-up position. It is not designed to hold the diver's face above the surface should he/she become unconscious or immobile.

A marking on the backplate indicates that the BCD is suitable for use with two 3 litre cylinders & rebreather. Of course, any number of neutrally buoyant bailout cylinders can be added to provide enough bailout gas supply. It can be applied to any other piece of equipment with neutral buoyancy, such as propulsion vehicles (scooters), large diving lights etc.

There are some options if bailout cylinders are not perfectly neutrally buoyant and you need a large quantity of backup gas. First option, typical for cave diving, is not to carry all the gas in one moment. Attach stage tanks with backup gas to the appropriate points on the cave line during a preparation dive. Then make a push dive(s). Then collect unused backup gas during a cleanup dive.

Second option, typical for deep wreck diving, is making your backup tank's buoyancy perfectly neutral. You can achieve this with a light regulator, SPG and hoses attached to the stage tank (typically aluminum S80) filled with helium rich gas mix.

1.14 Ballast

The ballast system is composed of two pouches placed on the sides of the scrubber canister and is attached to the tanks. In the lower part of the pouches, there is a loop through which the attachment strap of the rebreather body is passed. The loop in the upper part is generally not used; it is intended for additional securing if needed. The internal pouches, which contain the individual weights, are inserted into the external pouches. The upper flap of the external pouch is intended for inserting weights before a dive and removing them after. For emergency jettisoning of ballast, pull the red strap on the lower part of the pouch. This will open the external pouch and will release the internal pouch containing the ballast.

For common removal of the ballast, do not use the method for emergency jettisoning. This could lead to excessive wear of the Velcro.

A diver in a dry suit typically needs 2×4 kg of ballast. Proper ballast weight and distribution is a subject of the CCR Liberty diver course.

1.15 Weights of individual parts

The listed weights are merely an indication. The weight of the parts for each particular apparatus may vary.

Backplate with the wing, harness and hoses, without counterlungs	10.68 kg
Weight pockets (without weights)	0.43 kg
Couterlungs incl. all valves	1.86 kg
Tank with valve, empty	5.44 kg
Corrugated hose, complete	1.11 kg
Scrubber body and cartridge, without sorbent	3.76 kg
Head incl. handsets, HUD and BD	4.59 kg
Charger with cable	0.09 kg
Supplied accessories and small parts (without chargers)	1.00 kg
Peli Stormcase iM2975	10.30 kg
Oxygen 3 l at 200 bar	0.84 kg
Diluent (air) 3 l at 300 bar	0.91 kg
Sofnolime	2.50 kg
Energy stored in batteries	4.16×10^{-11} kg

Section 2: Control-unit operation

2.1 Control elements

The control of all electronics in the CCR Liberty is performed via the handsets.

The following inputs and combinations are differentiated:

- Press upper key
- Press lower key
- Press both keys
- Long press upper key
- Long press lower key
- Long press both keys
- Coded key press (press both keys, then release one key and press it again, then release both keys)
- Tilt the HS away from yourself
- Tilt the HS toward yourself
- Tilt the HS to the left
- Tilt the HS to the right
- Tap the display glass
- Shine a light on the display

“Long press” means pressing the key for more than 2.5 seconds. The key-press operation is terminated at the moment the key is released or, when pressing both keys, when the last key is released.

The upper/lower keys and directions of tilting are determined by the configuration of the given HS, depending on whether it is set up for the left or right hand.

HS tilting can be changed in the configuration to tapping on the HS from any of the four sides.

2.1.1 Meanings of inputs in surface modes

The keys and other inputs are assigned meanings in connection with the current navigation item in the menu. At the same time, however, general rules, which apply wherever possible, are determined for their use.

Press upper key — confirmation of the selected menu item

Press lower key — cycle downward through the menu

Press both keys — exit the menu without performing any action

Long press upper key — page up

Long press lower key — page down

Long press both keys — return to main screen

Coded key press — switch to maintenance mode (this can be done only from the main screen)

Tilt HS away from yourself — increase the entered digit by one or check flag

Tilt HS toward yourself — decrease the entered digit by one or uncheck flag

Tilt HS to the left — move the cursor to the left

Tilt HS to the right — move the cursor to the right

Wherever possible (menu, editing screen), helpful symbols relating to the keys are displayed. A symbol can be either next to a key, indicating the action executed during a short key press, or between the keys, indicating the action executed during a short press of both keys.

The  symbol next to a key means scroll down one row in the menu. Scrolling in the menu is cyclical, so the first row appears again after the last row. The scroll-up function is not available due to two-key control.

The  symbol means return one level without executing any action.

The  symbol represents confirmation of the action or selection.

2.1.2 Meanings of inputs in dive modes

The meanings of inputs are the same as in surface modes. Other possibilities are:

Long press upper key — high setpoint

Long press lower key — low setpoint

Tilting is expanded with movement in decompression games; entry of digits, for which tilting is used in surface modes, is limited during the dive to special cases only.

Tapping on the display glass - switch on (activate) the display if it is switched off (deactivated).

Shining a light on the display - in the dark, illuminating the display with a dive light activates it in the same way as tapping on the glass. In the light, the display can be activated by covering and then uncovering it.

2.1.3 Language

All textual information on the CCR Liberty is in English. Controlling the apparatus requires knowledge of the English language at a level that at least allows the user to thoroughly understand this information.

2.2 Switching on the unit

In order for it to be possible to switch on the CCR Liberty's control unit, it must be in standby mode, which is indicated on the HUD (slowly flashing blue LED) and the buddy display (slowly flashing green LED).

If the jumpers are removed (or turned so that the pins are not inserted in the connector), the rebreather's control unit cannot be turned on, except with USB power when connected to a computer via an adapter.

2.2.1 Activation

The device is activated by pressing both keys on either handset for three seconds.

Automatic activation occurs in the event of entering the water with a deactivated rebreather. In such a case, the user cannot continue the dive, but must perform complete pre-dive preparation on the surface as soon as possible.

Using automatic activation, it is also possible to switch on the CCR Liberty in the event of damage or loss of both handsets. Using this option is risky and should thus be considered only for a rescue attempt, for example for the evacuation of a diver from the siphon of a flooded cave.

Upon activation, the rebreather switches to surface mode. If submerged to a depth greater than 1.5 m, the rebreather automatically switches to CCR mode.

2.3 Surface mode

2.3.1 Entering surface mode

The CCR Liberty switches to surface mode when switched on and activated by pressing the keys. In the water, surface mode can be selected in the menu if the depth is less than 1.5 m.

2.3.2 Surface mode primary screen

Date and Time

Maintain correct local time setting. It will be used for log recording.

Stack time

The scrubber stack timer runs continuously in dive mode (except OC bailout) regardless of depth, even on the surface.

If you spend a long time in dive mode while not breathing from the rebreather's loop, then increase the time for the stack time warning.

Don't forget to reset the timer when you refill the scrubber (Pre-dive → Stack time reset).

Max altitude

The maximum allowed altitude calculation is based on the ZHL decompression algorithm with an additional safety margin ($GF = 0.80$).

No fly

The calculation of the no fly time is based on the maximum allowed altitude according to the Bühlmann decompression algorithm ZHL.

The air pressure in the cabin of a commercial aircraft is maintained at a level corresponding to air pressure at 1800–2400 m (6000–8000 feet) above sea level while cruising altitude falls in the range 11 000–12 200 m (36 000–40 000 feet).

The no fly time calculation uses the decisive altitude 4464 m (14 646 ft). At this altitude compartments containing the oxygen masks will be opened automatically and the oxygen masks will drop down in front of the aircraft passengers.



2015.07.30 08:44		Surface time 4 days
Stack time 2:26	Setpoints Descent ---	Low 0.70 High 1.30
Max altitude 5050 m	No fly 0:00	pO ₂ 0.20

Battery symbol

A graphical indication shows the remaining battery capacity. Two batteries are indicated separately.



The battery is full



Bar height is proportional to the remaining battery capacity



Color is changed at less than half capacity



Plugged to a charger

Setpoints

Descent (“-.-” if disabled), low and high setpoints are listed.

pO₂

Measured partial pressure of oxygen is displayed.

2.3.3 Surface mode O₂ sensors screen

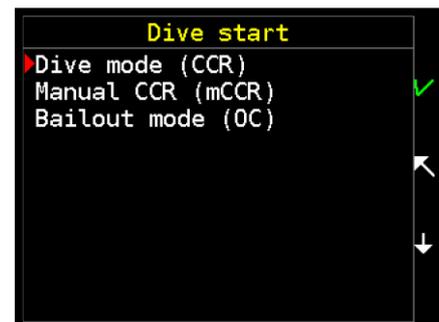
Not only the pO₂ but also the voltage on the sensors can be read. If the state of a sensor is not in operational mode (not connected, offline, error, excluded, disabled, uncalibrated), the appropriate tag appears instead of the pO₂ value.

You can find also the local time, the max. sensor’s reading difference and the stack time on the O₂ sensors screen.

2.3.4 Switching to other modes

In the menu the user can switch from surface mode to the CCR, manual CCR, bailout and standby modes.

If submerged to a depth greater than 1.5 m, the rebreather automatically switches to CCR mode.



2.3.5 pO₂ control

Simple pO₂ control is started in surface mode. If the oxygen content in the loop falls below 19% (with respect to the current atmospheric pressure), pO₂ is increased to 23% by opening the solenoid. Then O₂ is injected in six-second intervals. This control algorithm is intended to prevent the dangerous decline of pO₂ and the subsequent loss of consciousness by the user, who could mistakenly breathe from the circuit without activating dive mode.

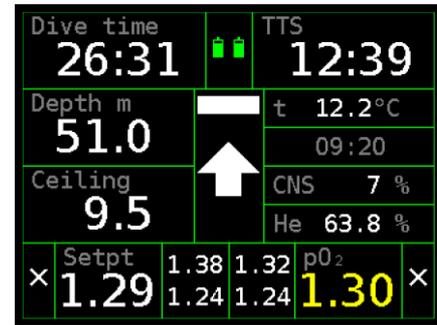
pO₂ control is subject to other conditions — the oxygen tank must be full, connected and open; pO₂ sensors must be installed and calibrated; and the user may not exert excessive effort which causes high consumption of oxygen.

pO₂ control in surface mode only maintains the oxygen level closely above the hypoxia threshold; therefore, it may not be used routinely for breathing.

2.4 Dive mode

2.4.1 Detailed screen

The primary screen displays all necessary information during a dive. Most information is provided by clear values and unambiguous symbols.



Dive time

The timer starts after submersion (depth > 1.5 m) and halts after surfacing (depth < 0.5 m). In case of stay on the surface (or at very shallow depth) followed by a second submersion (during a time set in the dive termination timeout) the dive time indicated will be the time from the first submersion including the surface time.

Depth

The depth can be read in the units set in the setup (m or ft). Depth is calculated from measured hydrostatic pressure. Fresh water (default) or seawater density can be set for the depth calculation (units and salinity are set in Setup → Preferences).

Setting fresh/sea water doesn't affect decompression calculations. Decompression is based on ambient pressure and is independent of the displayed depth.

No deco

You can stay for the indicated time at the current depth, breathing the current mixture (current He content and current SP), to avoid a decompression obligation.

Ceiling

The depth of the decompression ceiling decreases continuously up to the surface. The reading is not artificially stopped anywhere during the ascent. Always stay below the depth of the ceiling, even if the ceiling depth is very shallow.

Ascending above the ceiling generates a warning. Further violation, more than 1 m (3 ft), leads to an additional alarm. Both alarms are logged. The decompression calculation will continue without a penalization. The diver is responsible to decide how to minimize the probability of severe consequences.

Battery symbols



The battery is full



Bar height is proportional to the remaining battery capacity



Color is changed at less than half capacity

Combined graphic symbol

The combined graphic symbol on the detailed screen is intended for rapid orientation. It tells the diver what must be done. The color of the warning symbols changes from yellow to red according to the degree of importance.



Permitted to ascend to the surface.



Permitted to ascend to the depth of the decompression stop or decompression ceiling.



The depth of the decompression ceiling or decompression stop has been reached; do not change depth.



The depth of the safety stop has been reached; do not change depth.



The ascent rate has been exceeded; slow your ascent.



The current depth is less than the depth of the decompression ceiling; descend.

TTS

The time to surface (TTS) includes the complete decompression profile.

t (Temperature)

Water temperature is measured inside the HS case. After a water temperature change wait about 1-2 minutes until the temperature reading reaches a stable value. The air temperature is affected by many factors and is only an indication.

CNS

The so called “oxygen clock” is a percentage of consumption of CNS toxicity limit. Calculation is based on NOAA oxygen exposure limits.

See also 3.3.1 [Breathing high oxygen content gases](#).

He

This shows the fraction of helium in the breathing mixture. The He fraction display method depends on the setting in Setup → Preferences.

Solenoid symbols

In the lower left and right corners, there are symbols indicating the state of the solenoids according to data from the control units.

X - solenoid in closed state

= - solenoid in open state

Setpnt

The setpoint is a required pO_2 value; for information on adjusting the setpoint, see 2.8.2 [Setpoints](#).

O₂ sensors

pO_2 as measured by four O₂ sensors is displayed.

pO₂

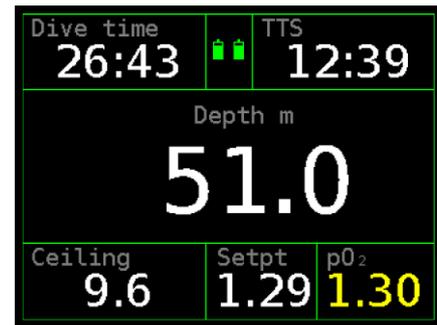
The pO_2 can be measured directly (using O₂ sensors) or indirectly (using He fraction sensors). It shows the average value.

See 1.9.2 [Direct measurement of pO₂](#) and 1.9.3. [Measurement of He content](#)

2.4.2 Synoptic screen

The depth value is easy to read. It is accompanied by other important information.

The meaning of all values is identical to the detailed screen.



2.4.3 Big Screen

The most important information is written in really big characters.

This screen is useful when visibility is very bad. Many divers can read the numbers even without a mask.



2.4.4 Dive profile screen

Start

The time of submersion is useful for checking compliance with the schedule.

Avg

The average depth is indicated with the yellow horizontal line and with a number displayed in yellow.

Current depth

See lower left corner.

Dive time

Runtime of current dive is placed in lower right corner.

Max

This is the maximum depth reached during the dive. The field with this value is placed in the middle of the bottom line.

2.5 CCR mode

This is the primary dive mode with the CCR Liberty.

2.5.1 Entering CCR mode

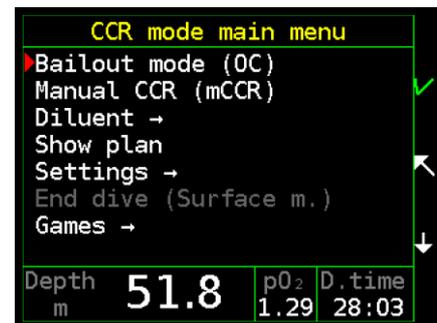
The standard method of switching to CCR mode is by selecting it in the menu from surface mode.

If submersion to a depth greater than 1.5 m occurs in surface mode or standby mode, the rebreather will automatically switch to CCR mode. Do not intentionally use this switching method; it is intended only for emergency situations.

2.5.2 Switching to other modes

It is possible to switch from CCR mode to the manual CCR and bailout OC modes in the menu.

If the current depth is less than 1.5 m, it is possible to switch to surface mode and standby mode.



2.5.3 pO₂ regulation

The basic function of the CCR Liberty is to maintain correct partial pressure of oxygen.

A predictive algorithm of pO₂ control is used. Measured pO₂ is adjusted according to the mathematical model of the breathing loop. The calculation of O₂ delivery and possible subsequent opening of the solenoid is performed at six-second intervals. Oxygen is added alternately using the solenoids corresponding to both control units.

In the event that it is not possible to determine the actual depth (due to a malfunction or manual exclusion of all pressure sensors), regulation of oxygen delivery switches to a simple algorithm.

Setpoint

The setpoint is a required pO₂ value; for information on adjusting the setpoint, see 2.8.2 [Setpoints](#). Two special values, “low setpoint” and “high setpoint” are set. These can be selected simply by a long press of the upper key (for the high setpoint) or lower key (for the low setpoint).

In the default setting, the low setpoint has the value of 0.7 bar (70 kPa). It is possible to reset it within the range of 0.4 to 1.3 bars.

In the standard setting, the high setpoint has the value of 1.3 bars (130 kPa). It is possible to reset it within the range of 0.7 to 1.6 bars.

Upon starting CCR dive mode, the low setpoint is activated by default.

Descent setpoint

The descent setpoint is designed for situations when it is necessary to rapidly descend to a given depth, for example when diving in a current. The utilized algorithm uses the natural rise of pO_2 during descent. It is necessary to descend rapidly. The natural rise of pO_2 has to be faster than the oxygen consumption.

Use of the descent setpoint must be enabled in the configuration.

If it is enabled, the descent setpoint is automatically activated when switching from surface mode to CCR mode. It cannot be activated in another way. The descent setpoint has a variable value. The initial set value gives the pO_2 on the surface. At depth, the current setpoint increases linearly by 0.2 bar (20 kPa) for every 10 m of depth (i.e. it increases by the same absolute values as when diving with an open circuit with air, only with a different initial value).

The descent setpoint is automatically switched to the low setpoint upon reaching the value of the low setpoint or upon completing or significantly slowing the descent, but no later than after ten minutes.

When using the descent setpoint, the user must continuously check whether he/she has reached or exceeded the maximum physiologically permissible pO_2 limit and adjust the rate of descent accordingly or take other measures.

Setpoint limitation

Besides the set value, the setpoint limit is defined by the ambient pressure. For example, at a depth of 3 m, where the hydrostatic pressure is 1.3 bars, pO_2 can reach a maximum of 1.3 bars when using pure oxygen.

For practical reasons (unattainability of a precisely 100% oxygen atmosphere in the breathing loop), the setpoint is set at 90% of the ambient pressure by default. This value can be reset within the range from 60% to 96%.

2.5.4 Decompression

The decompression algorithm takes measured pO_2 values and inert gases according to the set diluent composition into account.

During a dive, the safety level can be set in the menu by switching the set of standard and bailout gradient factors (GFs) without affecting the mode in which the CCR Liberty is operating.

2.5.5 Specific handset control

Long press upper key — high setpoint

Long press lower key — low setpoint

2.6 Manual CCR mode

This mode serves primarily for resolving emergency situations.

2.6.1 Entering manual CCR mode

It is possible to switch to manual CCR mode from the menu in CCR mode, bailout OC mode or surface mode.

2.6.2 Switching to other modes

In the menu, it is possible to switch from manual CCR mode to CCR mode and bailout OC mode.

If the current depth is less than 1.5 m, it is possible to switch to surface mode and standby mode.

2.6.3 pO₂ regulation

Manual CCR mode is based on CCR mode. However, automatic replenishment of oxygen is not available and pO₂ regulation is performed only manually. Measuring and display of pO₂, decompression calculations and the display of all other data are operational.

It is assumed that the user adds oxygen manually using the manual bypass valve or by manipulating the oxygen-tank valve if any solenoid is locked in the open state.

If the pO₂ falls below 0.3 bar, then oxygen will be added to the breathing loop automatically for security reasons. This is only possible if the solenoids are operational and an oxygen supply is available.

When manually adding oxygen to the breathing loop, anticipate a delay between adding oxygen and the change in measured values. This delay is due to the fact that oxygen is added to the exhalation bag and the mixture must pass through the scrubber before it reaches the sensors.

2.6.4 Decompression

The decompression algorithm takes measured pO₂ values and inert gases according to the set diluent composition into account.

2.7 Bailout OC mode

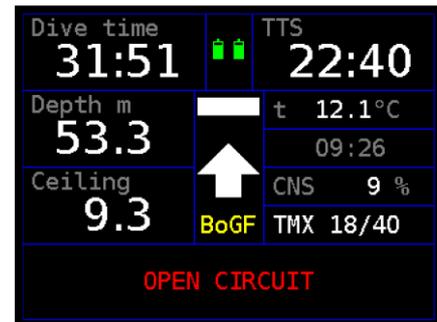
This mode serves primarily for resolving emergency situations.

2.7.1 Entering bailout OC mode

Switching to bailout OC mode is possible from the menu in CCR mode, manual CCR mode or surface mode.

2.7.2 Switching to other modes

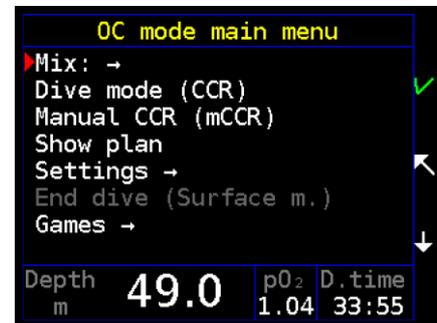
In the menu, it is possible to switch from bailout OC mode to CCR mode and manual CCR mode.



If the current depth is less than 1.5 m, it is possible to switch to surface mode and standby mode.

2.7.3 Mixture

It is assumed that the diver will not breathe from the apparatus's breathing loop, but will rather use a separate open-circuit apparatus. Automatic pO₂ regulation is deactivated in bailout mode; the apparatus functions only as a decompression computer.



Up to eight preset breathing mixtures are available in this mode. The user can select the currently utilized mixture from the menu or can successively select individual mixtures with a long press of the upper or lower key. After switching to bailout OC mode, the configured default mixture is set.

2.7.4 Decompression

The decompression algorithm takes the partial-pressure values according to depth and the set mixture into account.

After switching to bailout OC mode, the safety level is automatically set using the bailout gradient factors (GFs). It is possible to switch between the standard and bailout GF sets in the menu without affecting the mode in which the CCR Liberty is operating.

2.7.5 Specific handset control

Long press upper key — change of mixture (up according to the list, cyclically)

Long press lower key — change of mixture (down according to the list, cyclically)

2.8 Setup

The CCR Liberty is configured in surface mode. Activate the surface mode main menu with a short press of both keys and select Setup.

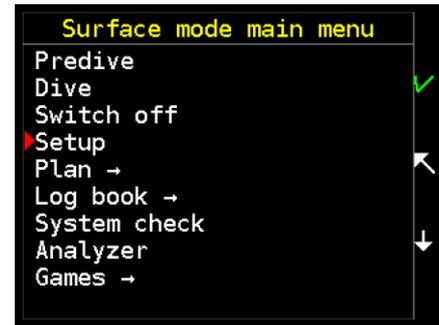
Some values can be set during a dive; however, this possibility is reserved for resolving exceptional and emergency situations only.

The particular set values depend primarily on the user's experience, physiology and personal preferences. The fact that the CCR Liberty enables setting a certain value does not mean that such a setting is safe and suitable for you and for your planned dive.

If you are not sure which value to set, leave the values on the default setting.

The manufacturer does not provide a warranty for faulty operation of the CCR Liberty if this faulty operation is the result of improper setup.

The factory default setting value is shown between square brackets in headlines of following text.



2.8.1 Editor use

The majority of variable values is edited in a similar manner.

Tilt toward yourself— decrease the entered digit by one or uncheck flag

Tilt to the left — move the cursor to the left

Tilt to the right — move the cursor to the right

Press upper key — discard editing (reset to previous value)

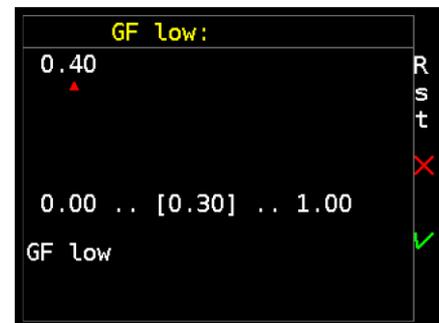
Long press upper key — reset to default value

Press both keys — exit without save

Press lower key — save and exit

Permissible range is indicated by <minimum .. [default] .. maximum> value.

The display shows a brief description below



2.8.2 Setpoints

Use descent SP [Off]

This enables the use of the descent setpoint.

See also 2.5.3 [Descent setpoint](#).

pO₂ descent [0.4 bar]

Value of the descent setpoint (range: 0.2—1.0 bar).

See also 2.5.3 [Descent setpoint](#).

pO₂ low [0.7 bar]

Value of the low setpoint (range: 0.4—1.3 bars).

See also 2.5.3 [Setpoint](#).

pO₂ high [1.3 bar]

Value of the high setpoint (range: 0.7—1.6 bars).

See also 2.5.3 [Setpoint](#).

pO₂ limiting [90%]

The setpoint is limited to the percentage of ambient pressure (range: 60—96%).

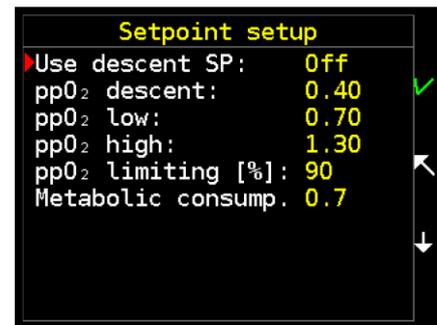
Setting a percentage that is too low reduces the effectiveness of decompression in small depths. Setting a percentage that is too high in small depths increases the intake of oxygen, which makes it necessary to discharge the content of the breathing loop and makes balancing more difficult.

See also 2.5.3 [Setpoint limitation](#).

Metabolic consump. [0.7 l/min]

Physiological consumption of oxygen falls in the range 0.5—1.5 l/min. The pO₂ predictive regulation algorithm takes this value in the breathing loop into account.

Entry of an incorrect value reduces the accuracy of pO₂ control. Do not change the value if you do not know your physiological consumption with regards to the conditions of the planned dive.

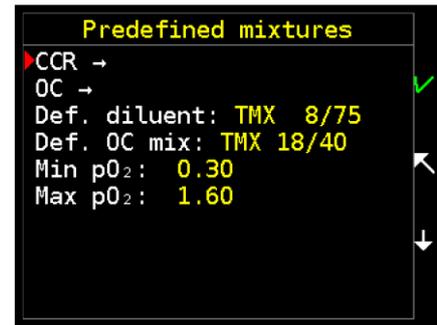


2.8.3 Mixtures

CCR

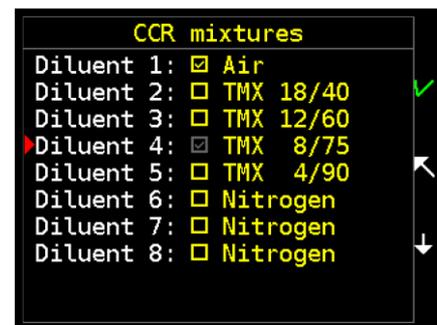
Eight different diluent mixtures with variable fractions of oxygen, nitrogen and helium can be preset.

Select the mixture to edit with the upper key short press, use tilting for changing the values and cursor position.



Each mixture can be enabled (marked checkbox) or disabled (clear checkbox). This can be done in the editing screen or via a shortcut – long press of the upper key in the list of mixtures.

The mixture that you use as diluent must be among the set mixtures. Setting an incorrect diluent composition will lead to an incorrect calculation of the decompression procedure and can lead to an inaccurate determination of the proportion of oxygen in the mixture if the rebreather switches to indirect measuring using the He sensors.



See also 3.1.4 [Diluent](#).

OC

Eight different OC bailout mixtures with variable fractions of oxygen, nitrogen and helium can be preset.

Each mixture can be enabled (marked checkbox) or disabled (clear box). Only enabled mixtures can be selected.

Mixtures that you have prepared for bailout (stage tank) must be entered and enabled.

In an emergency, a mixture can be enabled during a dive. Furthermore, a new mixture can be defined during a dive. These possibilities are reserved for emergency situations only.

Def. diluent

A different default diluent can only be selected from mixtures that are enabled.

Def. OC mix

A different default OC bailout mixture can be selected only from mixtures that are enabled.

2.8.4 Decompression

GF low [0.30]

Gradient factor at the start of decompression (range: 0.05—1.00).

GF low determines an additional increase of safety at the depth of the decompression ceiling at the start of decompression. Setting a value of 1.00 corresponds to the Bühlmann decompression algorithm without additional increase of safety using the gradient factors method.

Setting low values leads to deeper and longer stops at the start of decompression.

GF high [0.80]

Gradient factor at the end of decompression (range: 0.10—1.00).

GF high determines an additional increase of safety when ascending to the surface. Setting a value of 1.00 corresponds to the Bühlmann decompression algorithm without additional increase of safety using the gradient factors method.

Setting low values leads to longer shallow decompression stops.

Bailout GF low [0.80]

Gradient factor for bailout at the start of decompression (range: 0.05—1.00).

As a general rule, for bailout GF low, a higher GF value (a lower additional increase of safety) is set than for standard GF low.

Bailout GF high [0.95]

Gradient factor for bailout at the end of decompression (range: 0.10—1.00).

As a general rule, for bailout GF high, a higher GF value (a lower additional increase of safety) is set than for standard GF high.

Ascent rate

Speed 1 [10 m/min]

Anticipated ascent rate at small depth, in zone 1 (range: 1—20 m/min).

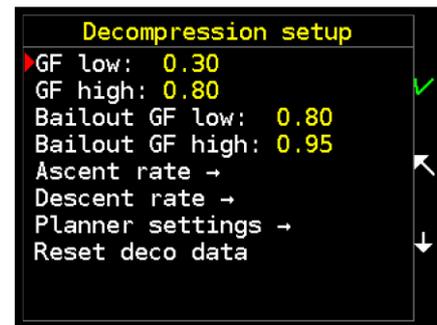
The set rate is used for calculation of the ascent plan.

This value is displayed in m/min or ft/min, as set.

Depth zone 1 [10 m]

Zone 1 lies between the surface and the set depth (range: 0—300 m).

This value is displayed in m or ft, as set.



Speed 2 [10 m/min]

Anticipated ascent rate at medium depths, in zone 2 (range: 1—20 m/min).

Depth zone 2 [80 m]

Zone 2 lies between Depth zone 1 and the set depth (range: 0—300 m).

Speed 3 [10 m/min]

Anticipated ascent rate at large depth, in zone 3.
(range: 1—20 m/min).

Descent rate

Warn under [10 m]

This threshold marks at which depth the alarm is activated to indicate exceeding of descent rate. At smaller depths, exceeding the descent rate is ignored.

This value is displayed in m or ft, as set.

This alarm is disabled by factory default. It can be enabled in Setup → Alarms → Alarm sources → Rates → Descent rate.

Max rate [20 m/min]

Anticipated descent rate (range: 1—40 m/min).

The set rate is also used for dive planning.

This value is displayed in m/min or ft/min, as set.

Reset deco data

This resets the saturation of biologically inert gases and the calculation of oxygen toxicity to a state that corresponds to a very long period after the previous dive.

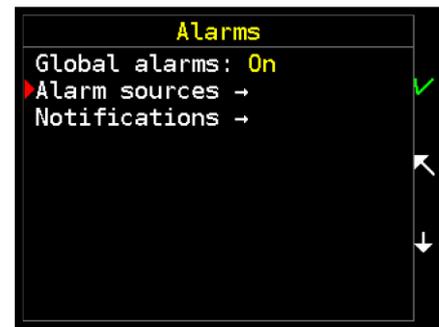
A diver that uses the CCR Liberty after resetting the decompression data should not dive for 48 hours prior to submersion with the reset apparatus. Do not dive for 24 hours with reset apparatus after a significantly increased altitude above sea level.

2.8.5 Alarms

Global alarms [On]

This turns all alarms on or off for the entire CCR Liberty system.

Turning off all alarms is intended only for exceptional cases. If you do not have any serious reason to deactivate the alarms, leave them switched on. If you switch off alarm signaling, you must check all dive parameters very often and with great care.



Alarm sources

Ceiling [On]

Decompression ceiling has been exceeded.

CNS [On]

Oxygen toxicity limit has been reached.

pO₂

Partial pressure of oxygen has exceeded the allowed set range.

Rates

Descent rate [Off]

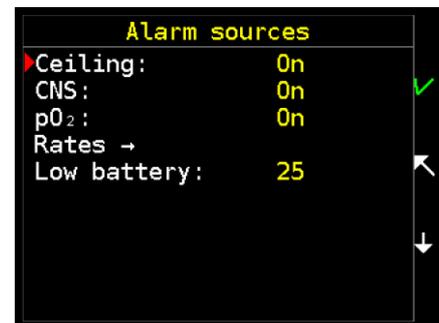
Descent rate has exceeded the set limit.

Ascent rate [On]

Ascent rate has exceeded the set limit, with a tolerance to very short, fast movements.

Low battery [25%]

Battery power has dropped below the set limit (range: 0—40%). Setting 0 means deactivation of this alarm.



Notifications

No deco end [On]

End of the dive in zero time (in the terminology of the Bühlmann decompression model), i.e. notification that it will be necessary to reduce the ascent rate and/or perform decompression stops.

Gas switch reminder [Off]

Recommendation to switch to a different mix. This is used only in bailout OC mode.

Gas switch done [On]

Change of mixture (in bailout OC mode) or diluent has been executed.

Depth

Notification that the set depth during the descent has been reached. It is possible to set three separate depths within the range of 0—300 m. 0 means deactivation of the notification.

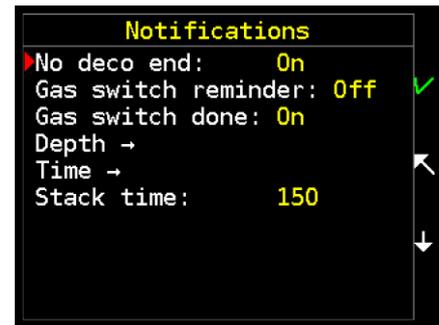
Time

Notification that the dive time has been reached. It is possible to set three separate times within the range of 0—999 min. 0 means deactivation of the notification.

Stack time [150 min]

Notification that the cumulative time in any close circuit dive mode has been reached (range: 0—360min). 0 means deactivation of the notification.

To reset a timer go to the Pre-dive menu.



2.8.6 Preferences

Display

Orientation

Setting for left/right hand.

Screensaver

The display becomes inactive after the set period (range: 0—120 s). 0 means that the display will be constantly active.

Dive mode screens

Any of the five following screens can be enabled or disabled. This can be done during a dive.

Detailed - the primary screen displays all necessary information

Synoptic - the depth value is easy to read; it is accompanied by other important information

Big - the most important information written in really big characters

Graph - Dive profile screen

O₂ sensors - detailed state of the sensors

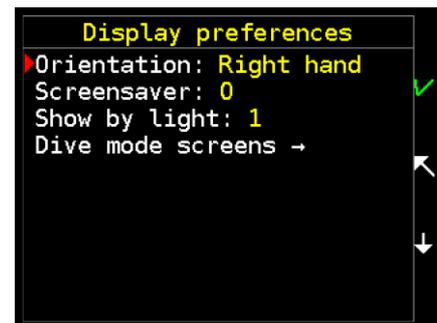
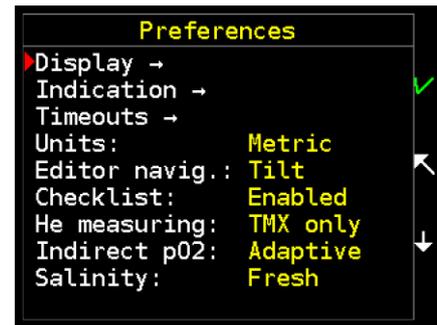
Indication

Auxiliary displays

Setting the position of HUD and buddy display. The default positions are on the right side for HUD and on the left side for BD.

Color blind mode

If you cannot distinguish blue and green LED lights on HUD, switch color blind mode on. See 1.10.2 [Head-up display](#)



Timeouts

Key press delay [1]

Minimum key press duration (range: 1—5, in 100 ms).

Auto switch off

The time period after which the CCR Liberty switches from surface mode to standby mode (range: 0—999 min.). 0 deactivates automatic switching to standby mode. If no handset is connected, switch-off will occur after 150 minutes regardless of the setting.

Units [Metric]

Metric and imperial units (or, more precisely, the US traditional systems of weights and measure) can be set for the entire apparatus. All physical calculations are internally executed using the metric system; results are converted for display only.

Editor navig. [Tilt]

The numbers in the editor can be increased or decreased by tilt or by tap. To control with tapping it is necessary to practice a little. Do not change the tilt setting unless you have a strong reason.

Checklist [enabled]

When entering CCR mode from the surface mode menu, a checklist is displayed. This can be disabled.

He measuring [TMX only]

TMX only - He sensors are used only in case that the selected diluent contains helium.

Always - He sensors are used in all cases.

Never - He sensors are permanently deactivated.

Rev. pO₂ src [Adaptive]

Adaptive - Backup algorithm for calculating the partial pressure of oxygen indirectly using the proportion of He; the diluent composition is adaptively adjusted.

Diluent - For indirect calculation of the partial pressure of oxygen, the diluent composition entered in the setting is used.

2.8.7 Calibration

Calibrate He-Air

The He sensors are calibrated with air. The sensor is stable for a long period of time; therefore, perform calibration only after replacing the sensor or in case there are doubts about its accuracy. Sensors must be free of any traces of helium.

Oxygen purity [99.5%]

The oxygen concentration in the calibration gas can be set. If possible, use oxygen with a purity of at least 99.5% for calibration.

Do not use air for calibration. The partial pressure of oxygen in air at atmospheric pressure differs significantly from the partial pressures determined by the setpoints. At the end of its service life, an oxygen sensor can successfully undergo calibration to 21% (air), but will no longer be capable of measuring pO₂ of 1 bar or higher.

See also 3.1.7 [Calibration of oxygen sensors](#) and 3.1.4 [Oxygen](#).

Recommended [3 days]

Recalibration of the oxygen sensors will be recommended after a set number of days (range: 0—30).

2.8.8 Faulty sensors

Oxygen sensors

Overview of sensor status with the possibility to exclude individual oxygen sensors for pO₂ calculation.

Normal - no sensor malfunction detected; the sensor is used as a data source.

Uncalibrated - sensor has not been calibrated.

Excluded - sensor excluded automatically by the algorithm. The algorithm can return the sensor to Normal status if it determines that the reason for exclusion has no longer exists.

Disabled - sensor excluded manually.

Error - sensor not present, or bad contact.

Offline - sensor not available (digital communication at the module level is not functioning).

Pressure sensors

Overview of pressure sensors with the possibility to manually exclude individual sensors. Do not start a dive with more than one malfunctioning pressure sensor.

Normal - no sensor malfunction detected; the sensor is used as a data source.

Disabled - sensor excluded manually.

Error - sensor not present, or bad contact.

Offline - sensor not available (digital communication at the module level is not functioning).

See also 1.9.4 [Measuring of pressure](#).

2.8.9 Miscellaneous

Set time

Date and time setting is done in the format YYYY/MM/DD
hh:mm:ss.

Horizontal calibration

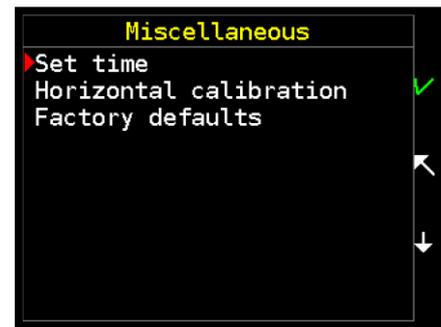
The accelerometers are used for control by tilting and tapping. They have to be calibrated.

Place the handset on a level surface (e.g. a table) before starting calibration.

Factory defaults

This resets all settings to the default values.

Following a reset, make sure to change all necessary settings before a dive.



2.9 Games

Do not disable error messages and notifications if the games are played underwater.

Ensure to not accidentally reposition while playing during a dive. Check the pressure gauges and rebreather state on the second handset on a regular basis. Playing a game will reduce your attention. Remember: you want to dive safely, not just achieve a higher level in the game!

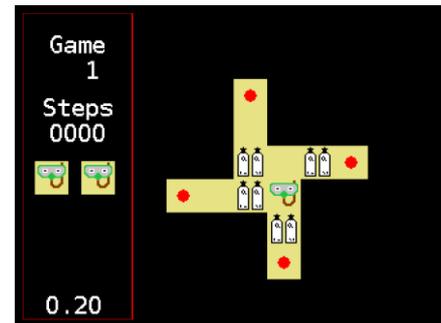
The games were tested on children. Nobody was hurt.

2.9.1 Sokoban

Sokoban is a type of transport puzzle, in which the player (a diving mask with snorkel) pushes tanks or crates around in a warehouse, trying to get them to storage locations (red dots).

The game is played on a board of squares, where each square is either a floor or a wall. Some floor squares contain tanks, and some floor squares are marked as storage locations.

The player is confined to the board, and may move horizontally or vertically onto empty squares (never through walls or boxes). The player can also move into a tank, which pushes it into the square beyond. Tanks may not be pushed into other tanks or walls, and they cannot be pulled. The puzzle is solved when all tanks are in the storage locations.



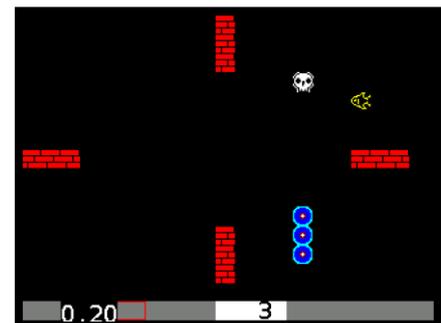
2.9.2 Snake

Snake is a game where the player maneuvers a line which grows in length, with the line itself being a primary obstacle.

The player controls the head of the snake. As it moves forward, it leaves a trail behind, resembling a moving snake. The snake has a specific length. The player loses when the snake runs into the screen border, a trail or another obstacle, or eats poison (skull), or starves to death.

The snake lose its length slowly (every 30 steps), and when it is too short, it dies from starvation.

The player attempts to eat fish by running into them with the head of the snake. Each fish eaten makes the snake longer, so maneuvering becomes progressively more difficult.



Section 3: Procedures

3.1 Dive preparation

3.1.1 Replacement of CO₂ sorbent

Sorbent service life

Continually keep records of the extent of consumption of the scrubber cartridge. Set a stack time warning and don't forget to reset the stack timer after replacing the sorbent. If ever in doubt, replace the sorbent.

The recommended scrubber filling material is Sofnolime 797 sorbent (producer: Molecular Products). The cartridge holds approximately 2.5 kg of sorbent.

The maximum safe operating period of the sorbent is 168 min, determined by a test in accordance to EN 14143:2013 (Article 6.6.2). During the test 1.6 l/min of CO₂ were added to the breathing loop with ventilation of 40 l/min in water with temperature 4 °C, exhaled gas with temperature 32±4 °C, 40 m depth and limit at pCO₂ 5 mBar (test provided by Life Support Test Facility - LSTF 0916). This is the worst case scenario and it considers a very high level of body exertion. Corresponding oxygen consumption is 1.78 l/min.

Typical oxygen consumption for scuba diving is from 0.4 l/min for a diver in rest using DPV (Smith, 2008) to 1.2 l/min for moderate work.

In normal conditions scrubber duration can be considered to range from 4 h in deep cold water with moderate work to 6 hours for an easy dive.

	O ₂ consumption (l/min)	CO ₂ production (l/min)	Scrubber duration (hh:mm)
Diver in rest	<0.5	<0.5	>8
Easy dive, experienced diver	0.8	0.7	6
Mild work	1.0	0.9	5
Moderate work	1.2	1.1	4
EN 14143	1.78	1.60	2:48

The physiological limit is not pCO₂ 5 mBar, but ten times higher (Knafelc, 2000). A respiratory quotient 0.9 is too high; a more realistic estimate is 0.8-0.85. Sorbent service life is longer (or safety margin bigger) than previously stated.

In the course of the sorbent's service life, it is allowed to remove the scrubber cartridge maximum two times (see 3.4.3 [CO₂ scrubber maintenance](#)).

Sorbent replacement procedure

Handle the sorbent in accordance with the manufacturer's instructions. Comply with all safety instructions and use protective gear. Take environmental protection into account when disposing of used sorbent.

Remove all of the old sorbent content from the cartridge.

If you disinfect the rebreather, proceed according to 3.4.2 [Cleaning and disinfection](#). However, it is preferable to disinfect after a dive rather than waiting for a longer period.

Place the scrubber cartridge on a clean surface. Handle it with clean, thoroughly washed hands. We recommend using disposable surgical gloves. Dirtying the cartridge can contaminate the breathing circuit and cause infection. A seemingly clean surface can be contaminated with microbes, especially in tropical and subtropical conditions.

If you cannot ensure the cleanliness of a surface, place the cartridge on a clean towel.

Follow these hygienic principles not only when filling the scrubber, but also when handling it in any way.

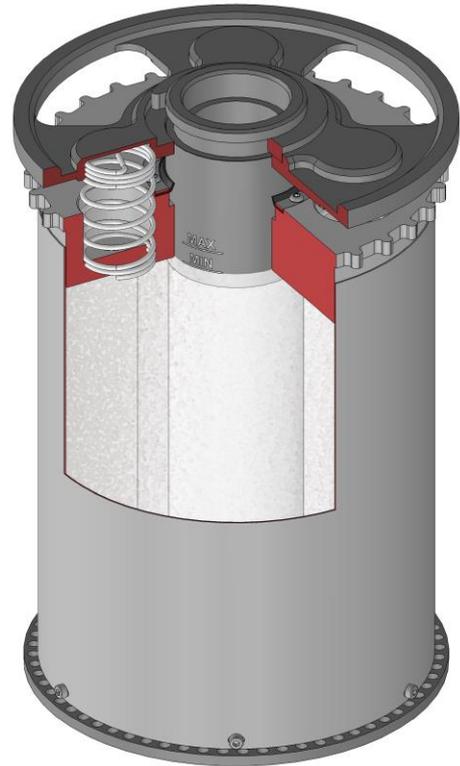
If you are working outside (recommended) and there is, at least, moderate wind, stand sideways to the wind and pour the sorbent slowly into the cartridge from a height of approximately 20-30 cm (1 ft). Allow the wind to remove the finest dust particles.

If you are working indoors, pour the sorbent into the cartridge from a minimal height. Sorbent dust is aggressive and can cause corrosion. Therefore, we do not recommend working with the scrubber inside of an automobile, for example.

In order to prevent the sorbent from falling into the central tube, place the lid of the sorbent canister on the opening or plug it by other suitable means.

Pour sorbent into the cartridge until it is approximately one-third full. Then gently lift the cartridge and allow it to fall three times from a height of approximately 1 cm (1/2"). Repeat this process when the cartridge is two-thirds full and again when it is completely full. The cartridge is completely full when the sorbent reaches a level between the min and max lines marked on the central tube.

After filling, close the lid and pressure plate with springs and press down. Then remove the pressure plate and lid and verify that the surface of the sorbent is levelled and that no channels have formed in it. Then close the lid and pressure plate with springs again,



press down and secure the assembly with the retaining ring. The retaining ring must fit into the slot in the pressure plate.

If the cartridge is not filled sufficiently, a gap of less than 6 mm or no space at all will remain between the edge of the lid and edge of metal mesh. In such a case, add sorbent and then shake and close the cartridge according to the procedure described above.

If the cartridge is overfilled, there will be a gap greater than 17 mm between the edge of the lid and the edge of the metal mesh and it will not be possible to insert the retaining ring without excessive force. In such a case, remove the excess sorbent with a clean teaspoon or any other suitable tool. Shake the cartridge and close the lid again.

Before inserting the cartridge into the scrubber canister, check to ensure that the water trap is dry. If that is not the case, remove the water trap and dry it with a towel.

Sorbent dust damages textiles, especially polyamide and cotton fabrics. Therefore, after working with the scrubber, immediately rinse the towel on which the cartridge was placed and all clothing that was exposed to sorbent dust.

Do not work with sorbent in the vicinity of load-bearing straps, ropes or even metal mountain climbing or speleological equipment. In the event of possible exposure to sorbent, ropes and load-bearing straps should be discarded immediately, as their load-bearing capacity can deteriorate significantly.

Condition of the scrubber before submersion

The scrubber must have sufficient absorption capacity for the planned dive.

The sorbent must contain moisture so that chemical reactions that enable the scrubber to remove CO₂ from the breathing mixture can take place. This means that it cannot be completely dry and cannot be frozen.

In freezing weather, stow the rebreather in a warm space prior to the dive. If you are outside with the apparatus and a delay happens, maintain the temperature of the sorbent by breathing from the apparatus.

3.1.2 Assembling the rebreather body

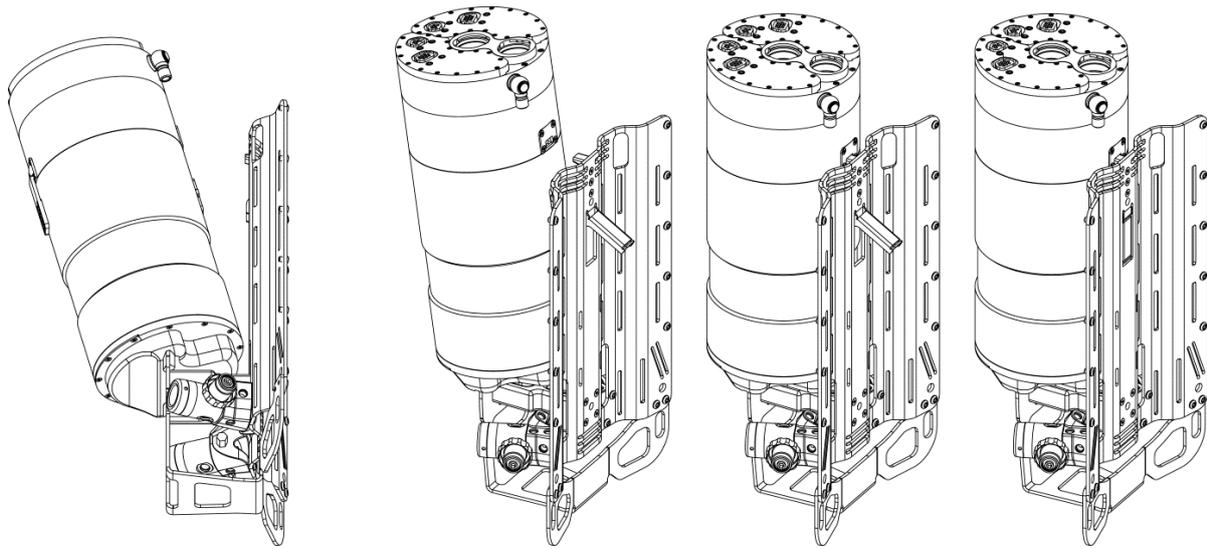
Mount the head on the CO₂ scrubber canister.



When mounting the head, push the scrubber canister pin into the opening on the head and close the head.

Press the head from above so that it is fully seated. If too much force is required to completely close the head, apply a small amount of lubricant to the O-ring on the neck of the head. You can also choose an O-ring with a smaller cross section diameter.

3.1.3 Mounting the rebreather body



Procedure:

1. Mount the body of the apparatus on the frame so that the recesses in the lower part fit into the protrusions on the base.
2. Lift the lever in the center of the backplate.
3. Press the rebreather body against the backplate so that the tongue in the upper part of the backplate fits into the recess in the head of the apparatus. If necessary, forcefully press the top of the head downward.
4. Press down the lever in the middle of the apparatus and check whether the lock is closed.
5. Check whether the apparatus is firmly attached.
6. Secure the body with the securing strap.

3.1.4 Attaching the counterlungs and hoses

The position of the counterlungs in relation to the diver's body determines inhalation and exhalation resistance and work of breathing. Adjust the position by shifting the upper strap on the back side of the counterlung.

Procedure:

1. Attach the counterlungs using the buckles so that the T-piece bulkheads are roughly at shoulder level and the flaps with Velcro are facing the centre (toward each other).
2. Connect the manual diluent bypass valve to the lower bulkhead of the left breathing bag.
3. Connect the overpressure valve to the lower bulkhead of the right breathing bag.
4. Connect the manual oxygen bypass valve to the middle bulkhead of the right breathing bag.

5. Attach the inhalation T-piece (without the partition) to the upper bulkhead of the left breathing bag.
6. Attach the exhalation T-piece (with the partition) to the upper bulkhead of the right breathing bag.
7. Attach the terminal elbow of the inhalation (left) corrugated hose to the opening in the centre of the head.
8. Attach the terminal elbow of the exhalation (right) corrugated hose to the opening on the edge of the head.
9. Screw the short oxygen hose to the 9/16" elbow on the side of the head. Tighten the union nut firmly by hand.
10. Route the LP hoses to the ADV and to the manual diluent bypass valve and the HP hose to the diluent pressure gauge, so that they pass together over the shoulder strap from the outside to the inside of the strap.
11. Attach the ADV to the middle bulkhead of the left counterlung.
12. Attach the quick-release connector of the LP hose to the manual diluent bypass valve.
13. Straighten the hoses and secure them under the Velcro flap of the left breathing bag.
14. Route the LP hose to the manual oxygen bypass valve and the HP hose to the oxygen pressure gauge so that they pass together over the shoulder strap from the outside to the inside of the strap.
15. Attach the quick-release connector of the LP hose to the manual oxygen bypass valve.
16. Straighten the hoses and secure them under the Velcro flap of the right breathing bag.
17. Route the LP hose of the buoyancy control device (BCD) under the first rubber band on the corrugated inflator hose of the BCD, then under the rubber band on the left shoulder strap above the D-ring and finally under the second rubber band on the corrugated inflator hose.
18. Connect the quick-release connector to the inflator of the BCD.
19. Adjust the position of the BCD inflator hose so that it is easily accessible when diving.

For attaching devices to the connectors, see also 1.3.3 (Corrugated hoses) [Connection to the breathing bags](#), 1.4 [Inhalation bag](#) and 1.5 [Exhalation bag](#).

3.1.5 Tank filling

When filling the tanks with the breathing mixture, follow the procedures and rules with which you were familiarized in the course on blending mixtures for technical diving within your training system (trimix blender, etc.). If you have not successfully completed such a course, leave the blending of mixtures to a qualified person.

When handling oxygen, follow the procedures and rules with which you were familiarized in a course on diving with trimix and subsequently in a course on diving with the CCR Liberty. If you have not successfully completed such a course, do not handle the CCR Liberty.

Diluent

Choose the diluent to be breathable and able to flush high oxygen mix from breathing loop. Prepare the diluent so the partial pressure of oxygen will not exceed the low setpoint (or 1.1 bars, which is lower) at the greatest depth of your planned dive. Partial pressure of nitrogen should not exceed 4 bars (3.2 bars are recommended).

Regarding to oxygen compatibility and cleanliness for oxygen service of the parts working with diluent, do not exceed the oxygen concentration of 21% ($\pm 1\%$) in the diluent. Minimum oxygen concentration is 5%.

Contaminant content of the diluent should not exceed the limits given by the standard EN 12021 Section 6.2 for compressed air for a breathing apparatus.

Make sure that the diluent was filled by a compressor with properly maintained filters. Alternatively, you can use an additional personal filter. When using a compressor with a combustion engine, ensure that the exhaust gases from the engine cannot get into the compressor intake.

To analyze breathing gas using He sensors, the He content should be 35% or more. A higher He % is better.

Mixtures with higher helium content are more advantageous for a number of reasons. If you are not planning to exceed a depth of 140 m, do not use a mixture with a proportion of oxygen smaller than 10%. A low O₂ mix on the surface and in small depths, with a lack of breathability, significantly increases risks.

After filling, write the mixture composition with a permanent marker on a label (piece of duct tape) and attach it to the tank.

The consumption of diluent depends on the dive profile, frequency and extent of depth changes. Diluent capacity is not limited by time but by the dive profile. This should be taken into account especially when planning dives in caves. Diluent is consumed mainly during the descent. During the ascent there is a zero theoretical consumption and any practical consumption is mainly due to mask clearing.

Based on a practical experience, the typical diluent consumption during a simple dive to a depth of 100 m is approximately 50 to 70 bar. It does not increase by staying longer at the same depth.

Always keep a sufficient safety margin (at least 50 bar) to cover unforeseen situations. If the pressure in the diluent tank is lower than 70 bars even a brief dive should not be started.

The standards according to which the CCR Liberty is CE certified and designated do not cover diving to depths greater than 100 m. Therefore CCR Liberty is CE certified to 100 m.

Oxygen

Use oxygen intended for breathing. Contaminant content of the oxygen shall not exceed the limits given by the standard EN 12021 Section 6.2 for compressed air for breathing apparatus

We recommend using oxygen with a purity of at least 99.5%.

Oxygen consumption for gas duration calculations is 1.78 l/min according to the EN 14143. When considering the initial tank pressure of 200 bar and a final pressure of 50 bar in the tank, the oxygen supply suffices for 253 minutes. In this calculation oxygen contained in the diluent is not considered.

These conditions correspond to high levels of physical effort during a dive. If a diver is calm during a dive, consumption significantly decreases and the quantity of oxygen and the sorbent service life is extended. A dive plan, which relies on the fact that the whole dive will be in a low-effort, is wrong.

In any case an oxygen tank filled to 200 bar is sufficient for a dive which greatly exceeds the duration of the CO₂ scrubber.

If the pressure in the oxygen tank is lower than 70 bars even a brief dive should not be started.

According to the valid technical standards, filling oxygen to operating pressure greater than 200 bars is prohibited.

3.1.6 Battery charging

Before charging the batteries, remove the jumpers from the sockets.

We recommend charging the batteries to full capacity one week or less before diving. Before a brief dive (up to one hour), it is permissible to store fully charged batteries for up to one month.

Do not completely discharge the batteries before charging. The service life of the batteries is extended by frequent charging.

For charging the batteries, use the enclosed charger or any USB charger dimensioned to 2 A (most chargers used with vehicle power outlets are not sufficiently dimensioned). Fully discharged batteries require approximately eight hours of charging with the charger.

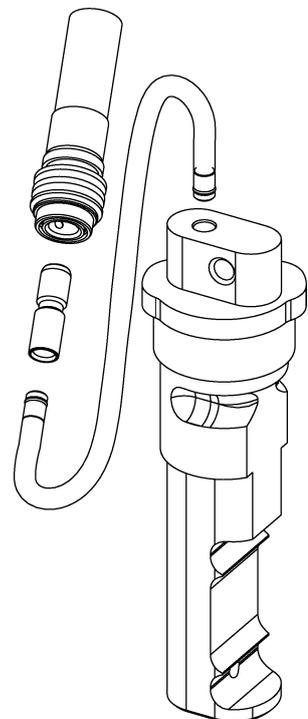
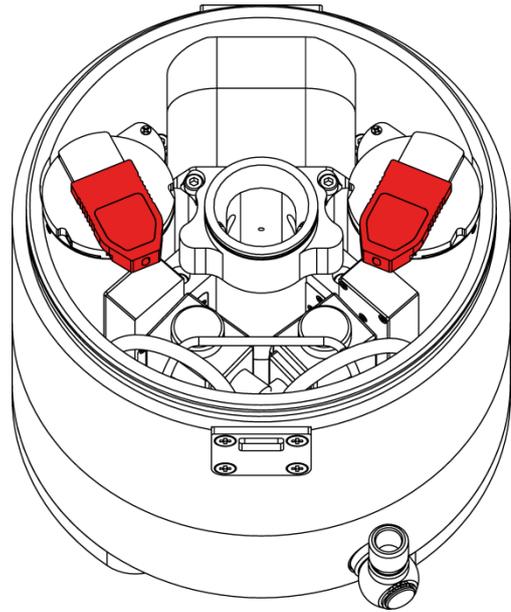
Charging from a computer's USB port is possible, though charging is done with a significantly lower current. The time required for charging fully discharged batteries in this manner is approximately 15 hours. Charging from a computer's USB port can be done via an adapter connected to the external connector of the handset.

In you prepare the CCR Liberty for diving no more than one week after charging, insert the jumpers so that their pins are inserted into the connector. The rebreather will thus be switched to standby mode and it will be possible to switch on the control unit using the handset. Otherwise, insert the jumpers in reverse position with the pins outside; in this position, the power supply is completely disconnected and the control unit cannot be switched on.

3.1.7 Calibration of the oxygen sensors

Insert the measuring jig into the inhalation opening (in the center of the head). The head can be, but does not have to be, mounted on the scrubber canister. Connect the flow limiter to the oxygen hose quick-release.

A hissing sound that accompanies the flow of oxygen can be barely heard in a quiet environment. The flow also becomes apparent on a moistened finger covering the discharge aperture. Connect the sampling tube between the flow limiter and measuring jig.



Procedure:

1. Start O₂ sensor calibration on HS in PreDive → Calibration O₂
2. Wait for mV stabilization (this could take a while)
3. Start calibration
4. Save

Whether or not a sensor is already at the end of its service life is also determined during calibration.

At higher altitudes above sea level, the partial pressure of oxygen in the calibration mixture decreases in proportion to lower atmospheric pressure. The CCR Liberty measures atmospheric pressure and takes it into account during calibration. Therefore, do not perform any corrections at higher altitudes above sea level.

3.1.8 Preparing the bailout apparatus

The bailout apparatus must ensure a reliable return to the surface at any time during a dive.

The standard solution is to use a corresponding number of stage and decompression tanks with mixtures according to depth, distances and the bailout plan. For a deep diving backup it is recommended to use a mixture rich in He, regardless of the financial costs. The mixture will probably not be used for many dives. A higher content of He results in a lower negative buoyancy, which makes transporting the tank under water more convenient.

Preparation of the bailout stage tanks is similar to that of open-circuit diving with trimix. When planning and preparing, proceed according to the rules with which you were familiarized in a course on diving with trimix.

3.1.9 Setting parameters

Set or check the settings of all dive parameters.

For a detailed description, see 2.8 [Setup](#).

3.1.10 Directional valve check

The purpose of this test is to detect possible leakage of the directional valves of the dive/surface valve (DSV). This kind of leakage could seriously endanger the diver. It is not possible to assemble the complete breathing loop in the wrong direction but the diver has to be sure that this part is not missing or leaking.

Procedure:

1. Put the bayonet socket cover on both T-pieces.
2. Cover the left (inhale) elbow.
3. Place the mouthpiece in your mouth, open DSV and try to inhale. Inhaling shouldn't be possible. The left corrugated hose collapses. Exhaling should be possible.
4. Close the DSV and check for leakage (the corrugated hose should stay collapsed).
5. Open the DSV, unplug the inhale elbow and cover the right (exhale) elbow with bayonet socket cover.
6. Inhale from the mouthpiece and try to exhale. Inhaling should be possible.
7. Pull the exhalation elbow to extend the corrugated hose on the right side. Check for leakage (the corrugated hose stay extended).

If some leakage occurs, change the directional valves or do not dive.

3.1.11 Physical inspection

Check to ensure that the CCR Liberty is complete, correctly assembled and mechanically undamaged.

If the CCR Liberty is operated within an organization where someone other than the diver is responsible for the physical preparation of the apparatus, we recommend the implementation of detailed organizational rules. An assembly checklist in editable form is prepared for download on the CCRLiberty.com website.

3.2 Pre-dive inspection

The pre-dive inspection (PDI) procedure can be started in surface mode. Testing is conducted immediately before the dive, after transport, with a fully assembled rebreather with the control units switched on.

The user confirms the results of the individual inspection steps:

OK — test result is positive

FAIL — partial test failure, but the other steps of the PDI will be performed normally

ABORT — premature termination of the PDI. It is also necessary to use the ABORT command when a reparable defect is detected and the full PDI must be carried out again. The ABORT command is carried out automatically if the user does not respond to the prompt within two minutes.

The results of testing are recorded in the log.

The result of testing is displayed to the user (the apparatus can/cannot be used for diving), but does not influence the subsequent behavior of the apparatus; in particular, it does not block the functions necessary for undertaking a dive (in accordance with the Responsibility of the CCR Liberty User set forth in the introduction). Ignoring the conclusions of the pre-dive inspection is the diver's choice, for which he/she bears responsibility.

3.2.1 Internal testing of the control units

A test of communication between the control units and the peripheral devices is automatically started at the beginning of the pre-dive inspection.

Testing is automatic. Confirmation by the user is required only in the event that the test result is negative.

3.2.2 Negative pressure test

The purpose of this test is to detect possible leakage in the breathing loop, which appears when the pressure in the loop is lower than the ambient pressure.

The test is conducted immediately before diving, after transport, with a fully assembled rebreather.

Procedure:

1. Close the diluent and oxygen tank valves.
2. Open the DSV and create sufficient underpressure with your mouth according to the indication on the HS display.
3. Close the DSV and cease all movement with the rebreather; in particular, do not move the bags and corrugated hoses.

4. Wait 60 seconds; the countdown runs automatically on the display.
5. If the pressure indicator stops in the green field, the test result is positive.

Final evaluation of the test and confirmation of the result are left at the user's discretion.

See also Chapter 3.6.2 [Leak detection](#).

3.2.3 Positive pressure test

The purpose of this test is to detect possible leakage in the breathing loop, which appears when the pressure in the loop is higher than the ambient pressure.

Procedure:

1. Close the oxygen tank valve, open the diluent tank valve.
2. Close the DSV and close the overpressure valve.
3. With the manual diluent valve, create sufficient overpressure according to the indication on the HS display.
4. Cease all movement with the rebreather; in particular, do not move the bags and corrugated hoses.
5. Wait 60 seconds; the countdown runs automatically on the display.
6. If the pressure indicator stops in the green field, the test result is positive.

Final evaluation of the test and confirmation of the result are left at the user's discretion.

See also Chapter 3.6.2 [Leak detection](#).

3.2.4 Solenoid testing

The left solenoid is opened cyclically three times and closed with an interval of two seconds and with 1:1 duty cycle. The expected state of the solenoid is shown on the HS display. The right solenoid is subsequently tested in the same manner.

The test repeats cyclically if the user does not confirm the result or if automatic termination of the PDI does not occur due to the user's inactivity.

3.2.5 Battery testing

Both batteries are stressed with an artificial load caused by an intentionally increased power consumption by the processors, connected solenoids (without using energy-efficient control), vibration motors and the maximum brightness of the HS display. After completing the test, status of both batteries (%) and the estimated duration of the batteries in dive mode are shown.

The user then decides whether he/she considers the batteries' estimated duration to be sufficient for the planned dive.

3.2.6 Helium-sensor test

Functionality of the He-concentration sensors is performed. The user is informed of the ongoing test on the HS display.

The test is automatic. Confirmation by the user is required only in the event that the test result is negative.

3.2.7 Comparison of pressure sensors

The measured values of both pairs of pressure sensors are compared. The user is informed of the ongoing test on the HS display.

3.2.8 Comparison of oxygen sensors and their calibration

The current values of the individual sensors are shown on the display in millivolts and the pO₂ values are displayed in bars, using to the most recent calibration.

Final evaluation of the test and confirmation of the result are left at the user's discretion.

3.2.9 HUD inspection

The diodes light up in blue, red and green successively in three steps. At the same time HS displays which colors should light up on the HUD.

The test repeats cyclically if the user does not confirm the result or if automatic termination of the PDI does not occur due to the user's inactivity.

3.2.10 BD inspection

The buddy display successively lights up in green at low, medium and high intensity, then in red at low, medium and high intensity. A symbol with the same color is at the same time displayed on the HS; intensity is indicated by the size of the symbol.

The test repeats cyclically if the user does not confirm the result or if automatic termination of the PDI does not occur due to the user's inactivity.

3.3 Diving

3.3.1 Breathing high oxygen content gases

The mixture in the CCR Liberty circuit usually contains oxygen at much higher partial pressure than the air we breathe on the surface.

Acute (CNS) oxygen poisoning

Exposure to high oxygen partial pressure may under certain circumstances cause acute (CNS) oxygen poisoning. This may cause the affected person to drown.

The so called “oxygen clock” is a percentage of consumption of CNS toxicity limit. Limit the maximum partial pressure and total exposure so that acute oxygen toxicity cannot occur, according to the following NOAA table.

NOAA oxygen exposure limits

pO ₂ (bar)	Maximum Single Exposure (minutes)	Maximum per 24 hr (minutes)
1.60	45	150
1.55	83	165
1.50	120	180
1.45	135	180
1.40	150	180
1.35	165	195
1.30	180	210
1.25	195	225
1.20	210	240
1.10	240	270
1.00	300	300
0.90	360	360
0.80	450	450
0.70	570	570
0.60	720	720

Chronic oxygen poisoning

Long term exposure to oxygen partial pressure higher than 0.5 bar, common when using the CCR Liberty, leads to chronic (also known as pulmonary) oxygen poisoning. At exposures common to amateur technical diving, chronic toxicity symptoms are not significant. For very long dives it is necessary to calculate with long-term exposure limits and to limit the overall exposure.

The main symptom of chronic toxicity is a temporary reduction in vital lung capacity. Another symptom may be nearsightedness (hyperoxic myopia). Symptoms may persist for several months.

When $pO_2 \geq 1.4$ bar then the CNS toxicity limit is always shorter than the pulmonary toxicity limit.

For calculations related to chronic toxicity use the REPEX method that you know from the nitrox diving course. The CCR Liberty does not perform calculations associated with chronic oxygen toxicity.

3.3.2 Putting on the apparatus

After the pre-dive inspection, set the CCR Liberty on its stand on a hard surface – on the ground, a bench or table, or in a vehicle’s cargo space. Properly secure the rebreather so that it cannot fall, for example by having a partner hold it.

Procedure:

1. Flip the breathing bags and corrugated hoses with the DSV to the opposite side of the rebreather’s body.
2. Position yourself under the shoulder straps.
3. Put on the shoulder straps, ideally with both arms at the same time.
4. Stand up on both feet. Due to the weight of the CCR Liberty, avoid rotating your spine, which could lead to injury. When standing up from the ground, carefully assume a kneeling position and then stand up.
5. Take the crotch strap up between your legs and pass the belt buckle through the eye of the crotch strap.
6. Gently tighten the belt and fasten the belt buckle.
7. Flip the breathing bags and corrugated hoses with the DSV to the front.
8. Attach the breathing bags to the crotch strap V-straps with the buckles.
9. Make sure that all of the straps are adequately tightened and are not twisted.
10. Secure the handsets to your wrists. Ensure that the HS’s cables are wrapped around your arms.
11. Ensure that the HUD is attached to the DSV and its cable is wrapped around the corrugated hose.
12. Check the accessibility of the BCD inflator.

3.3.3 Using the DSV

The DSV must be closed at all times when it is not in your mouth. Close it before taking it out of your mouth; open it after putting it in your mouth and clear the DSV before inhaling.

Always exhale into the mouthpiece before inhaling from the mouthpiece under water.

Opening the DSV when it is not in your mouth will cause an immediate loss of buoyancy and could possibly flood the breathing loop.

3.3.4 Monitoring of devices

Partial pressure of oxygen

You must know the concentration of oxygen (pO_2) in the breathing loop at all times. Learn to use the HUD for continuous monitoring as it allows you to concentrate on other tasks.

Always know your pO_2 !

Check the partial pressure of oxygen on the handset display at regular intervals as well. If the values from various sensors differ, check whether any of the sensors is coming to the end of its service life.

Pay extra attention to the pO_2 reading when significantly changing depth.

Do not rely solely on the alarm indicating reduced partial pressure of oxygen.

Reduced partial pressure of oxygen is also signaled on the buddy display. Familiarize your diving partners with the BD signals so that they will be able to recognize in time that you need help.

Oxygen and diluent pressure

We recommend checking the pressure of oxygen and diluent approximately once every five minutes.

Compared to an open-circuit apparatus, the oxygen and diluent tanks have a small volume. Even a minor leak can cause rapid loss of pressure. Therefore, it is necessary to check the oxygen and diluent pressure gauges (SPGs) more frequently than when diving with an open circuit.

3.3.5 Switching to CCR mode

In surface mode, bring up the menu and switch to CCR mode.

Perform an inspection according to the displayed checklist.

3.3.6 Water entry

Do not enter the water without having performed a pre-dive inspection according to Chapter 3.2 [Pre-dive inspection!](#)

We recommend breathing from the rebreather for at least three minutes right before entering the water in order to make certain that the scrubber and the rest of the apparatus are working properly.

In freezing weather, do not allow the scrubber to cool down after transferring the rebreather from a warm environment. Limit the rebreather's exposure to freezing air. If necessary, keep the sorbent warm by breathing from the rebreather.

We recommend gradually entering the water and submerge the rebreather slowly.

If it is necessary to jump into the water, preferably use the "giant stride" method, whereby your legs and buttocks impact the water first, thus protecting the breathing bags and corrugated hoses from direct impact. When entering the water in this manner, have the DSV in your mouth; have it closed at the moment of entry. Sudden entry into the water must be supervised by a person qualified to provide assistance in the event that problems arise.

Perform a bubble check after entering the water. Due to the small volume of the oxygen and diluent tanks, minor leaks in the high-pressure and low-pressure parts, which are tolerable in open-circuit diving, can lead to a rapid decline of pressure in the tanks.

3.3.7 Submersion

For submersion, use the compensator (BCD) to control buoyancy.

Choose the amount of ballast with respect to the possible change of weight during a dive. Do not overload yourself in order to facilitate submersion. Unlike in open-circuit diving, weight reduction due to consumption of gases is minimal. The possible use of the open-circuit bailout apparatus has a more significant impact on weight reduction.

Determination of the correct amount of ballast is one of the skills that you will learn in a course on diving with the CCR Liberty.

3.3.8 In-water check

Verify the pO_2 control system and adjust buoyancy.

Perform a bubble check with your diving partner. Scan all parts of the breathing loop in the direction of the gas flow. Rotate horizontally using the "helicopter turn".

3.3.9 Descent

During the descent, the ADV adds diluent to the breathing loop; you can also add diluent manually. Diluent is added to the inhalation bag. During a rapid descent, the mixture delivered to the DSV is practically identical to the diluent.

If you use diluent with low oxygen content (e.g. when starting a descent to a great depth), it is necessary to significantly limit the descent rate. Continue this until you reach a depth where the pO_2 in the diluent exceeds 0.16 bar.

Do not descend rapidly in order to reach the depth at which the mixture is breathable. Low partial pressure of oxygen in the loop leads to significantly faster loss of consciousness than if you descend while holding your breath. Do not take this risk.

3.3.10 Controlling buoyancy and trim

When diving with a rebreather, buoyancy cannot be controlled by breathing as in open-circuit diving. Since you are breathing within a closed loop, there is no effect on the overall buoyancy.

Buoyancy, including minor corrections is controlled with the compensator.

For a very small, temporary increase of buoyancy (e.g. when swimming over an obstacle), instead of using the compensator, you can add a small amount of diluent into the breathing loop and breathe using the top of your lungs. Though this method is convenient, it also leads to a greater consumption of oxygen and diluent. Remember: swimming around an obstacle is better than swimming over it.

Keep balance corrections to a minimum by using other sources of buoyancy, such as a dry suit. The increased difficulty of controlling several sources of buoyancy would overload the diver with tasks.

The optimum trim of the diver is horizontal, even for descending and ascending. During the course on diving with the CCR Liberty, you will find the optimum ballast position. Do not use a weight belt.

When training to achieve the correct balance and trim while breathing continuously, try to remain motionless and not change depth or body position for several tens of seconds.

A backup source of buoyancy is always needed when diving. This can be a dry suit, disposable ballast or, for example, a liftbag.

3.3.11 Mask clearing

When diving with a rebreather, a significant portion of the mixture consumed during a dive can be lost when clearing the mask. Therefore, keep mask clearing to a minimum.

3.3.12 Increased physical exertion

The CCR Liberty adds oxygen to the breathing loop as needed. Unlike with some mechanical rebreathers, increased physical exertion does not lead to a reduction of the partial pressure of oxygen.

In the case of longer physical exertion, check the pressure in the oxygen tank frequently.

Take increased physical exertion into account for your decompression planning.

3.3.13 Ascent

Under normal conditions, i.e. when ascending at a rate of less than 15 m/min., with a setpoint at minimally 0.8 bar and a normal functioning apparatus, a decline of the partial pressure of oxygen (pO_2) below the limit value of 0.16 bar does not occur.

If inadvertent rapid ascent occurs in a small depth, pay greater attention to the pO_2 . It is possible that a short-term decline will happen, but this will be automatically corrected with two to three inhalations.

Before starting an ascent, check to ensure that the oxygen tank valve is open.

During the ascent, expansion of the mixture in the breathing circuit occurs due to the reduction of ambient pressure. It is necessary to expel the excess breathing mixture. The overpressure valve on the exhalation (right) counterlung is used for this purpose. Open the overpressure valve completely. Some divers consider it more convenient to expel excess breathing mixture via the nose through the mask. Do not expel excess mixture via the mouth around the mouthpiece as doing so increases the risk of water leaking into the breathing circuit.

3.4 Post-dive procedures

3.4.1 Immediately after surfacing

Close the DSV, put the rebreather in a suitable place, close the tank valves and switch off the control units.

If a stable, firm and level surface is available, set the rebreather up on its stand and take measures to prevent it from falling.

If you are in the field, where it is not possible to place the rebreather on its stand, lay it down.

When handling the rebreather, focus particular attention on protecting the corrugated hoses against damage.

3.4.2 Cleaning and disinfection

When in use, the rebreather's breathing loop is colonized by microorganisms from the diver's respiratory tract and from the external environment. The purpose of regular cleaning and disinfection is to prevent the multiplication of these microbes to an extent that would pose a hazard to the user and to prevent the transmission of infection between various users.

Not more than a week may pass from the first dive after disinfection until the next disinfection if the CCR Liberty is stored in a cool place. When storing the rebreather at a temperature higher than 25 °C, this interval is shortened to four days; the weekly interval can be maintained only for the scrubber cartridge. It does not matter how many dives you undertake during the stated period.

Disinfection is always necessary before changing users of the CCR Liberty. Never lend (or borrow) a rebreather that has not been disinfected! Transmission of infection can happen with a single inhalation. An infected user will not necessarily have any symptoms of infection.

Start cleaning by rinsing the assembled rebreather with clean fresh water. Disassemble the rebreather into its individual parts.

Procedure:

1. remove the ballast.
2. unscrew and detach the oxygen and diluent tanks, insert watertight stoppers in the regulator inlets.
3. remove the HUD from the DSV.
4. remove the breathing bags with corrugated hoses from the head.
5. remove the ADV, manual valves and overpressure valve from the breathing bags.
6. detach the breathing bags from the harness.

7. remove the head with the attached handsets and HUD.
8. remove the CO₂ scrubber from the cartridge and dispose of it safely.
9. remove the scrubber canister from the backplate and remove the water trap.

Put the head with control units in a clean, cool and dry place.

Prepare the antiseptic solution in a suitable vessel. The vessel must be clean and free of all mechanical and chemical impurities. For example, a child's bathtub, a mortar tub (a new, previously unused one) or large Tupperware container is suitable for disinfection.

For ordinary disinfection, use Mikrobac forte antiseptic in 0.5% concentration. Follow the instructions when working with the antiseptic agent.

Rinse with clean fresh water and place the tube, water trap, corrugated hose assembly with open DSV, breathing bags and CO₂ filter in the tub. Manipulate the corrugated hose assembly and the DSV to expel air so that the antiseptic solution fills the entire space (this necessary skill is part of the CCR Liberty training course). Completely fill the breathing bags with the antiseptic solution.

If you have noticed (either visually or by smell) mold growth, it is necessary to perform thorough disinfection and to clean the surfaces also mechanically. Most surfaces can be wiped with a rag soaked in the antiseptic solution; use a bottle brush (reserved specifically for this purpose) to clean the inner surfaces of the corrugated hoses.

Leave the parts in the antiseptic solution for one hour. Then remove them, rinse with clean fresh water and allow to them dry. Do not dry the parts in direct sunlight.

When more intensive disinfection is required, use a more highly concentrated solution (maximum 2%) or leave the parts in the antiseptic solution for a longer time (maximum four hours).

Instead of Mikrobac, it is possible to use a different antiseptic agent based on quaternary ammonium salts that is compatible with the materials from which the CCR Liberty is manufactured. The CCR Liberty's manufacturer does not guarantee the compatibility of antiseptic agents other than Mikrobac forte. In any case do not use chlorine-based agents.

In normal circumstances, the head, ADV, manual bypass valves and overpressure valve does not need to be disinfected.

In the event of increased requirements for disinfection, the oxygen sensors can be removed from the head and the remaining parts disinfected by washing them with the antiseptic solution. The ADV, manual bypass valves and overpressure valve can be disinfected by submerging them in the antiseptic solution.

The antiseptic solution is highly toxic to aquatic organisms. Dispose of it in an environmentally friendly manner.

3.4.3 CO₂ scrubber maintenance

As a general rule, it is necessary to dry out the water trap after every dive or at least at the end of the diving day. Detach the head, remove the scrubber cartridge, remove the water trap and dry it with a paper towel. With another paper towel, also dry the exterior surface of the cartridge.

If the sorbent capacity is sufficient, with reserve for the next planned dive and it will not be necessary to disinfect the rebreather until the next dive, it is possible to reinsert the scrubber cartridge into the canister and leave it in the rebreather. You can leave the scrubber canister opened for a maximum of 12 hours if stored in a dry place. Mount the head and close the breathing loop openings for longer storage.

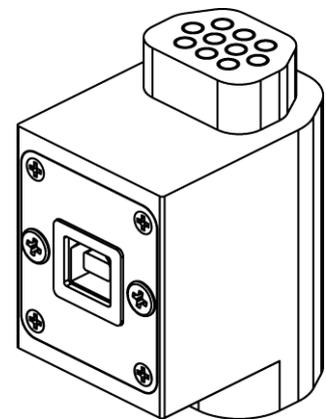
3.4.4 Battery care

Prevent complete discharging of the batteries. If possible, charge the batteries after every diving day.

3.4.5 Dive log download

After disconnecting the handset and attaching a multipurpose USB connector to the handset connector on the head (without the connected handset), the CCR Liberty's dive-record memory is accessible via the USB interface in mass storage mode. This means that for the computer to which the USB cable is connected, it appears as an ordinary flash drive with restriction to read only. Records of individual dives are stored as separate files in the divelog folder.

The control unit (CU) features the possibility to insert a micro SD card. Such card is installed by the manufacturer in CU and a separate dive log, which is not dependent on the CU's memory, is stored on it. The card's capacity is sufficient for storing detailed logs throughout the apparatus's service life, though the diver can delete logs from the card according to his/her needs. The card is generally accessed in the same manner as accessing a mass storage device via a USB cable, though in the case of damage to the CU, the micro SD card can be removed from the connector on the control-unit board and the dive log can be read using an ordinary reader.



Logs are generally worked with in the cloud at www.wetnotes.com. However, stand-alone software for PC (Windows 7 and higher) is available for download at www.CCRLiberty.com.

3.4.6 Long-term storage

Before storing the rebreather for a period longer than one week, proceed according to 3.4.2 [Cleaning and disinfection](#).

If the CCR Liberty is stored in a dry and clean environment, do not connect the corrugated-hose assembly with the DSV to the head or to the breathing bags and store the rebreather open. Dust occurs even in an environment with the same level of cleanliness as the home environment. Limit accumulation of dust by, for example, covering the unit with a washed cotton bed sheet. Store the detached corrugated hose assembly in a suitable container that will not prevent complete drying.

If you store the CCR Liberty in an environment with a lower degree of cleanliness, store it assembled and closed (without sorbent). Such an environment with a lower degree of cleanliness may be, for example, a home with pets.

Before putting the closed rebreather in storage, all parts must be thoroughly dried, including all creases in the corrugated hoses and the interior surface of the bags.

Charge the batteries at least once every six months.

If, after storing the unit for more than a month, you find that moisture persisted inside the apparatus or you can smell mustiness or mold from the corrugated hoses, it is necessary to disinfect the apparatus again.

When storing the rebreather, make sure that no rubber parts (hoses, cables) are pinched or compressed.

Ensure that no other objects are leaned against the rebreather. Secure the rebreather against falling.

3.5 Emergency procedures

Prevent the occurrence of emergency situations through high-quality training. Do not exceed the limits of your diving qualification. Carefully adhere to the prescribed procedures before, during and after every dive. In the event that prior to a dive you discover a problem associated with the rebreather and you are not able to resolve it, do not dive with the rebreather, regardless of the severity of the problem.

3.5.1 Emergency ascent (bailout)

Whenever diving with the rebreather is necessary to wear a backup breathing apparatus. A common type of backup device is a standard stage bottle.

If, during a dive, a malfunction occurs in the CCR Liberty that you are not able to resolve or precisely identify, or if you even have a suspicion that something is wrong with the rebreather, switch to the bailout breathing apparatus:

1. put the bailout breathing apparatus in the standby position,
2. exhale into the circuit and close the DSV, but hold a sufficient amount of the mixture in your lungs for removing water from the mouthpiece of the bailout apparatus,
3. Perform the standard procedure associated with starting breathing from the bailout apparatus, e.g. for stage tanks, check to be sure that you are breathing from the correct stage tank.

If you subsequently resolve the rebreather malfunction or if you determine that the cause of the problem is outside the rebreather, you can resume breathing from the rebreather.

After switching to bailout OC mode, the safety level is automatically set using the bailout gradient factors (BoGF). It is possible to switch between the standard and bailout GF sets in the menu without affecting the mode in which the CCR Liberty is operating.

Knowledge and skills related to the use of the stage bottles are among the entry requirements necessary for everyone interested in diving with CCR Liberty. In the CCR Liberty diving course, accredited by manufacturer, the use of stage bottle in the role of backup breathing apparatus is thoroughly practiced.

3.5.2 Oxygen-source malfunction

Low pressure in the oxygen tank

In this case it is necessary to terminate the dive.

It is necessary to switch to the bailout breathing apparatus no later than when the partial pressure of oxygen in the circuit falls below 0.3 bar.

If this situation arises due to a lack of thoroughness when preparing for the dive or due to failure to regularly check the pressure during the dive, please consider whether diving with a rebreather represents too great a risk for you.

Solenoids have stopped delivering oxygen

If the partial pressure falls significantly below the setpoint but there is still sufficient pressure in the oxygen tank, use the manual bypass valve to add oxygen.

Add oxygen gradually, with short presses. Breathe regularly. Oxygen is delivered to the exhalation bag. It takes several inhalations before the oxygen in the scrubber blends with the breathing mixture and reaches the sensors on the inhalation side.

If the situation persists, control the delivery of oxygen manually. In a stabilized state, invariable depth and with a low level of exertion (slow swimming), it is necessary to add oxygen approximately once or twice per minute.

This malfunction does not pose an immediate threat to the diver. However, do not continue in your descent or penetration. Start your return and ascent.

Manual O₂ bypass valve free-flow

Disconnect the quick-release. Disengaging the quick-release connector causes a disruption of the oxygen delivery via the manual bypass valve.

This malfunction does not pose an immediate threat to the diver. However, do not continue in your descent or penetration. Start your return and ascent.

Manual bypass valve does not function, oxygen is not added after pressing

This malfunction does not pose an immediate threat to the diver. However, do not continue in your descent or penetration. Start your return and ascent.

Oxygen delivery does not function by means of either the solenoids or manual bypass valve

In this case it is necessary to terminate the dive.

It is necessary to switch to the bailout breathing apparatus no later than when the partial pressure of oxygen in the circuit falls below 0.3 bar.

3.5.3 Diluent-source malfunction

The following procedures assume unavailability of off-board gas. Part of these problems can be solved by connecting off-board gas to the manual bypass valve.

Low pressure in the diluent tank

In this case it is necessary to terminate the dive. During the ascent, the diluent in the circuit expands and thus replenishes its volume in the circuit. If possible, do not increase depth during your return.

As long as the volume of diluent in the circuit is sufficient, it is possible to breathe from the rebreather. If it is not sufficient, it is necessary to switch to the bailout breathing apparatus.

Bear in mind that in this case it is not possible to perform the standard procedure for high pO₂ (flushing out the loop, adding diluent) and that such a situation can be resolved only by immediately switching to the bailout breathing apparatus, which you should therefore have in standby position.

ADV free-flow

Close the ADV by sliding the collar. This causes a disruption of the diluent delivery via the ADV.

This malfunction does not pose an immediate threat to the user. The dive can continue with manual addition of diluent to the circuit.

Manual bypass valve free-flow

Disconnect the quick-release. Disengaging the quick-release connector causes a disruption of the diluent delivery via the MBV.

This malfunction does not pose an immediate threat to the user. The dive can continue with automatic delivery of diluent into the circuit using the ADV. Manual delivery of diluent can be accomplished by pressing the ADV.

Manual bypass valve does not function, diluent is not added after pressing

This malfunction does not pose an immediate threat to the user. The dive can continue with automatic delivery of diluent into the circuit using the ADV. Manual delivery of diluent can be accomplished by pressing the ADV.

Neither the ADV nor the manual bypass valve functions

If the diluent pressure gauge indicates sufficient pressure, a malfunction in the first stage of the diluent regulator has likely occurred and it is no longer possible to add diluent to the circuit.

In this case it is necessary to terminate the dive. During the ascent, the diluent in the circuit expands and thus replenishes its volume in the circuit. If possible, do not increase depth during your return.

If the volume of diluent in the circuit is sufficient, it is possible to breathe from the rebreather. If it is not sufficient, it is necessary to switch to the bailout breathing apparatus.

Bear in mind that in this case it is not possible to perform the standard procedure for high pO₂ (flushing out the loop, adding diluent) and that such a situation can be resolved only by immediately switching to the bailout breathing apparatus, which you should therefore have in standby position.

3.5.4 Scrubber malfunction

If you need to breathe rapidly, with excessive frequency that does not correspond to your level of exertion, this is a possible cause of an increased concentration of carbon dioxide in the circuit due to a scrubber malfunction. You may also be afflicted with nausea, a headache and confusion.

On the contrary, another possible cause of similar symptoms is psychosomatic hyperventilation and reduced content of carbon dioxide in the blood and other bodily tissues. This usually occurs due to increased mental stress, such as when the diver is confronted with task overload.

If the symptoms are severe, immediately switch to the bailout breathing apparatus, as there is a risk of loss of consciousness. As soon as possible, take several slow, deep breaths from the backup apparatus. Of course, you should never allow such a situation to progress to the stage of severe symptoms.

If you experience discomfort when breathing but the symptoms are not so severe as to pose a risk of unconsciousness, test the concentration of carbon dioxide in your blood. Stay where you are without moving; do not in any case change depth significantly. Try to hold your breath for ten seconds.

If you are unable to hold your breath or you can do so only with great difficulty and with a tremendous, intense urge to inhale, it is apparent that the scrubber is not functioning (premature depletion of the sorbent, occurrence of channels in the sorbent by which air circumvents the scrubber) or there is a mechanical malfunction that has caused air to not pass through or to only partially pass through the scrubber (malfunction of the directional valve on the mouthpiece, joining of the inhalation and exhalation sides outside the scrubber). Switch to bailout and terminate the dive.

If holding your breath does not cause problems, the scrubber is working properly. Over the next several minutes, limit all other activity and concentrate on slow breathing.

3.5.5 Inadvertent release of the mouthpiece

When the mouthpiece falls out of the diver's mouth, the DSV has a tendency to float. However, its connection to the breathing bag prevents it from floating beyond the diver's reach.

If it falls out, it is necessary to immediately return the mouthpiece to your mouth. If the mouthpiece is returned quick enough, a significant amount of water will not have entered the breathing loop.

If this problem is not solved quickly, then the loop would flood. In this case proceed according to the following chapter 3.5.6 [Flooding](#).

There may be a strap (bungee cord) holding the DSV which prevents the mouthpiece from accidentally falling out. Adjust the length of the bungee by shifting the knots.

3.5.6 Flooding

The probability of significant flooding of the breathing circuit is very low. After carefully assembling the apparatus and performing the prescribed pre-dive procedures, flooding can be ruled out unless there is a major disruption of the breathing loop's integrity due to mechanical damage. In the event of significant flooding, it is necessary to immediately switch to the bailout breathing apparatus and to use the compensator (BCD) to prevent loss of buoyancy.

Do not inhale if the mixture from the rebreather's DSV contains fluid. In extreme cases, this could contain a so-called caustic cocktail, i.e. a caustic mixture with dissolved lye from the sorbent.

A smaller amount of water can enter the circuit through the open DSV when the mouthpiece falls out of the diver's mouth. In such a case, water gets into the exhalation bag. Though this does not represent an immediate danger, it is advisable to expel water from the exhalation bag with the overpressure valve as soon as the opportunity arises. Open the overpressure valve completely. In order to avoid a significant change of buoyancy, deflate the buoyancy compensator. Add diluent to the circuit with the manual bypass valve. Assume a position that brings the overpressure valve to the lowest point of the exhalation bag. Expel the water from the bag by exhaling and pressing on the bag with your hand.

3.5.7 Loss of buoyancy

The compensator (i.e. buoyancy control device or BCD) is the basic tool for controlling buoyancy. If the compensator is not functional, use other means of attaining buoyancy.

If the compensator's capacity does not suffice or if it is not possible after a malfunction to fill it with an inflator or orally, use your dry suit to attain buoyancy. The CCR Liberty user must have sufficient knowledge and skill to safely use a dry suit as a backup source of buoyancy.

If it is not possible to attain sufficient buoyancy by using the compensator and dry suit and if, at the same time, there is no other appropriate option, jettison the ballast. If it is not necessary to completely jettison the ballast, try to attain buoyancy by first jettisoning the ballast on the left side and then, if necessary, on the right side. Jettisoning ballast on the left side helps to bring the dry-suit release valve and the compensator's inflator in a position suitable for deflation.

Jettisoning ballast is a skill that, in addition to agility and mobility, requires training under the supervision of an instructor in a CCR Liberty diving course.

3.5.8 Rescue on the surface

When assisting an injured CCR Liberty user on the surface, it is possible to increase buoyancy by jettisoning the ballast.

Even if the diver's life is in serious danger and it would be necessary to jettison all equipment during the rescue buoyancy should be ensured by closing the DSV, inflating the compensator wings and jettisoning the ballast. Complete removal of the CCR Liberty and any other equipment attached to the harness can be time consuming. Sufficient buoyancy provided by CCR Liberty can aid the ongoing rescue procedure.

3.5.9 Malfunction of oxygen-concentration measuring

If the chemical oxygen sensors are not functional (in excluded, disabled, error or offline state, see 2.8.8 [Faulty sensors](#)), trimix is used as the diluent and the helium sensors are functional, then the CCR Liberty automatically switches to indirectly determining the pO_2 using the measurement of the helium content. See 1.9.3 [Measurement of He content](#).

Consider this as an emergency procedure only. Use it only when it is not possible to proceed according to 3.5.1 [Emergency ascent \(bailout\)](#).

3.6 Maintenance

Maintenance operations, including necessary technical information, are described in the maintenance manual. In the user manual, only basic maintenance operations that every CCR Liberty user should master are described.

Warning: There are no user serviceable parts or components inside the head other than oxygen sensor compartment, where the sensors can be replaced.

The user may replace only a compartment inside a head as a whole. Instructions for compartment replacement are included with new compartment and must be strictly followed.

Warning: Do not remove any screw with 2.5 mm hex key from outside the head. This may cause a CU's compartment leakage and will void the warranty.

Use only oxygen-compatible lubricant for the maintenance of parts that come into contact with oxygen under pressure.

3.6.1 Tools and replacement parts

Your toolbox for resolving problems in the field should contain:

- Surgical gloves
- Roll of paper towels
- PE bag for storing the scrubber cartridge
- DSV mushroom valves (2 pcs)
- Mouthpiece
- Tightening straps
- Oxygen-compatible lubricant
- 2.5 mm and 3 mm hex keys
- #1 Phillips screwdriver
- Tool for removing O-rings (O-ring pick, plectrum, bamboo toothpick)
- Adjustable wrench
- Duct tape
- Permanent waterproof marker for writing on duct tape
- Set of O-rings

3.6.2 Detection of leaks

If the source of a leak is not apparent, we recommend using overpressure to find the leak.

Leakage can generally be found by submerging the entire rebreather or a part in water while exerting pressure in the breathing loop. It is also possible to find leaks by applying a soapy solution on a certain area.

After eliminating the problem, negative and positive pressure tests must be repeated.

3.6.3 Regular service inspection

The CCR Liberty requires yearly service inspections (maximum 13 months) or after 150 hours of usage, whichever occurs first.

Service inspections must be performed by a service technician certified by Liberty Systems or performed by the manufacturer. The replacement of components and the inspection process are determined by the manufacturer's guidelines valid at the time of inspection.

3.6.4 Long-term maintenance

Oxygen sensors

When the oxygen sensors are calibrated, their degree of wear is checked. Of course, sensors can suddenly reach the end of their service life even during a dive, especially in an environment with high partial pressure of oxygen. Therefore, we recommend replacing the sensors no later than one year after putting them into operation or maximally 18 months after their date of manufacture.

It is not necessary to discard replaced sensors. Even though a sensor's degree of wear prevents it from reliably measuring higher partial pressures of oxygen in the rebreather, it will often suffice for reliable measuring of lower partial pressures of oxygen when preparing mixtures.

Hoses

If any hose shows signs of excessive wear or if damage is detected during a bubble check (see 3.3.8 [In-water check](#)), replace it. If mechanical damage does not occur as a result of careless handling, hoses should be replaced during a regular service inspection.

The service life of hoses is maximally five years from the date of putting them into operation and maximally seven years from the date of production.

Straps

Harness straps are highly durable. A strap that has been damaged on the edge should only be replaced in case that it was cut to more than one-third of its width.

Straps are generally replaced for aesthetic reasons. You can order a replacement when ordering a regular service inspection.

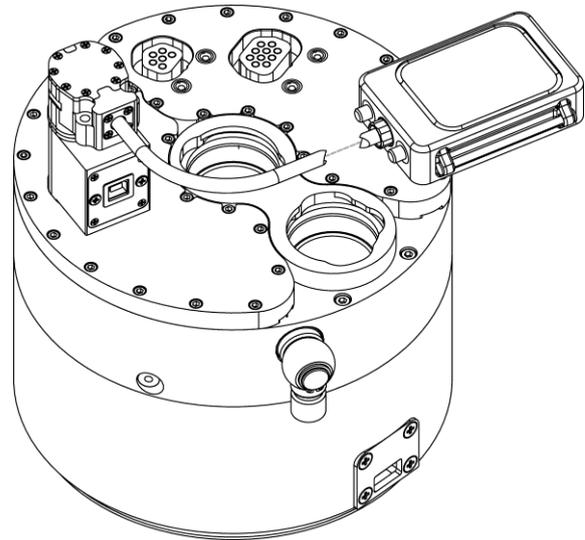
3.6.5 Firmware update

The CCR Liberty's electronics have two different types of firmware (FW): one for the control unit, the other for the handset. It is possible to download the current version of both firmwares in one package from the support page at www.CCRLiberty.com/support. Perform FW updates with respect to maintaining CE certification according to the description on the support page.

Perform updates with the head removed from the rebreather's body.

It is necessary to combine CU and handset FW updates. First load the FW into the CU and then allow routing (see below) and load the FW into the handset. Repeat for the other CU and handset. Check to ensure that both FWs were published in the same distribution package.

After performing an update, pay close attention to the correct functioning of the CCR Liberty, especially when diving. Do not perform an update immediately before an extreme dive. If you update the FW before embarking on an expedition-type event, we recommend that you take with you a multipurpose USB connector, a USB cable and a notebook with an installed and setup DSLoader and that you have an older version of the firmware available.



DSLoader

It is possible to update the firmware from a PC with the Microsoft Windows 7 or higher operating system on which a DSLoader application is installed (installation on Microsoft Windows XP is not supported, though it is possible for the DSLoader version from May 2014).

Download the DSLoader from the support page at www.CCRLiberty.com, install it on your PC and set it up according to the instructions provided on the support page.

Control-unit FW update

It is necessary to update each control units separately. Check to ensure that the same version of the firmware is installed on both CUs.

Procedure:

1. Disconnect both handsets.
2. Remove the jumpers from the battery (the CU is powered via USB when updating).
3. Connect a multipurpose USB connector to the handset connector on the head and then attach the handset to its upper connector.
4. Launch the DSLoader and connect it (click on the Connect DSLoader button).
5. On the disk, choose the firmware that you want to load into the CU.
6. Load the firmware into the CU (click on the Upload DSLoader button).
7. Repeat this process for the other CU.

The DSLoader is designed so that it does not load wrong firmware into the CU. The bootloader that performs updates on the CU side is separate from the updated firmware. Therefore, there is no risk of irreversible damage to the CU in the event of a power failure or disconnection of the USB connector during a FW upgrade. In this case, the CU will not be functional for diving. However, it suffices to reset the USB connection and repeat the FW upload.

Update handset FW

It is necessary to update each handset separately. Check to ensure that the same version of the firmware is installed in both HSs and both FWs (CU and HS) were published in the same distribution package.

Procedure:

1. Disconnect both handsets.
2. Remove jumpers from the battery (the CU and handset are powered via USB when updating).
3. Connect a multipurpose USB connector to the handset connector on the head and then attach the handset to its upper connector.
4. Turn on the handset, which will start in bootloader mode.
5. Launch the DSLoader; click on the Enable routing button (leave the route path at 0).
6. Connect the DSLoader (click on the Connect DSLoader button).
7. On the disk, choose the firmware that you want to load into the handset.
8. Load the firmware into the handset (click on the Upload DSLoader button).
9. Repeat this process for the other handset.

3.7 Transport

3.7.1 By car

Transport the CCR Liberty in the case in which it was delivered. Secure the case against unrestricted movement in the vehicle's cargo space.

The dustiness of the sorbent increases when transported in its loose state in the distribution canister. It is better to transport sorbent in the scrubber cartridge.

3.7.2 By boat

On a dive boat, it is usually possible to fasten the apparatus to a bench.

For securing the rebreather, use a line of approximately 1.5-2 m with secure knots. Tie the apparatus to a suitable structure.

Secure the ready-to-dive CCR Liberty by passing the line over the tanks and backplate, with the scrubber canister pressed to the back of the bench.

If you need to prepare the CCR Liberty for diving while onboard a boat, secure it using the holes in the upper part of the backplate to the back part of a bench. This will give you full access to the tanks for filling and you can easily remove the head and scrubber canister.

3.7.3 By plane

Pressure tanks

Airline regulations generally require that all transported pressure tanks should be empty with valves dismounted. Place the valves in clean PE bags (Ziploc) and place duct tape over the neck to prevent contamination. It is possible that security personnel will want to look inside the tanks; therefore, it is not appropriate to use tight plugs that cannot be removed without tools.

When checking your luggage at the airport, notify the airport personnel that you have pressure tanks in your luggage. Depending on local regulations, it is possible that you will have to take the tanks to a special counter.

Consider whether it might be better to rent pressure tanks at your destination. Dive centers equipped for closed-circuit diving usually have available tanks that can be used with the CCR Liberty. If you want to pre-arrange tank rental, which is highly recommended, refer to the size specifications available at www.CCRLiberty.com.

Sorbent

The sorbent canister should be empty. If you are also transporting a supply of sorbent, it must be in the original packaging or in an appropriately sturdy and airtight container. Familiarize yourself with the valid regulations concerning the air transport of sorbent. Consider the possibility of purchasing sorbent at your destination.

Head

For the purposes of air transport, the batteries must be disconnected by removing or turning the battery jumpers. Do not transport the CCR Liberty in standby mode.

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Certificate GB14/92281

Liberty systems, s.r.o.

K Haličů 756/14,
Praha 8,
180 00,
Czech Republic.

It is certified that the manufacturer's technical file and the PPE product detailed on page 2 have been assessed and found to be in accordance with

EC Directive 89/686/EEC

EC Type-examination

This certificate is valid from 28 November 2014
Issue 1. Certified since 28 November 2014

Authorized by

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Unit 202B Worle Parkway, Weston-super-Mare, BS22 8WA, United Kingdom
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SGS EC 03 1011

This certificate remains the property of SGS United Kingdom Ltd to whom it must be returned on request.
Page 1 of 2



Certificate GB14/92281, continued

Liberty systems, s.r.o.

EC Directive 89/686/EEC

EC Type-examination

Issue 1

PPE Product

CCR Liberty - a closed circuit electronically controlled rebreather with a maximum operating depth 100 m. The device incorporates over the shoulder mounted counterlungs, a radial scrubber, two controller/handsets, head up display, automatic diluent valve with an inline isolation valve, manual O2 addition, manual diluent addition and an integrated wing style buoyancy control device. The device is required to be used with an autonomous bailout system in accordance with the manufacturer's user information notice

It is certified that the manufacturer's technical file and the above mentioned PPE have been assessed and found to be in accordance with the requirements of Council Directive 89/686/EEC. When examined the PPE satisfied the relevant requirements in the harmonized standard, EN 14143:2013

The manufacturer's information notice (CCR Liberty Dated 27 November 2014), in English, has been inspected and found to have addressed all of the relevant requirements of the standard. However, the detailed content of the information notice is the responsibility of the manufacturer, as are translations into other languages.

This certificate is issued on the strict condition that appropriate checks on manufactured PPE, as detailed in Article 11 of the directive, are implemented and maintained while the model is in production.

Certification is based on technical file reference: CCR Liberty Technical file dated 8th September 2014, & supplemental Documents.
SGS Reference Number GB/PP 233262

This certificate remains the property of SGS United Kingdom Ltd to whom it must be returned on request.

Page 2 of 2



Certificate GB14/92282

The management system of

Liberty systems, s.r.o.

K Haličů 756/14, Praha 8, 180 00, Czech Republic

has been assessed and certified as meeting the requirements of

Directive 89/686/EEC

Article 11B

For the following activities

Manufacture of self-contained re-breathing diving apparatus.

Note: All products marked CE0120 must have a valid EC Type Examination Certificate issued under Article 10.

This certificate is valid from 09 December 2014 until 09 December 2017 and remains valid subject to satisfactory surveillance audits.
Re certification audit due before 19 November 2017
Issue 2. Certified since 28 November 2014

Authorized by

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CCR Liberty User Manual

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www.CCRLiberty.com

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Use of this manual approved by

Lucie Šmejkalová, CEO

EC Type-examination for Directive 89/686/EEC by

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