

How to use the scrubber monitoring system on the rMS

Version 0.1 22 02 2012 not final yet: updates will follow

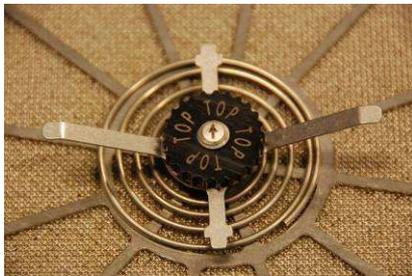
Latest modifications in **yellow**

Unfinished parts in *italic*

1 preparation of the unit

Besides all the normal preparation, this highlights the typical rMS features

- fill both scrubbers as normally
- put the spring locking screws on the units, and tighten them gently till the end of the thread
- if some grains of sorb come out of the mesh, poor them away
- put the 'top-marker' on one of the canisters



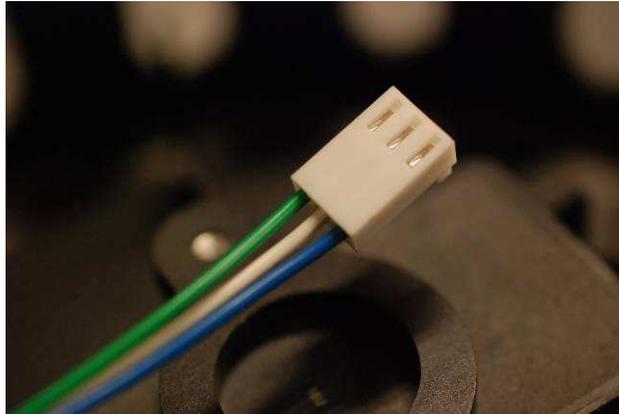
- put the canister with the 'top marker' on top of the exhale lung, in the upper place of the rebreather, **and make sure the arrow on the central ax points to the top of the unit**



- put the other canister in the lower position, and make sure the arrow also points to the top of the unit
- close the unit and do the normal checks / calibration as usual using the checklist. (closed check)

ATTENTION:

When you have installed the oxygen sensors on the sensor tray of your rMS, you will have noticed that there is now a 4th molex connector, with 3 wires, green, white and blue, unlike the normal molex connectors for oxygen sensors, that have only 2 wires, red and blue.



In the rMS, this new extra connector is for future applications: we already added this connector, so that when in the future new types of sensors come on the market, you don't have to change anything on the unit.

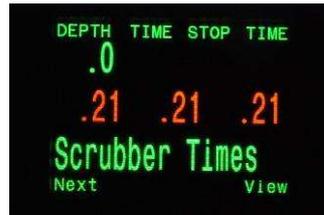
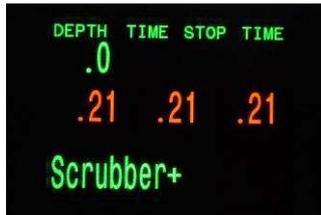
Later, when we want to, we can activate and use this connector, by just a software upgrade, just like the current software upgrades from Shearwater.

So at this moment, don't do anything with that connector, and surely do not connect it to an oxygen sensor.

2 dive planning

Before diving, always check the remaining cycle time of the scrubber: make sure you never start a dive unless your remaining cycle time after the previous dive is more than the planned dive time: the idea is that you never use your scrubber till you have zero remaining scrubber time: as at that moment you are really near the end of the scrubber, so it is never a good idea to plan a dive so that at the end of that dive, you will come close to scrubber break-trough!

To make dive planning easy, there is a log of the remaining cycle and scrubber times at the end of the previous dives: you find this in the menu by pressing left until you see:



The 'Scrubber Times' screen shows you the Remaining Cycle Time (RCT) and the Remaining Scrubber Time (RST) of the actual dive, and of the 2 previous dives.

Do notice that during any dive, there are 2 different 'remaining cycle (RCT) / remaining scrubber times (RST)': the 'actual' (now), and the 'minimum' during that specific dive

In surface mode, and while the scrubber is cold, there is no prediction of remaining times, so the screen just shows '? Warm-up'

Once the scrubber is warming up, and the dive starts, remaining times are calculated and displayed in the line 'Now'

Once the scrubber is fully ready (fully warm), the minimum cycle/scrubber time is recorded/updated all the time during the dive, together with the associated depth and temperature when the minimums were recorded: this is needed for future dive planning.

At that moment both the actual 'Now' and the minimum 'Min' remaining times are displayed.

The main screen of the predator shows you the **actual** remaining cycle/scrubber time for the actual dive: because the actual time can vary during a dive: going deeper will decrease the time, going shallow will increase the remaining time etc.

Example: you do a 60m dive with 1 hour bottom time, and all the rest deco. At the end of your 1 hour bottom time, your remaining cycle time is X. (usually the minimum remaining time will be identical to the actual remaining time at that moment.)

Now when you start to ascent, the temperature profiles will change in the scrubber, and when coming close to surface for the long deco, the actual remaining cycle time will have increased again, (as you can stay much longer on the scrubber at deco depth then at bottom depth). This actual remaining time is also the reality: it will give you the time you have left on your unit from that moment on.

The minimum remaining time at the end of the bottom time however is logged. This is useful for planning the next dive: as from that data, you know what the minimum remaining cycle time will be when you will be at the same (or lesser) depth in the next dive.

In the screen you see that in the previous dive, the minimum recorded RCT was 1h25 and that happened at a depth of 15 meters while the water was 20°. So if you plan another dive at a depth of around 15m, for one hour, there is no need to change the scrubber.

Still to work out deeper:

Now what happens if you want to do a much deeper dive?

How to plan, and what is the correct relation between remaining time at 15m and remaining time at 45m?...

*At this moment, **the safe approach** is using the following rule of thumb:*

A: if the minimum RCT of the previous dive is recorded at a depth of >20m depth, then

: always consider that remaining time is inverse linear with depth of future dive if you go for a deeper dive, and is equal to the remaining time of the previous dive if you go for a more shallow dive. Example:

1 At the end of your previous dive, your minimum RCT was 2 hours at 40m depth.

Your next dive is to 30m: you can consider that you have a RCT of 2 hours at 30m depth.

2 At the end of your previous dive, your minimum RCT was 3 hours at 20m depth.

Your next dive is to 40m: you can consider that you have a RCT of 1.5 hours at 40m depth.

B: if the minimum RCT of the previous dive is recorded at a depth between 0 and 20m, assume it was recorded at 20m depth: now follow the rule of thumb A: Example:

At the end of your previous dive, your minimum RCT was 3 hours at 0m (surface): you can assume that you have 3 hours at 20m depth. My next dive is to 40m depth: you can consider that you have a RCT of 1.5 hour at 40m depth.

We know that this is a conservative approach, and that it does not take into account the temperature: but till further notice it is a safe approach!

Do remember that the scrubber prediction is only working with rEvo approved scrubber material!

Anyway: the basic rule will always stay:

- never plan a dive where you assume that your RCT will become zero
- diving with an RCT below zero should be seen as an emergency mode

So:

- always Cycle one canister before your planned remaining cycle time becomes zero,

And

- after every dive: write down the time you used the scrubber, even if the rMS logs the remaining times after the previous dives

3 starting a dive

When you have installed the rMS canisters in the rEvo and closed the cover, you can switch on your Shearwater

Normally you will see:



If you don't see 'C ?' this means that your temperature probes are switched off in the 'System Setup'. Go to the setup menu and change the setting of the temperature probes to 'on'. Switching 'off' the temperature probes can be done when diving on the dual radial scrubbers, or when using classic non-rMS axial scrubbers.

When the ? after the C (Cycle time) is yellow, this indicates that the system asking for temperature data from both canisters, but has not received any info.

As soon as the ? becomes green, communication is established, and temperature data is communicated. However, the ? indicates that the temperature data does not allow to make any prediction of cycle/scrubber. (mostly because the scrubber is still cold, as you have not yet started pre-breathing)

You can always check the activity of the scrubber by pushing on the right button till you see:



This screen shows that the unit is ready for warm up, but none of the 7 zone's have started to become active (they are all grey) so no prediction can be made for RCT or RST

If a red X shows after the C, this means that the attempt to communicate was unsuccessful, and the unit will try again later (for example when the canisters are not installed, or not touching the solenoid/oxygen board): pushing right will give you:



If all ok, and the display shows the green ?, you can start pre-breathing your unit. (as part of the pre-jump check: see checklist)

When you start pre-breathing your unit, the first zone's in your scrubber will start to warm up, due to the absorption of CO₂, and as soon as enough warmth is produced, the green ? will change into a number:

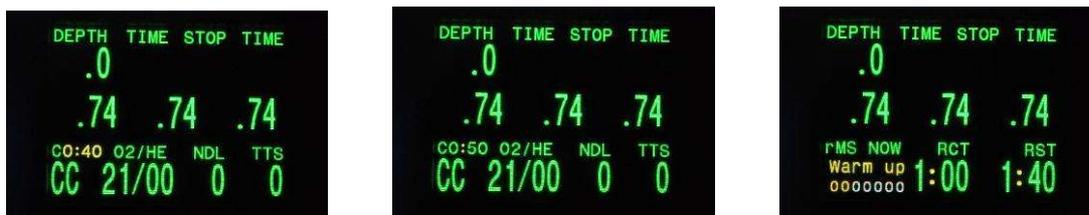


With only the temperature info at the inlet of the scrubber, the system has already received enough data to predict a minimum remaining time. You can see on the info screen that the warming up of the first zone in the scrubber has started: the color changed to yellow. However, only when that zone is fully warm, the color will be come green.

IMPORTANT:

Once you start to pre-breathe your unit, and the scrubber starts warming up, do NOT switch off your computer anymore: if you do this, then part of the information for the algorithm is missing, some zone's in the scrubber will not be able to reach 'ready' status or even 'warm-up' status, so the monitoring system will never show full working conditions

When you continue to pre-breathe, you will notice that when the remaining cycle time reaches 45 minutes or more, the color of the numbers changes into green:



So this will become a new rule when using the scrubber monitoring system: always pre-breathe until you have at least 45 minutes CYCLE time (green): this means that the scrubber is working, and that during further warm-up of the scrubber, the remaining cycle time will increase until the complete scrubber is warmed up:

Now, this warming up of the scrubber can take between 20 to 40 minutes in real diving situations, and you don't want to wait for diving until your complete scrubber is warmed up: this is not needed! : if the logged remaining cycle time after the previous dive is sufficient for the next dive, you know that it will reach that time once the scrubber is fully warmed. So as soon as you know that your scrubber is active and has sufficient capacity ($C > 0:45$) you can start your dive. (when you finished the other pre-jump checks)

(do notice that the screen shots show depth and time in surface mode, in normal diving you will of course see depth, time stops etc)

During diving you can follow the warming up of the scrubber on the info page. Once the scrubber is fully warm, you have reached the maximum remaining times for that given depth.



Also on the main screen there is an indication if the scrubber is fully ready or not: as long as the warming up is not yet finished, the colon between the C and the number is yellow, and only when the scrubber is fully warmed and ready, the colon becomes green, and full information of the total scrubber can be used to predict the cycle and scrubber times.



From this point on, and in dive mode, the minimum remaining cycle and scrubber time of the dive is logged, while at the same time the actual RCT/RST is shown on the main screen and the extra info screen.

You will notice that the actual remaining RCT and RST can vary during the dive, depending on the water temperature, the depth, the effort you do etc. Only make sure you stop the dive before the RCT decreases to zero, as the RST is your safety margin for diving! (color changing on the C numbers will indicate that you come close to zero RCT)



So you should never see the following screens during diving! :



If you make it a habit to immediately empty a canister when you have removed the 'TOP-MARKER', you will not make a mistake when exchanging/filling/replacing canisters. So:

- 1 take the top canister, with the 'TOP-MARKER' out of your rebreather
- 2 unscrew the 'TOP-MARKER' from the canister and immediately empty that canister.

(you are now sure you emptied the exhausted canister)

3 screw the 'TOP-MARKER' on the remaining (full) canister, and either put that canister in the upper position of the unit, or if you are finished diving, in a sealed container or plastic bag.

4 fill up the empty canister, and put it in the lower position of the rebreather, or in a sealed container if you finished diving

5 mark separately which canister is in top position, and that you refilled the bottom canister with fresh sorb

So the rule of thumb will always be: if you remove the 'Top-Marker', empty the canister!

Warnings:

- do not breath on the rebreather when the shearwater is off: scrubber monitoring is also based on temperature variations over a given time period: if you breath on the unit, and the rMS has not been able to detect the temperature changes due to breathing, it will not be able to detect a correct warming up of the scrubber, and so might never get to full ready/working status

- do not touch, try to bend, force the temperature sensing probe

- the maximum allowed temperature on the sensing probe is 70°C: so do not rinse the canister with hot/boiling water!

- never disassemble the probe from the canister: you need a tool for this, and if you try, the sensing probe will be damaged

- do not use the following functions in the Scrubber+ menu, unless you were asked to do by rEvo or your instructor, and only for trouble shooting:

