



opinion

Text and photos  
courtesy of Gareth Lock

**At the Rebreather Forum 3 conference held in Florida in May 2012, a number of presentations were made which advocated the use of checklists as a means to prevent diving incidents from occurring, or at least reducing the likelihood of occurrence. Consequently, there was a consensus opinion made at the end of the conference that checklists should be more actively promoted by both the manufacturer and the training agencies and should become the norm. Significantly, there should be overt use by senior members of the diving community in the same way that leading figures in snowboarding and skiing have changed the attitudes over the use of helmets, with the result that it is 'not cool' to not wear a helmet. To further emphasise the endorsement of the use of checklists, at the 2014 TEK Dive USA held in Miami from 17-18 May 2014, PADI provided T-Type CCR checklists for all attendees in the delegates' bags.**



# Checklists

— *A Tick in the Box*

Checklists aren't just about diving equipment, but also about the aim of the dive. Make sure the camera is not stuck on Manual Focus before taking the shot!

The reason why the presentations and consensus statement arrived at this position was because there is considerable evidence from aviation, medi-

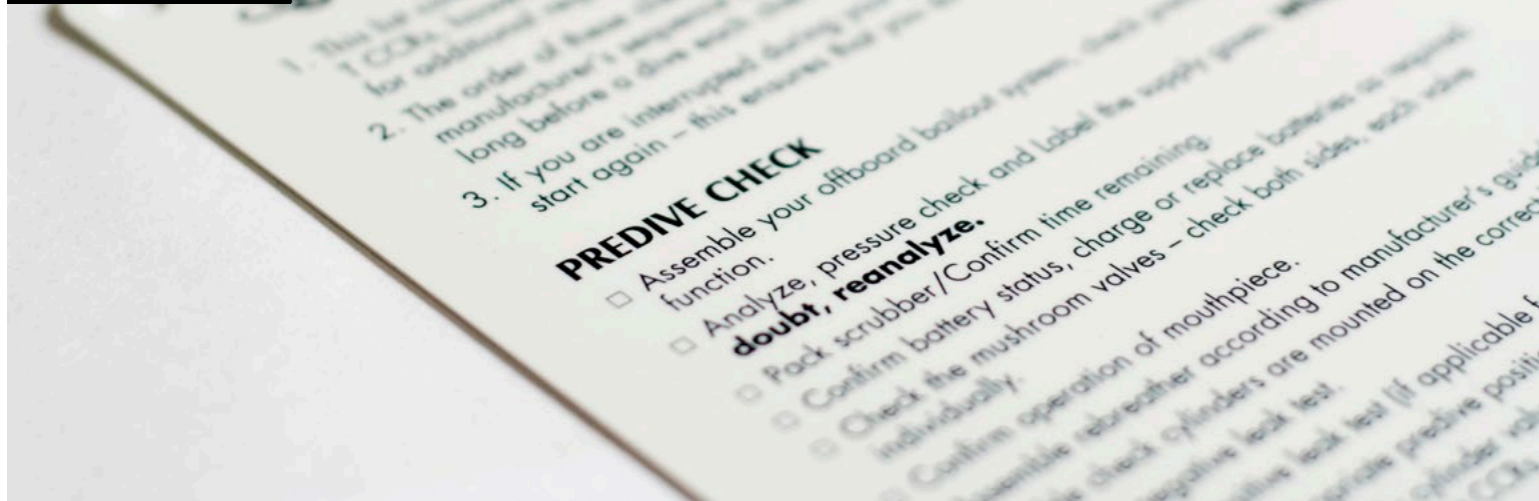
cine and other fields and disciplines that shows the proper use of checklists reduces the probability of incidents occurring. Simple examples of how

checklists have improved safety include making sure the limb for amputation has been actively and correctly identified, positive confirmation of the dose

and identity of the drugs being administered or making sure the correct engine is being shut-down in the event of an aircraft engine fire. Whilst these may

appear to be really obvious situations which should not need an additional level of oversight, there are a considerable number of documented events





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where these things had gone wrong because the wrong selection or decision was made.

However, just because you have a checklist it doesn't mean you won't prevent incidents from occurring. An oft-quoted line, "In all of the CCR fatality investigations I have been involved in, there wasn't a single checklist present on the diver," can be countered with, "All of the commercial airliners which have crashed in the last ten years have had checklists (hardcopy or electronic) in the cockpit."

This counter doesn't mean that checklists don't have their use, they do, but to make them effective, the community has to create the environment where their use is the norm and also allows divers to be challenged if they are not completed properly. Given the culture in some parts of the community, this will be a major challenge.

**The Checklist Manifesto**  
Between October 2007 and

September 2008 there was a World Health Organisation study to investigate the effectiveness of checklists in operating theatres and hospitals to reduce the numbers of incidents, accidents and fatalities; at the time there were 150,000 people dying every year in hospitals following surgery. Despite these statistics, there was considerable resistance, especially from the more senior doctors, surgeons and consultants because they did not believe they made the mistakes and felt that they should be trusted to carry on with the status quo.

However, despite the protestations, the trial was run across eight hospitals in eight cities around the world. The results were staggering. "Overall, in this group of nearly 4,000 patients, 435 would

have been expected to develop serious complications based on our earlier observation data. But instead just 277 did. Using the checklist had spared more than 150 people from harm—and 27 of

*To make [checklists] effective, the community has to create the environment where their use is the norm and also allows divers to be challenged if they are not completed properly.*

them from death," and, "The rate of death was 1.5% before the checklist was introduced and declined to 0.8% afterward. Inpatient complications occurred in 11% of patients at baseline and in 7% after introduction of the checklist."

The checklists themselves were really simple but they required an active element to tick off items against a list rather than being verbally completed from memory. However, it wasn't the checklist per se that was the most important factor in improving the safety in the surgical theatres, it was empowering the very junior staff to prevent procedures from start-



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As the dive gets more complicated, the complexity of the checks also increases

## Checklists

being rushed, 'rent a buddy' and not being sure what they are expecting, not wanting to question another diver and so on. This situation is made worse when divemasters or instructors do not undertake buddy checks either and therefore set a bad example for their charges to follow: "my instructor isn't doing a buddy check, why should I?"

Following RF3.0 a number of agencies provided CCR checklists for use on their courses, some of which were small enough to be clipped onto the unit at all time, whereas others were the size of a training slate.

### Evidence of effectiveness of checklists in diving

A recent study by DAN in the summer of 2013 appears to have shown the benefit of completing checklists by conducting a trial where the group was split into a control group who could choose to complete formal checklists before they started their dive, and the subject group who were given a checklist to use just before they entered the water. The checklist group had fewer reported incidents than the control group and

a number of issues were detected which would have otherwise been missed had the checklist not been followed.

A full analysis is expected to be published shortly in the scientific literature. Now this is only one study and only involved one environment so

there are likely to be some biases involved, but it certainly showed the merit of using checklists.

Another example was the Guam

ing or progressing until the checklist items had been completed.

This empowerment came from the most senior management within the hospitals and, in effect, provided 'top cover' for the nurses and assistants to tell a consultant or surgeon to not progress, no matter how much they protested.

This was a massive change to the culture in the operating theatre where it had always been considered that the surgeon or consultant was 'God', but now one of the most junior staff could question this authority.

By providing a means by which someone else confirms that the checklist is completed, it ensures that someone doesn't pay lip ser-

vice to the checks. (Whilst it can't reduce this possibility to zero, it seriously reduced the opportunity).

This is the same process used in multi-crew flight deck operations where one pilot reads the checklist out loud and the other actions it, confirming that the action has been completed when they have done so. This process is known as "challenge and response".

Notwithstanding the above, care must be taken to ensure that there are not checklists for checklists, or that checklists are appropriate for their intended use. A single checklist cannot cover equipment preparation, pre-dive equipment/configuration checks, in-water emergencies, or post-dive dismantling of

equipment and therefore there is considerable skill required to target checklists and their application.

### Diving checklists

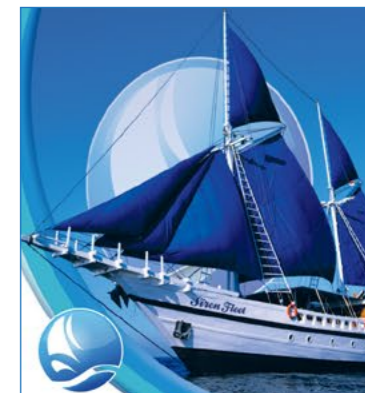
Many diver training organisations provide verbal checklists in their training manuals and try to instill the habits and cultures to use them effectively and regularly. Examples include BWRAF (BCD, Weights, Regulators, Air and Final Check), GUE EDGE (Goal, Unified team, Equipment, Environment, Decompression, Gases and Exposure) and BAR (Buoyancy, Air and Releases). The idea being that these are 'last ditch' checks completed just before the diver gets in the water and provide some assur-

ance that their equipment is ready for use and will provide them with a working gas supply and adequate buoyancy.

However, there is significant evidence that these checks are not completed regularly or effectively. The non-completion of checks happens at all levels of diving, from beginners in blue water holiday environments to technical OC and CCR divers with multiple stages.

The reason why they are not completed varies from relaxed or complacent attitudes to checks,

*The non-completion of checks happens at all levels of diving, from beginners in blue water holiday environments to technical OC and CCR divers with multiple stages.*

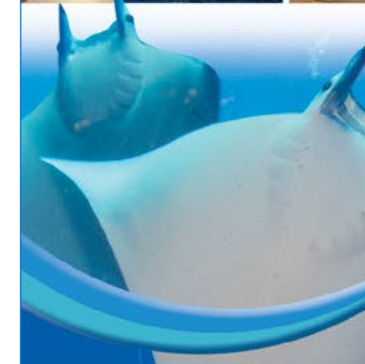


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Checks can ensure that the correct equipment is carried on the dive

### Application to the real world

So how do we make checklists work in a sport or recreational environment when you don't have the same level of empowerment given to you by someone senior? Even more challenging, when you are just diving with a buddy or friend and not in a commercial environment with a formal hierarchical structure.

You achieve it by creating the norm that checks are done, and if they are not, questions are asked between buddies or team divers. This goes for instructors and divemasters; there should be no

*By creating the 'normal' situation such that the divers are empowered to stop someone going diving with them if the gas isn't analysed, we have created a check that can be 'challenged and responded to'.*

One of the processes described through all dive training covering nitrox or trimix is that all gas must be analysed to measure the oxygen content before getting in the water to reduce the probability of having an oxygen toxicity event. The analysis should be done on the day of the dive to ensure that there hasn't been a mix-up with bottles or regulators. If you have

shame or disagreement when someone asks for the checks to be demonstrated. Just because you are a divemaster or an instructor, it does not mean you won't make a mistake.

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the correct social or cultural environment, you can also say you are not getting in the water until your buddy's gas has been analysed correctly—after all, it is your gas too in the event of an emergency.

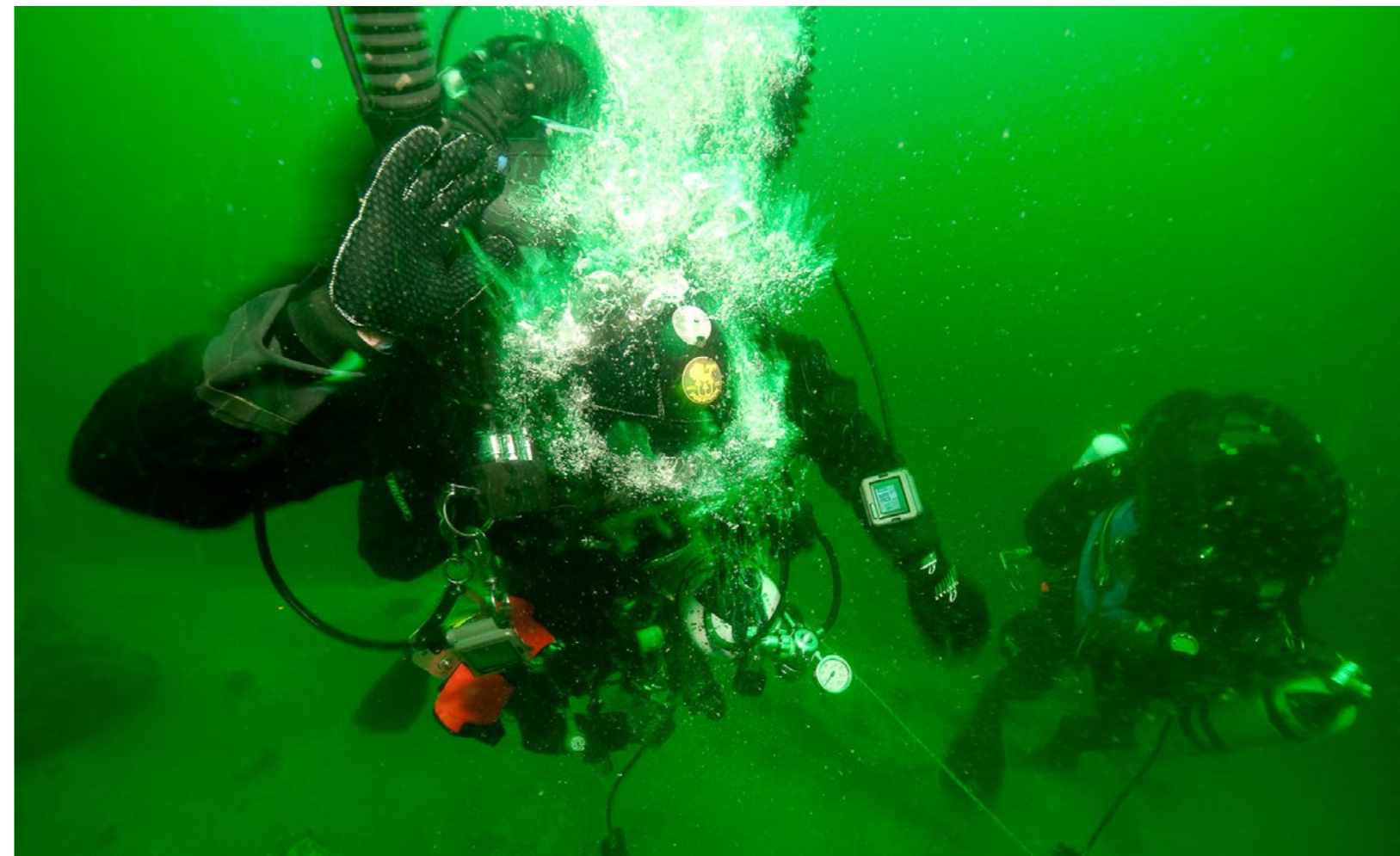
I have personally not gone diving with a very close buddy of mine until they have analysed the gas. I have also been two minutes from jumping off the boat and realised that the stage cylinder hadn't been analysed that day even though the regulator had not been removed. I could have jumped in and hoped it was okay, but hope has no place in diving especially when all it takes is the time to unscrew the DIN, put the analyser on, open the valve, read the display, put the

Project, which ran for five years and completed 9360 hours of in-water CCR diving with a small team of divers operating two Mk15 CCR units. Although there were a number of unit failures and problems detected on the surface, they never had one in-water failure of their CCR units despite the massive number of

hours of in-water time. This was down to following robust pre-dive checklists and procedures.

A final example is the GUE CCR Beta programme which has involved 50 instructors, instructor-trainers and experienced OC and pSCR divers developing the course material for the new GUE CCR Level 1 programme. In all,

the GUE divers had completed nearly 900 hours in water and never had one in-water failure despite a number of failures being detected on the surface, either during the assembly period or the pre-breathe. Again, these were all detected by rigidly following a checklist.



Failures normally follow a predefined process—a process which can be reinforced through checklist use



Really. There are no Dive Police out there!

small plastic checklists that can be clipped onto the unit or harness by a bolt-snap so that it is available to the diver at all times. However, there are examples of these checks not being completed because the diver has been rushed or has had inferred peer pressure to complete the task more quickly. It takes an alert buddy to make sure these checks are completed by watching them complete the check; sometimes this is impossible because they are on the other side of the boat facing the other way!

Whilst the majority of agencies now teach team-diving in-water, only a small number actively promote and teach pre-dive, in-water and post-dive team diving practises. This pre-dive team approach includes equipment configuration demonstration, access to emergency equipment and gas analy-

has a series of actions to be completed with initial blocks next to each one action to show that it has been completed once signed, on the other could be developed. This sticker is then attached to the unit or cylinders pre-dive in the same way that a gas analysis sticker is.

Completing such a checklist has the secondary effect of slowing down the checks which means divers need to be a little more prepared (which is no bad thing) but in some cases, e.g. hard-boat diving where it takes a few hours to travel to the dive site, it may not be possible to write on the sticker (but graphite pencils should work).

By initialling and signing the sticker in the relevant sections, another team member can quickly and easily check to be sure that their team member has

*Some of the agencies have produced small plastic checklists that can be clipped onto the unit or harness by a bolt-snap so that it is available to the diver at all times. However, there are examples of these checks not being completed because the diver has been rushed or has had inferred peer pressure to complete the task more quickly.*

completed their own checks correctly and that the unit is in a safe condition to dive. In the same way that a diver can stop the dive because there is no completed and signed gas analysis tape, they can do the same for the CCR pre-dive checklist. No completed and signed checklist, no dive. Simple.

This approach is the same as that used in surgical theatres; if the checklist has not

been completed then the procedure doesn't progress. The difficulty will be creating the environment whereby divers are happy to be challenged by their team mate or buddy when they are not necessarily close friends or even know each other; this is because there is no 'norm' at the moment.

Whilst it could be argued that less scrupulous divers could race through and scribble their initials to appear to get the checks done more quickly, there is

reg back on. So that is what I did. The gas was correct. I also had a word with my buddy about not checking my gas analysis!

By creating the 'normal' situation such that the divers are empowered to stop someone going diving with them if the gas isn't analysed, we have created a check that can be 'challenged and responded to'. So why not create a similar process for checklist use, especially CCR where there is a much greater risk of missing something due to the complexity of the equipment compared to OC? Maybe because there isn't the same level of dependency or reliance on other divers when undertaking CCR diving?

Same ocean diving is not an unknown configuration.

### Checklists: What are they?

The following section deals primarily with CCR checklists because of the number of steps required to assemble and pre-dive check the units, but the basic premise is the same and could or should be applied to OC.

There are a number of options available to divers when it comes to checklists and their CCR units: build checklists, final pre-dive checklists, emergency checklists and post-dive breakdown checklists. Each checklist has a differing level of detail within the tasks at hand; no one

checklist can cover everything otherwise it becomes too unwieldy and will not be used.

What we need to do is create a simple pre-dive checklist which ensures that ALL of the basic life support capabilities are working in the CCR unit and that there is nothing likely to be lying dormant in the system that will impact the diver later in the dive. We also need to ensure that the other team members can see that the diver has undertaken and completed the checklist, in the same way that a properly completed gas analysis sticker shows that the gas has been analysed correctly and is current.

Some of the agencies have produced

sis markings which are checked by team mates prior to entering the water. If pre-dive checks can be completed in a challenge and response manner with verbal responses or demonstrated actions, why not consider the same process when looking at detailed checklists such as those found in CCR diving?

A potential approach could be the same as gas analysis tape which shows when the analysis took place, the actual gas analysis and the initials of the person who undertook the analysis. A checklist which is self adhesive on one side, and



# opinion

an expected level of trust and professionalism from divers who undertake dives where CCR is required and therefore this shouldn't be much of an issue. It should also be recognised that it will take nearly as much effort to 'fake' the checklist as it does to undertake the activity properly so why not do it properly the first time?! This responsibility towards your teammate or buddy should be part of the mentality that goes with team-diving—working together for a safe outcome, not same ocean diving.

This suggestion may not be acceptable to those divers who undertake solo dives, but even if they don't have someone else

to check their checklist sticker for them, the use of a checklist will reduce the number of pre-dive issues if it is used properly.

The more technical solution to this is to include the checklist as part of the electronics in the system, e.g. Poseidon Mk VI and SE7EN, VR Sentinel and Hollis Explorer, which would prevent the unit from working (apart from immediate life support) if a checklist has not been completed. A criticism of some of these systems is the lack of reliability, which means the checklist system prevents the diver from diving due to a genuine system failure. Whilst this is a good thing as it fails safe, it can lead to divers shortcutting

Overhead diving introduces additional challenges which means checks are more important

CCR divers on a training course (below). A training course is the best place to develop and reinforce the mindset of checklists

the system to go diving if the system is not reliable.

Another criticism likely to be levelled at such a procedure is that it is taking away personal responsibility and that divers should be able to do everything themselves. In part, this is correct, but pilots are trained to undertake emergencies from memory and then follow up with checks because they may have missed something. Why not CCR checklists?

## Application of checklists to the recreational diving community

The majority of this article has been about the use of formal, predominately written, checklists in technical diving. However, the most predominate type of diving is recreational, normally considered to be diving undertaken with no deco, single cylinder and shallower than 40m.

So how do we apply the same methodology and mindset to recreational diving? Easy. Just complete the checklists, albeit verbal ones, that have been taught in recreational diving courses. They are simple and easy to remember, they just need to be completed.

If your buddy, team member or instructor doesn't do a check, prompt them and say that you would like to complete



# Checklists

it, introducing humour if need be. The hard part is if they refuse to do the check. My bigger concern wouldn't be that they don't want to do a check, it would be more about what their attitude is to the rest of diving safety.

## Summary

Whilst it is fantastic that all of the agencies and the CCR manufacturers have provided checklists for users, with the majority of unit checklists downloadable from <http://www.tdisdi.com/rebreather-checklist/>, providing checklists isn't enough. There needs to be a change in attitude to their introduction and usage.

This runs from the first dives when the OW instructor or dive-master completes their BAR or BWRAP checks, even when no students are watching, through to instructors and instructor trainers when undertaking fun dives;

this isn't about the Dive Police, but rather about demonstrating sound practices.

Unfortunately human nature means that we are more likely to copy someone's activities rather than listen to what they say and follow that, especially if that person is someone we look up to.

There is limited value in having a checklist to complete an activity if there is no way to make sure the checklist is actually completed e.g. verbal checks without independent monitoring. There is just too much scope for human variable performance to introduce errors, errors which may cost a diver his or her life.

The irony is that divers don't believe they make enough mistakes to warrant the use of a checklist, but how many of those errors or mistakes would have been picked up by using a checklist? Just think, how many

surgeons thought they didn't make a mistake before checklists were introduced? They are professionally trained and undertake these activities more regularly than you go diving and they still make mistakes.

Therefore whilst there is credible evidence that checklists can prevent a significant number of incidents from starting, developing and reaching fruition, the checklists themselves need to be properly used to be effective. □

*Gareth Lock is an accomplished technical diver based in the United Kingdom. Currently serving in the Royal Air Force, Lock is undertaking a part-time PhD examining the role of human factors in scuba diving incidents. For more information, visit the Cognitas Incident Research & Management website at: [Cognitasresearch.wordpress.com](http://Cognitasresearch.wordpress.com)*

