How Much Gas is Enough? Running on "Empty"

By Andrew Ainslie

I just had a rude awakening after a dive recently that has made me re-evaluate my attitude to gas management, and my ability to handle emergencies rationally. I thought that I'd write the case up as a short article, in the hopes that it will make others reconsider what constitutes adequate reserves, and to recognize the sort of mental spiral that almost killed me recently.

On my last trip to Florida, I decided to push an infrequently dived section of a cave section with a new sidemount rebreather setup that I had been playing with. While this is not the time to talk about the errors that I made in that configuration, it turned out to not be the right configuration for the task. At approximately 4800 feet of penetration, I tore a hose on the rebreather, instantly wetting the scrubber and flooding the rebreather to a level that made it fairly unusable. At that point, I had what I felt would be an outrageous amount of gas – I had a scooter, twin 85's overfilled to 3600 psi in a sidemount configuration, a stage at 4000 feet, and a stage at 2000 feet. Under ideal conditions, a single one of those 85's should have gotten me out.

My head, however, had different ideas. It took me approximately 10 minutes to get back through the restriction that I had just spent 10 minutes getting through in the other direction – and I really mean 10 minutes, I verified it afterwards on my computer log. During that 10 minutes I ultimately ended up completely removing one of the 85's and pushing it ahead of me, then half removing the other 85 and pushing it ahead of me as I scrabbled behind it. The puffing and panting, together with my mounting concern, had my SAC up to an outrageously high level. By the time I got back to 4000 feet, I had emptied one of my 85's – that's over 100 cubic feet of gas in under 800 feet of cave, swimming with heavy flow assisting me. I was shocked when I saw the gauge so low – I hadn't even considered swapping tanks yet, and I'd emptied one!

I went onto the second 85, attached my stage, and started heading out. I lost concentration at one point, and drifted off the "main" line (which is a white line) onto a side line, without noticing that I'd made a jump. This line led me almost immediately into a really low section of cave. I, together with my rebreather, 2x85's and an 80, almost immediately got funneled into a mud-bottomed restriction that I couldn't get past. My rapidly worsening mental state led me to try to force my way past the restriction, instead of slowing down and trying to work out what was going on. In the process, I created an outrageous mess, with a silt-out so bad that I now lost this new line. I finally stopped moving, and waited for what felt like an eternity (but was probably about 5 minutes) for the silt-out to subside, while I shone my light around, until to my huge relief, I found the line again. By now, my mental state was extremely poor, I was no longer thinking logically, and my SAC rate was beyond horrible.

Back on the line, I came to a restriction around 3500 feet that requires one to turn sideways

when in a sidemount configuration. I turned on my side and squeezed halfway through when I felt my reg start to breathe hard. My immediate reaction (which turned out to be wrong) was that I had just finished my second 85 – that's over 200 cubic feet of gas in just 1300 feet with flow! I stopped pulling through, moved backwards until clear of the restriction, and deployed and went onto my stage, now seriously concerned about my ability to get to my second stage at 2000 feet – i.e. another 1700 feet ahead of me – with no backup source of gas. I thought that I was now running on a single tank of gas.

At this point the cave starts opening up. I started focusing on breathing slower, and relaxing, as I rode my scooter home. At 2000 feet, I picked up my second stage with huge relief and clipped it off. Remember that at this stage, I thought that my primary 85's were both empty. Given that, I should have deployed the second stage in order to have an alternate source of gas at the ready. I didn't. I can only put this down to my deteriorating state of mind.

The next 1400 feet were pretty uneventful. But just 400 feet from fresh air, the inevitable happened – my stage started breathing hard. No problem, I thought, just deploy the other stage… but I just couldn't get to it fast enough. I was fumbling unsuccessfully with the clip, realizing with mounting disbelief that I just wouldn't be able to do it fast enough. I was about to drown less than 400 feet from the exit, with an untouched stage on me! Rapidly running out of options, I did the only thing that I could think of – I went back onto the flooded loop, hoping to get enough breaths out of it to finish deploying the stage. It was with incredible relief that I found that I could breathe through the gurgling loop, and that the now soaking wet scrubber wasn't yet putting out nasty enough fumes to be unbreathable. I really do believe that if it had been unbreathable, I would not have been here today to tell this story – even though I had huge amounts of unused gas on me. However, I got lucky, and within a minute I deployed the stage, and was once more breathing from a good source.

By now, I was mentally a complete wipeout. I headed out breathing that last stage, just hoping that there wouldn't be yet another problem, as I really believe that I no longer had the mental capacity to deal with it – I was mentally drained. It had completely freaked me out that I had almost drowned only a few hundred feet from the exit, and there was nothing rational about my state of mind. Less than 10 minutes later, finally breathing my oxygen, I lay in disbelief at how badly the dive had gone, and how lucky I was to be breathing, alive, and able to exit. After about an hour of deco, I surfaced to a silent, dark summer's night, very happy to be breathing uncompressed gas.

When I had removed all my gear, I started doing a post mortem. The first big shock was that I actually had 1500 psi in one of my 85's! What I had assumed was an empty tank in the restriction at 3500 feet was merely a rolled-off tank. I simply hadn't checked, in my panicked state. But the equally scary thing was, I had an empty 85, an empty 80, 1500 psi in the other 85, and 2000 psi in the second 80. I had gone through well over 300 cubic feet of gas to travel 4800 feet with the current, using a scooter for most of that distance. I've done 4000 feet into flow before using less than 80 cubic feet in the same cave, many times!

What had gone wrong? I remember writing once, that there is rarely such a thing as a real emergency in the caves. The key to surviving an incident such as the one that I had just encountered is to SLOW DOWN and THINK! That night, I did not follow my own advice. I repeatedly allowed myself to be conned into believing that I was running out of air, when in fact I had hours of reserve on me. I repeatedly neglected to check valves and gauges in my excessive zeal to exit the cave. And in my rush, I accidentally made a jump… silted out the cave to the point that I then lost that line… had a roll off that I misdiagnosed as an empty tank… and attached my last redundant source of gas without stopping to deploy the reg. That's four major mistakes in a row that occurred from not slowing down and thinking, and each time, instead of realizing what had created the error and methodically fixing it, I allowed my mental state to deteriorate even further and then started moving ever faster, ever more carelessly, with a spiraling descent into a set of circumstances that really could have resulted in a drowning… while I had well over 100 cubic feet of available gas that poor planning made unavailable to me.

Put differently, it turns out that I'm not as rational as I thought. I actually do believe that I'm usually reasonably calm under pressure. But a very difficult 10 minute scramble through a restriction started a narrowing of my perception, and every problem after that moved me into an even more panicked, illogical state of mind until the truly inconceivably dumb move – not deploying my last stage's reg – very nearly killed me.
What did save me? The answer is simple - huge gas reserves (and a bit of dumb luck). I had over 400 cubic feet of bailout gas on a dive that I had calculated needed about 100 under perfect circumstances. I needed every one of the 4 cylinders – admittedly because of an error of judgement on my part, but still, had I not had that second stage as well as two steel sidemount tanks (which seemed like insane overkill before the dive), I would now be dead. And the fact that a badly compromised loop gave me a couple of minutes of decent breathing gave me the latitude I needed to fix my idiotic error.

My takeaways –
1) On a rebreather, calculate how much gas you need for bailout or for reserve, and at the minimum, double it. On OC, it is simply not enough to just apply the rule of thirds, particularly in a complex system or when doing exploration. Thirds is an overly simple rule, and will not save you in low flow or if a secondary problem strikes. When I hear teams planning "team bailout" where between the team members they barely have enough gas to get one person out, or when I hear divers planning thirds in no-flow caves like Peacock and Mexico I cringe – on this dive I had enough theoretically to get 4 divers out, yet needed all of it. Remember, when an emergency strikes, you will need way more gas because of your panicked state of mind and because of the added time needed to deal with the emergency than you usually do. Plan accordingly. Rules like thirds are a starting point and an insufficient, bare minimum. They are not the final answer. I would really appreciate it if instructors taught this, and got their students to always turn below thirds in all but caves with howling flow and huge passages – and particularly that they enforce such an approach in places like Peacock.

2) Once you've planned properly, when a situation occurs that gets your attention, keep reminding yourself of what an outrageous amount of gas you have on you, and use that time to

move as rationally and slowly as you can. Don't stop doing your normal checks and protocols because of your desperation to get out of the cave. This really is an example of slow and careful being ultimately safer and probably even faster than a flat-out dash to the exit.

3) At every transitional point when moving from one gas source to another, use that time to ask yourself – just how much gas do I have in each tank? Are the tanks truly opened, and am I sure that they haven't rolled off? Do I have an alternate to go to if my current reg stops working for any reason? Where exactly is that regulator? Are the others stowed so I don't accidentally pick up a non-functioning reg when I need one? Be methodical and organized at all times. The same applies to any jumps or T's. When your rationality is compromised, it is even more important than usual to make sure that your navigation is going correctly. Pick up your spools, markers and arrows, and as you're doing so, run a mental check that the information that these devices are giving you ensures that you are still swimming to the exit.

I'm not proud of this dive, or of how close I came to a less auspicious outcome. But I'm willing to air my appalling performance in public in the hopes that each of you will reconsider just how well you will perform in an emergency, and how well you've planned for that emergency. Keep thinking, slow down, and allow yourself huge reserves of gas. This is particularly important on bigger dives, but equally important on even the shortest one. I hope that sharing this experience will change someone's behavior enough to allow them to survive a dive that would otherwise have killed them.