Having now firmly established themselves as the alternative and often preferred form of underwater life support for a lot of sport diving activity, Rebreathers are here to stay. Supported by PADI, the world’s largest recreational diving training agency, there is now a growing momentum to transfer electronic Closed Circuit Rebreather (eCCR) technology into ‘mainstream’ diving under the banner of the recreational or rCCR. However, it is said that those who fail to study the past are doomed to repeat it and one of the most poignant questions asked at the Rebreather Forum 3 (RF3) conference held in Orlando, Florida during May 2012, was:

“Given that the fatality rates are 5-10 times that of open circuit scuba, should we morally offer this technology to the recreational diving community, before putting our house in order?”

Prior to this question, when asked, not a single RF3 delegate considered the safety record of sport rebreather diving to be acceptable. The delegation consensus on poor sport rebreather safety and the question of CCR technology being aimed at the ‘mainstream’ diving market, suggests that collectively, manufacturers, training agencies, international standards committees and regulatory authorities still have not adequately addressed the broader safety issues associated with sport rebreather use – an unsettling proposition as the sport diving industry stands at the rCCR juncture.

A Glance In The Rear View Mirror
In 1969 the Kanwisher / Stark Electrolung became available to professional diving organisations in the USA. This was an exciting era of sub-sea exploration where advances in electronic engineering were enabling the realisation of constant Oxygen Partial Pressure (PO$_2$) life support systems. Despite its price of around $2000 (a significant sum back then), being the world’s first production electronically controlled Closed Circuit Rebreather (eCCR), the Electrolung promised to revolutionise diving.

With a number of commercial and military contract potentials, the future looked encouraging for the technology and the manufacturer Beckman Instruments Inc, who had purchased the Electrolung design rights. However, the bright future anticipated was not to be following three ‘sport diving professional’ fatalities. Despite two losses being classified as user error, in 1970 Beckman withdrew the Electrolung from the market fearing the financial impact of product liability. Other manufacturers such as Biomarine and Inner Space Systems persisted with the eCCR concept and a number of pioneering offshore professional
diving companies used the *Porpoise Pack 1 (PP1)* for a brief period in the mid 1970’s in both the US and UK offshore oil fields, including successful 150m (500ft) submersible vehicle lock-outs - exciting times indeed. (N.B: Inner Space Corporation (ISC), the manufacturer of the Megalodon CCR is not the 1970’s company Inner Space Systems)

The US Department of Defence began trials during this period and the Biomarine USN Mk15 was subsequently borne for Special Operations Forces (SOF), eventually leading in the mid 1980’s to the Mk16 for Explosive Ordnance Disposal (EOD) and later the numerically displaced Mk15.5, again for naval special warfare applications. Until the mid 1990’s the US military was the only nation with an electronically controlled CCR in-service. This was to change with US government granting Mk16 export approval in the mid 1990’s. With regard to sport diving, the eCCR had been squeezed back into its box; but not for too long. It was only a matter of time before the attraction and benefits of CCR would eventually cause that box to burst open.

**A Technical Revolution**

In the 1990’s open circuit ‘technical diving’ was rapidly expanding out of the USA and establishing itself globally as a separate discipline of sport diving. On the shoulders of some incredible pioneers, open circuit technical diving methodology began to facilitate unheard of exploration. However subterranean and sub-surface exploration was becoming increasingly constrained by the limited duration and immense logistic requirements of open circuit SCUBA. A clear demonstration of the need for new life support technology is the incredible story of Olivier Isler’s R2100 triple redundant rebreather and Dr William (Bill) Stone’s development of the CIS Lunar eCCR, immortalised in the book *Beyond The Deep* – a must read for anyone with an interest in exploration and CCR development.

This emerging ‘technical diving’ community was hungry for new technology and information to help facilitate exploration. In response to this enthusiasm, in 1993 the revolutionary technical diving journal aquaCORPS brought out an issue dedicated to rebreathers. The C2 (Closed Circuit) N7 issue fanned the Rebreather flames of interest worldwide and remains to this day a key reference for those interested in rebreather development. With the aim of dispelling the many myths that abounded within the technical diving community regarding rebreather technology and its application, a year later the Editor of aquaCORPS Michael Menduno (affectionately known as M2, who is credited with introducing the term ‘Technical
‘diving’ into our diving vocabulary), organised Rebreather Forum 1 (RF1) in Key West, Florida.

On the back of the technical diving revolution, with a growing global appetite for rebreather technology, diving equipment manufacturers and numerous ‘cottage industry’ enterprises began investing significant human and financial resource into product development. The race was on, the company that first brought a safe and reliable rebreather to market could potentially realise a significant return on its investment.

By 1996 the Cis-Lunar Mk5 eCCR was available to those who could afford the $15,000 price tag. For the ‘masses’, the Japanese Fieno and German Drager Atlantis (later Dolphin) had been introduced. Both were nitrox constant mass flow Semi Closed circuit Rebreathers (SCR), which despite their simplicity offered limited diving benefit but many of the disadvantages associated with rebreather use. SCR technology was not going to meet market requirements and so with affordable eCCRs threatening to emerge at any moment, with the assistance of a number of industry organisations including PADI, that year M2 organised Rebreather Forum 2 (RF2) in Redondo Beach, California, the principle objective being to discuss the many safety and training issues associated with the use of rebreathers by the sport/technical diving communities. In addition RF2 provided a platform to showcase emerging eCCR technology and numerous manufacturers from around the world attended. Various rebreather subject matter experts spoke at RF2, which included respected members of the offshore, military and scientific diving communities. A general consensus amongst RF2 delegates and speakers was:

**Loss of consciousness presented a significant hazard when using rebreathers, likely to result in death by drowning.**

“Loss of consciousness and death by drowning”, I will revisit this later. In the mean time fast-forward to todays’ rebreathers, in particular CCRs. Either electronically or manually controlled, they are now frequently seen at diving sites around the world and since RF2 there have been significant leaps in rebreather technology. Where once government and the offshore industry led diving equipment development, it is less so these days. Driven by the technical diving market and a number of highly inventive visionaries within it, the sport diving industry has taken the lead in equipment research, particularly rebreather development and decompression management tools. Following FR2, by 1998 the UK Manufacturer AP Valves (later Ambient Pressure Diving) had productionised the prototype eCCR developed by Dave Thompson and launched the Inspiration onto the sport diving market. As the first ‘affordable’ eCCR, sales of the Inspiration took off and today it still remains the best selling eCCR.
However, despite all the technological advances and incredible exploration, the last fifteen-years has not been a rebreather diving utopia. To quote the technical diving training pioneer Billy Deans back in the mid 1990's:

“The challenge is going to be bringing the technology to market without killing too many divers in the process!”

Unfortunately this remark has become the sport diving industry’s reality and of course that of the many families left behind. Since 1998 there have been over 200 rebreather diving related fatalities worldwide. With approximately 20 rebreather deaths per annum that number continues to grow and despite the advances made by the rebreather sport diving industry, still today it remains that statistically you are significantly more likely to die whilst using a rebreather compared with using open circuit. The reasons for this are complex and varied, so with the benefit of hindsight, in Part 2 I will review some of the 1996 key RF2 conclusions and consider where sport rebreather safety is today, where it may potentially be heading and how it might be improved.