

CHAPTER 10 - THE RUSSIANS

Well into the 1990's the impression amongst the Western European AIP producers was that they were the only people in the game : The Americans had abandoned conventional submarines, the Russians were largely nuclear and the Chinese had a big fleet of conventional and nuclear submarines but were not interested much in AIP. One of the main preoccupations of the companies interested in AIP was to convince naval personnel that the new systems were workable and worthwhile.

Most people in the AIP community believed that the Swedes had started first and had gradually developed a system which worked. You might object to it on various grounds, but it was an operational system. The *Naecken* chugged its way blamelessly through various trials and entered the Swedish navy to be followed by orders for more such boats.

Closed Cycle Diesels were at that time under intense development at a company called CDSS Ltd in the UK where I was working at the time. One day we were told by an Indian officer that they might not prefer to buy our system because a cheaper alternative was being offered by a Russian company called Rubin. This naturally put us into somewhat of a fug, and we set about contacting this Rubin company which we only really knew of as a builder of nuclear submarines. I also asked my wife's relations to cast about St Petersburg to see what information was readily to hand about Rubin.

The first thing that happened was that once contacted, the Rubin company sent us a message saying that they were more interested in fuel cells than in closed cycle diesels. They stunned us into silence by adding that "the closed cycle diesel systems which they had previously built for the Soviet fleet had not been all that successful". They enclosed some barely readable photocopies not only about these submarines but about other boats they'd built with Walther turbines in them. At all event, they said, not to worry because the Director Spassky and his head of conventional submarines Mr Kormilitsin would soon be coming to England and would visit us.

In due course Spassky and Komilitsin appeared at the factory and the first of several outstandingly interesting meetings took place. It appeared that the Russian had experimented for a long time with an early form of closed cycle diesel which we now call the Riccardo Vickers system. Essentially this diesel has a mixture of carbon dioxide and oxygen circulating round the system. Many such rigs have been constructed in recent times in research establishments round the world. The systems are characterised by poor performance of the diesel which is running on a mixture of gases which the designer never intended for the diesel. Carbon forms in the pipe work in copious quantities; you can always tell that this system has been in use because of filthy state of the workplace.

A constant problem with running closed cycle combustion engines has been to control the oxygen content well enough. If there is too little oxygen the diesel runs badly and eventually stops. If there is too much the lubricating oil can start to burn. The problem was only really

convincingly solved at Newcastle University in the late 1970's by Alan Fowler and his colleagues who I think based their work partly on earlier experiments at Riccardo's in Shoreham, England. They used a zirconium sensor which had a very fast response.

So far as I know the Russians had no such sensors in the period just after the war. Nevertheless, the Russians are extraordinarily inventive engineers and they somehow overcame the control problems. I am not really sure how they managed this. In the Soviet era it appeared to be relatively easy to start large scale projects. At a time when Western countries were scarcely beginning to think about AIP boats, the Russian started to build several boats of the "*Quebec* Class" which had Riccardo Vickers type closed cycle diesel engines fed from liquid oxygen tanks. The invention of the new power plants in these boats was kept extremely secret. When I was told by the Russians about these developments I could hardly believe what I was hearing. I assembled all the copies of "Janes Fighting Ships" from 1948 to 1995, and looked at the relevant entries. The *Quebec* Class was mentioned first in the 1959-60 edition, but it was not until 1973-74 that a small footnote was added about the possibility of there being Air Independent propulsion in the boat. In 1979-80 Janes added more discussion about the possible use of a closed cycle diesel and the Walther turbine. I later discovered by reading all the literature I could find, that J. G Hawley had published several papers (Ref 1) pointing out the existence of the *Quebec* Class boats. (see Ref 3)

There is a limit to how far you can question a foreign submarine manufacturer about the details of their work, and there is a lot about these boats which I don't understand. However, it seems quite clear from what the Russians told me that they suffered repeated fires and other technical mishaps in these boats. I also think that they could not silence them sufficiently. Eventually, I think that a combination of technical difficulties and the increasing attention being paid to nuclear boats led to the *Quebecs* being withdrawn.

Nor did the Russians restrict themselves to one particular form of AIP, they also made at least one boat of the *Whale* class (Ref 3), which had a Walther turbine in it. I briefly discussed this in the chapter on supply of oxygen. Essentially, high test peroxide (a concentrated form of hydrogen peroxide) is squirted into a turbine together with diesel fuel, or it is squirted into a combustion chamber close to the turbine. The mere motion is enough to cause combustion and a vigorous reaction releases heat to drive the turbine. The system has a very high power to weight ratio and a 1000 te submarine can be propelled at speeds well in excess of 30 kts. High test peroxide is difficult to manage in an engineering environment. Although I have not been able to turn up a completely reliable procedure for causing a detonation even in 100 % HTP, there seems no doubt that small leaks and other unwanted contaminations can result in pressure sensitive materials which can then set off other portions of HTP. I am myself inclined to think that mechanical engineers make potential problems of chemistry worse than they might otherwise be, by the cavalier way in which they deal with chemists and chemistry. Reasons and details notwithstanding, the Russians suffered a series of accidents with the *Whale* class. Unfortunately, it seems that a similar type of accident caused the loss of the *Kursk*.

After having a few meetings with the Rubin Bureau, I had not really expected to learn much more about these extremely interesting AIP powered boats. But then something unexpected

happened. My stepson, who is Russian, found a book recently published, by a man called Basilyevski describing the development of the Russian submarine fleet in the period from 1917 up to the late 1960's when atomic boats became dominant. My stepson said he was almost afraid to buy this book. Possession of such information only a very few years before, he said, would have resulted in either execution or a very close and prolonged acquaintance with distant parts of Siberia.

Basilyevski was a senior designer and he writes extremely interestingly about the engineering and organisational problems of creating a submarine fleet entirely from scratch after 1917. He describes the development of both the *Quebec* and the *Whale* class submarines. There is no doubt that the Russians were far ahead of any western country in the early development of AIP. The fact that they built systems that were in some ways defective does not seem to me to be of much relevance. The British also built boats with Walther turbines, and if they didn't sink any of them as the Russians did, they still never got them to work very convincingly.

I had been brought up when young to think of the Russians doing everything in committee and being completely afraid to work independently. Yet the older I get, and the more times I go to Russia, it seems less and less likely that this bears much relation to how Russians actually behaved inside their own industrial complexes. In reality, they seem to have been very free thinking and effective engineers.

The more I think about it, the more I think that the Russian attitude to engineering resembles that of the Victorian pioneers. Neither group was constrained by not being able to work out all the answers in advance, there are very few regulations to worry about, they would not be pursued for fifty years by ambulance chasing lawyers if some obscure fault developed in the product. Above all, both groups understood that it was better to make a machine that worked a bit, and then to improve it, than through inaction not make a machine at all.

(A downside to all this is the contempt that Russian officers and bureaucrats have for mortals of lesser rank. Safety, as we understand it in Europe, is not a factor that Russians think much about.)

I worked on a project commissioning a chemical plant in Leningrad during 1984. Before this time the Russians had mostly built "turnkey" plants in which western teams constructed the entire plant and got it working and then symbolically handed over the keys. In our case, the Russians had bought the design and built it themselves. When we went there to help them commission the plant, we found quite a few mistakes. Several things happened which were of interest. In the plant plastic material was fed to an air powered milling machine. In the original British plant the polymer was fed in through a 150 mm diameter pipe and was taken away also through a 150 mm pipe. In the Russian version of the plant the polymer entered via a 150 mm pipe and left via a 100 mm pipe, leading at once to blockage in the outlet. Of course we asked to see the chief engineer to ask him why he had done this. But there wasn't one. The inlet pipe team arrived two men and a woman, and the outlet pipe team two women and a man and, it seemed, never had the twain met. It seemed mighty strange to me, but it did not stop them drilling 150 mm holes through four concrete floors and fabricating about 90 metres of 150 mm stainless steel pipe in a very short time to correct the matter. When we could not find a means of measuring the

size of the milled particles because the wrong type of microscope had been ordered, they said not to worry and, having noted that the intended size of the particles was close to the size of white blood cells, they produced a haematologist from a nearby hospital and *he* measured the size of the particles. When we looked in the main reduction gearbox we found that it had been filled with sump oil rather than a hypoid. Shit they said and flew a man from Moscow with “the book”. The book contained a list of every grade of oil in the western world and showed its Soviet equivalent.

What we saw in Russia in 1984 was not what we had been led to expect and I fell to thinking hard about the nature of Russian engineering. Ten years later a colleague had an opportunity to go to the submarine yards in Nizhni Novgorod. Initially this completely confused us. Nizhni Novgorod is thousands of miles from the sea, how on earth could they be building submarines there ? Well, they do it. Nizhni Novgorod which may be shown on your maps as Gorki is on the Volga. It seems that the Russian build most of the Submarines at NG and then they start towing them up the Volga in a WNW direction to Ryabinsk reservoir. Then they go through something called the Sheksna canal into Lake Kubyenskoye from where they go into the River Sukhona and the River Dvina. Down the Dvina to Severodvinsk where fitting out is completed. The distance is thousands of kilometres. Only the Russians could do this. Much interesting information on the Russian fleet is contained in the Bellona web site (Ref (2))

Although the Russians are predominantly a nuclear fleet, it is policy to continue building non-nuclear boats. Some are to be used in the Russian fleet and some are to be sold for export, this being relatively important at a time when the Russian economy is undergoing substantial changes. As far as I understand it, the Russians favour a fuel cell based boat. It is not clear to me from the material to hand whether they favour hydrogen storage or whether they have some sort of conversion device in mind. Very little has been published about the Russian fuel cells presently available.

Ref(1) In preparing this Chapter I found that the existence of AIP in Russian boats was mentioned in a Paper by J G Hawley and G T Reader 24th Intersociety Energy Conversion Engineering Conference 6-11 August 1989.

Ref (2) <http://www.bellona.no>. This is a Norwegian site which seems to be inspired by fear of the radioactivity leaking out of scrapped nuclear boats located in or near the Russian northern naval ports. The Bellona people seem to have gathered a lot of otherwise relatively inaccessible material into one site. Mind you, it made my hair stand on end to read it.

Ref (3) In November 2005, there is a web site www.deepstorm.ru which gives a lot of detail about Russian submarines up to about 1992. The Quebec submarines are Project 615 and Project A615. Whale is Project 617

A NOTE ON TRANSLATIONS

In recent years , an increasing number of books have appeared about Russian naval matters. I think the authorities have largely abandoned their blanket of secrecy, perhaps realising that if they want to penetrate export markets, they have to take pride in their achievements and publicise them. There is somewhat of a problem about translation. I referred, in the chapter on carbon dioxide disposal, to a book by Bazilyevsky. This book is about 150 pages long. Even at warp speed at which I can read technical Russian, it would take me about an hour to translate, write out, and edit a single page. If I charged £20/hour you are into £3000 just for the translation. There seems no way to get the money back. Perhaps there's a business model that would work, but I can't think what it would be like.