



**S. RAJARATNAM SCHOOL
OF INTERNATIONAL STUDIES**
A Graduate School of Nanyang Technological University

RSIS COMMENTARIES

RSIS Commentaries are intended to provide timely and, where appropriate, policy relevant background and analysis of contemporary developments. The views of the authors are their own and do not represent the official position of the S.Rajaratnam School of International Studies, NTU. These commentaries may be reproduced electronically or in print with prior permission from RSIS. Due recognition must be given to the author or authors and RSIS. Please email: RSISPublication@ntu.edu.sg or call 6790 6982 to speak to the Editor RSIS Commentaries, Yang Razali Kassim.

Air-Independent Powered Submarines in the Asia-Pacific: Proliferation and Repercussions

Richard A. Bitzinger

23 June 2009

Singapore's recent acquisition of submarines with air-independent propulsion (AIP) is being matched by similar purchases by other regional navies. While AIP-equipped submarines do not necessarily upset regional military balances, they are part of a larger trend in regional naval expansion which could have far-reaching repercussions.

RECENT ARTICLES about the Republic of Singapore Navy's (RSN) acquisition of two used but refurbished *Archer*-class submarines from Sweden were not particularly newsworthy – the well-publicised purchase had been consummated four years ago. There was however one noteworthy admission by the RSN that was nearly buried in the news: these submarines have been outfitted with special engines for air-independent propulsion (AIP).

What is particularly astonishing about this disclosure is that these submarines were *not* originally outfitted with AIP; the RSN did not simply acquire this capability by happenstance of purchase. Obviously, the Singaporean Navy paid the Swedish submarine builder Kockums to do a retrofit, which involves literally cutting the hull in half and inserting an “AIP plug” – no small feat. In other words, this was a conscious effort by the RSN to get the most advanced conventional submarine they could.

Singapore, therefore, has become the first country in the southern Asia-Pacific to acquire AIP-equipped submarines. It will by no means, however, be the last, and the coming “mini-proliferation” in AIP submarines could significantly impact the way subs are employed in the region.

What is AIP?

Air-independent propulsion is a means of powering conventional diesel-electric submarines without using their batteries or having to surface to recharge. This permits the sub to remain submerged for much longer periods of time, two to three weeks, as opposed to just a few days on battery power. There are basically three kinds of AIP:

- **The Stirling engine:** This is the type of propulsion used by the new *Archer*-class submarine. Developed by the Swedes (who have installed it in three of their own subs), the Stirling design actually dates back to the 19th Century, and is a closed-cycle engine (meaning no exhaust) based on heat exchange. It is quiet and highly efficient.
- **MESMA system:** The French-developed MESMA (*Module d'Energie Sous-Marine Autonome*) system uses a steam turbine power plant to generate heat that in turn runs generators that powers the engine. MESMA is an option for France's *Scorpène* class submarines.
- **Fuel cells:** Germany has developed the Type-212 diesel-electric submarine that uses proton exchange membrane (PEM) hydrogen fuel cells to generate electricity. An export version, designated the Type-214 is also available.

AIP “Proliferation” in the Asia-Pacific Region

Other Asian-Pacific navies are not standing still when it comes to acquiring AIP-equipped submarines. Japan is currently building the new *Soryu*-class of diesel-electric submarines, which is outfitted, like the RSN *Archer*, with the Stirling engine; at least four boats in this class are envisioned. Meanwhile, South Korea is constructing, under licence from Germany, three fuel cell-equipped Type-214 submarines – the first of which was commissioned by the South Korean Navy last year – and it holds options on six more.

India recently signed an agreement to acquire six *Scorpène*-class submarines, which will be constructed under license at India's Mazagon Docks shipyard; the last three subs in this buy will have the MESMA AIP module installed in them. Not to be outdone, Pakistan has ordered three Type-214 submarines from Germany.

Australia, given its plans to double the size of its submarine fleet from six to twelve boats by 2030, will likely also acquire AIP – probably the Stirling engine, given its longstanding association with Kockums of Sweden.

Finally, rumours abound that China may also soon acquire an AIP-equipped submarine, based on its new *Yuan*-class diesel-electric sub. What type of air-independent propulsion the Chinese will employ is still unknown, however, but it will probably be a variant on the Stirling engine.

Implications for the Asia-Pacific

In and of themselves, AIP-equipped submarines do disturb the overall military balance in the Asia-Pacific. They do extend the operational endurance and range of conventional diesel-electric submarines. At the same time, it should be noted that all AIP systems are only *auxiliary* power sources, intended to supplement normal diesel-electric propulsion. They do not have anything like the speed of an electric motor – a Stirling engine-equipped submarine, for example, has a cruising of around ten knots, half that of a sub running on batteries – or the endurance of a nuclear-powered submarine, which can remain submerged almost indefinitely.

AIP, therefore, is probably best suited for long-endurance silent running, hiding from threats and hunting prey; this gives them expanded capacities for operations like anti-submarine warfare or trailing surface ships. They are also more capable of projecting power further out into the open ocean. Consequently, they can do a better job patrolling sea-lanes of communication (SLOCs) or protecting exclusive economic zones (EEZs). At the very least it can be said that AIP greatly expands the range of options and opportunities for local navies' submarine forces.

Beyond Modernisation

At the moment, too, the number of AIP-equipped submarines, current or planned, does not appear to threaten a new, even mini-arms race – yet. Malaysia, which is acquiring two *Scorpène* submarines, has not bought the MESMA-equipped version (although after the *Archer* deal, future Malaysian sub purchases, if any, could include this option). Indonesia had once considered acquiring several Russian submarines, but this deal fell apart over infrastructure financing (Jakarta wanted to use Russian export credits to build a sub base, which Moscow refused to fund).

Still, one should always be concerned about the impact of injecting new capabilities into regional military balances. In particular, it should be noted that these new submarine acquisitions are part of an overall trend in qualitative improvements to regional navies, resulting in increased capacities when it comes to long-range force projection, stealth, amphibious operations, lethality, and precision-strike.

All these trends add up to something much more than the “mere” modernisation of naval forces, which, depending on how these forces are utilised, could have far-reaching repercussions for regional peace and stability. Unfortunately, these developments are too often underexplored and underappreciated for their possible negative consequences.

Richard A. Bitzinger is Senior Fellow with the S. Rajaratnam School of International Studies (RSIS), Nanyang Technological University where he serves on the Military Transformation Programme. Formerly with the RAND Corp. and the Asia-Pacific Centre for Security Studies, he has been writing on Asian military defence issues for more than 15 years.