SEMAPHORE

SEA POWER CENTRE - AUSTRALIA ISSUE 07, 2012

SM2 AND SEA CONTROL

A NEW AIR WARFARE CAPABILITY FOR THE RAN

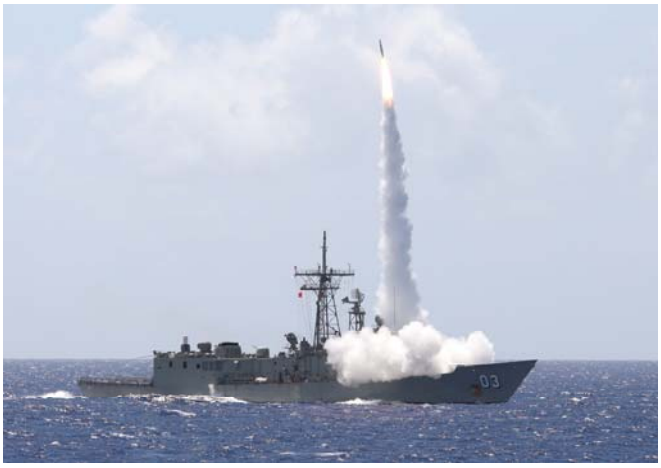
In June 2011 HMAS *Sydney* conducted a series of missile firings on the US Navy's Pacific Missile Range Facility off the coast of Hawaii. A key aim was to prove that the upgraded *Adelaide* class frigates (FFG) could exploit the full capabilities of the SM2 Standard Missile after a major upgrade program that saw it replace the previous SM1 surface to air missile. A proven, contemporary surface to air missile capability is a core component of the surface force's ability to gain and exploit sea control. Without sea control, a maritime force will be unable to adequately protect sea lines of communication or conduct maritime power projection operations.

The SM2 missile is the mainstay of the US Navy's anti-air warfare system and will be the major weapon in the RAN's new *Hobart* class destroyers (DDG). It is a solid fuelled, tail controlled, supersonic surface to air missile designed to defeat the full range of aircraft and missile air threats. It is a very capable weapon, having a range of 90nm and speed of >Mach 3. However, it is only one variant in the Standard Missile family. Its predecessor, the SM1, was first test fired by the United States in 1966 and was introduced into the RAN *Perth* class DDG in the late-1970s. SM1 was the original weapon on the *Adelaide* class FFG and upgraded versions of the missile are still in service with a number of navies around the world. The SM3 variant is gaining prominence as the weapon used in the US ballistic missile defence system and SM6 is the next generation surface to air missile destined to replace the SM2.

The FFG are the first RAN ships to be modified to fire SM2. The missiles are fired from the same launcher as were SM1 missiles, although modifications were required to the launcher to cater for the new missile interface and capability. The FFG class is in service with seven nations around the world, but the RAN is the first navy to attempt to integrate the SM2 into the class and the magnitude of this effort should not be underestimated.

HMAS *Melbourne* conducted the RAN's first SM2 firing in late 2009 against a surface target to prove the modifications made to the combat system and launcher. HMAS *Newcastle* conducted the second firing, and first against an air target, during Exercise RIMPAC off Hawaii in 2010. These first two firings were designed to prove the ships were capable of replicating the capability of the SM1 missile that was replaced, but at that stage the supporting software and associated systems to allow the full capability of SM2 to be used were still under development. The firings conducted by *Sydney* were an integral part of that development and tested a number of the high level features available in the missile. To understand the large increase in capability the SM2 will give the RAN it is necessary to understand the differences between the SM1 and SM2 missiles.

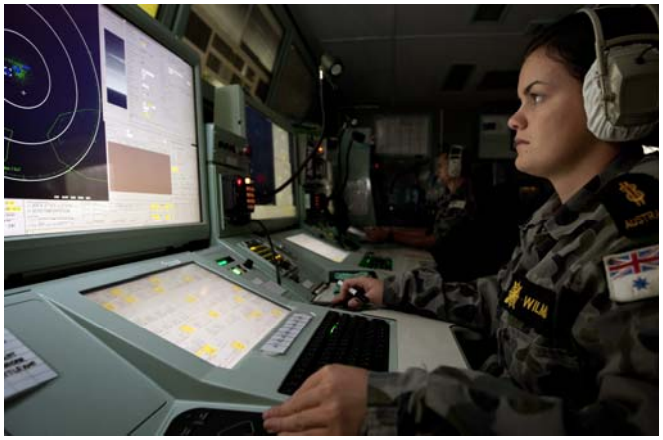
The SM1 has a nominal range of 25nm, flies at Mach 2 and is a 'home all the way' semi-active missile.[1] In order to engage a target the ship must first illuminate it with a continuous radar wave (known as continuous wave illumination, or CWI). The missile is then fired and detects the reflected radar energy that is returning from the target. The SM1 missile homes on this reflected signal until it intercepts the target.



HMAS Sydney *launching a SM2 missile on the Pacific Missile Range Facility off Hawaii*

The continuous wave illumination required to guide the SM1 is transmitted from a dedicated fire control radar on the ship that must continue to point at the target throughout the missile's flight. The RAN's FFG have two fire control radars for this purpose, so the ships were capable of engaging two air targets simultaneously. Should the SM1 missile lose reception of the CWI signal, the missile self destructs as there is no other method of homing onto the target.

The SM2 missile has a number of significant improvements over the SM1 including a greater range (90nm) and speed (>Mach 3). While it can be fired in the same 'home all the way' mode as SM1 it can also be fired without needing the CWI radar return to guide it until the terminal phase. In the FFG this is known as mid course guidance mode, where the missile initially flies autonomously towards a predicted intercept point (PIP) calculated by the ship's combat system immediately prior to launch. The ship continues to update the PIP based on changes to the target's movement after the SM2 is fired with an updated PIP being transmitted as necessary to the missile which then adjusts its flight accordingly. Once the missile gets close enough the ship's fire control radar commences transmitting the CWI signal for the missile to home on the target during the terminal phase of flight. Consequently the SM2 does not waste energy by unnecessarily manoeuvring early in its flight which increases both its overall range and its ability to manoeuvre heavily in the terminal phase of the engagement.



Able Seaman CSO Maxine Wilmott in the Operations Room of HMAS Perth *monitoring the SM2 launch*

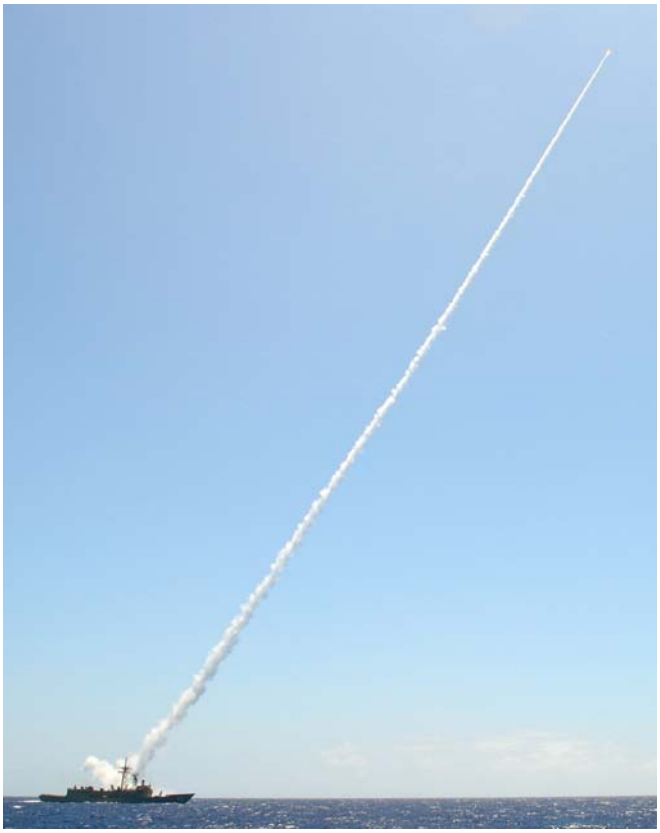
The mid course guidance mode has other advantages. CWI transmissions are easily detected by a target so once illumination commences, the target gains valuable warning time of an imminent threat. As the SM2 missile does not need to have the target continually illuminated with CWI for its entire flight, there are reduced warning queues for the target. In the current FFG configuration, there does need to be fire control radar support to track the target and provide the target's 3-Dimensional position for the PIP calculations. Not so with the new *Hobart* class DDG as its AEGIS combat system will be able to track all targets in 3-Dimensions at all times. Using the SPY1D(V) radar (the primary radar fitted to the ships) as a tracking source, data is continuously sent to the SM2 in flight by the SPY radar as guidance commands, again without the target detecting that it has been engaged. AEGIS can manage multiple weapons at multiple targets at any one time, with the CWI illuminators time sharing illumination of the targets during the terminal phase of the engagement.

The trials *Sydney* conducted in Hawaii covered a number of key aspects of the SM2 missile system. The specific details being explored and the results are classified, but were very promising. One firing was conducted in the 'home all the way' mode to prove that capability, while other firings explored various performance limits, system redundancies and operating modes, including firing at the edge of the designed operating limits. A number of firings were conducted where the target was deliberately manoeuvred after the missile was fired to ensure the ship's combat system could accurately monitor the PIP and send updates to the missile. There are also a number of key redundancies built into the SM2 system and simulated faults were injected in some firings to test these redundant modes.

The results of these firings are now being used to refine the various software systems in the FFG with the final product to be delivered to all four ships shortly. Once this happens, the RAN will have a tested and proven anti-air warfare capability out to 90nm from the firing ship, which will fundamentally change the way the ADF conducts air warfare. The range at which hostile aircraft will feel threatened by ships has effectively increased from 25 to 90nm, significantly complicating their ability to detect and identify surface contacts while simultaneously reducing their own weapon performance. This is a tremendous advance in the RAN's current anti-air warfare capabilities; an advantage that will be further boosted once the *Hobart* class DDG enter service later this decade.

The RAN's SM2 capability will also greatly increase the operating area that friendly aircraft can operate in which provides a tremendous increase in the ADF's air warfare capability. For example, Airborne Early Warning and Control (AEW&C) aircraft can operate at some distance from the ships, whilst remaining under the protective umbrella provided by SM2. Indeed, the AEW&C aircraft will provide much of the cueing and targeting information for the ships' weapons to use; an excellent example of the whole being greater than the sum of the parts.

The combination of ships and aircraft working together to detect and identify air threats and then ships and combat aircraft being able to engage those threats will be a powerful force multiplier for the ADF. Knowing where a threat is situated is one thing - SM2 brings the capability to deal with those threats if necessary. The trials conducted by *Sydney* in June 2011 validated the very good work undertaken by the RAN, the Defence Materiel Organisation and a number of Defence contractors to bring the full capabilities of the SM2 missile to the RAN.



HMAS Sydney *firing a SM2 missile on the Missile Range facility off Hawaii*

The RAN is now well placed to provide significant air defence capability when and where it is needed and, in doing so, gain sea control in order to execute military missions.

Peter Leavy

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[1] A 'semi active' missile detects the return signal transmitted by the firing platform. An 'active' missile transmits its own radar signal and detects the returns.