Progressive HARM: An evolution in capability

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The suppression and/or destruction of enemy air-defence systems is essential to sustaining US and allied anti access/area denial mission superiority. *Robin Hughes* explores the evolution of the AGM-88 High-speed Anti-Radiation Missile in advancing this capability

US Naval Air Systems Command (NAVAIR) awarded Northrop Grumman a USD322.5 million contract on 7 March for the engineering and manufacturing development (EMD) phase of the Advanced Anti-Radiation Guided Missile-Extended Range (AARGM-ER) programme. The award marks the latest chapter in the evolution of the most widely used and enduring anti-radar homing (ARH) missile in the US and allied inventories; it also closes a procurement loop between the US Navy (USN) and US Air Force (USAF) by providing the baseline for the USAF's future Stand-in Attack Weapon (SiAW).

An AGM-88C under the wing of a USAF F-16 multirole combat aircraft. (Raytheon)

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The suppression/destruction of enemy air defences (SEAD/DEAD) has been an important element in the projection and protection of US and allied military air power for more than 50 years. However, the emergence, evolution, and proliferation of more sophisticated and longer-range adversarial ‘double-digit’ surface-to-air missile (SAM) systems and related anti-access/area denial (A2/AD) technologies (early warning radars, ground-control intercept radars, SAM and anti-aircraft artillery fire-control radars, and radar-directed air-defence artillery systems) suggest that prosecuting the SEAD/DEAD mission is likely to remain a significant challenge for the foreseeable future.

Although the US and its allies have at their disposal various air-to-surface effects to support the SEAD/DEAD mission, anti-radiation missiles (ARMs) have an unparalleled capability to home in on active emitters and disrupt or destroy the components of an integrated air-defence system. Accordingly, and to enable the US and allied air forces to continue to operate in complex A2/AD environments, the US has over the years committed to evolve and enhance a dedicated ARM capability.

“The evolution of the ARH missile has increased the technology to adapt to the evolving threat radars, and increased the range to provide improved survivability of the launch platforms,” Mike Stuart, Northrop Grumman Defense Electronic Systems’ director of Strike Weapons and Advanced Programs Business Development, told *Jane’s* .

The current US and allied ARM capability is delivered by the AGM-88B/C High-Speed Anti-Radiation Missile (HARM) and its specific evolutions for the USAF (AGM-88F) and for the USN (the AGM-88E AARGM). However, the antecedents of these missiles, and subsequent ARM evolutions, essentially lie in two Vietnam War-era passive radar homing missile developments: the supersonic AGM-45 Shrike and AGM-75 Standard ARM.

However, the AGM-45 and the improved AGM-78 contained various limitations, including poor seeker sensitivity and frequency coverage, relatively low speed, limited destructive capability, and limited stand-off range. Production of the AGM-78 ceased in 1978 and all Standard ARM missiles were removed from the US inventory in the late 1980s, to be replaced with a significantly evolved capability: the AGM-88 HARM.

HARM development

A USN-led joint USN/USAF programme, the AGM-88 HARM missile was approved for full-rate production by the Defense Systems Acquisition Review Council (DSARC) in March 1983; the initial production variant, the AGM-88A, entered USN and USAF service the same year.

Developed by Texas Instruments (now Raytheon Missile Systems: production of HARM was taken over by Raytheon when it acquired the defence business of Texas Instruments in 1997), HARM introduced a significant capability evolution over the earlier AGM-45 and AGM-78 SEAD weapons.

The main improvements include the guidance section housing a broadband spiral antenna, a software programmable radio frequency (RF) seeker providing coverage from the C to J band (2–20 GHz) and a digital processor; control section housing a digital autopilot, an inertial navigation system (INS), and control surface actuators; a Thiokol YSR-113-TC-1 two-stage (boost-sustain) solid-propellant low-smoke rocket motor delivering an unclassified stand-off range of 150 km; an active laser fuze; and 68 kg WAU-7/B high-explosive blast fragmentation warhead section comprising 25,000 preformed steel cube fragments.

The major innovation in the HARM was in its intelligent RF video processor-based seeker, which was designed to recognise the characteristic pulse repetition frequencies (PRF) of threat radars, enabling the missile to select a specific radar operating in any given band. However, the AGM-88A seeker incorporated a fusible link memory that required the seeker to be reprogrammed in the factory.

HARM has since been evolved and fielded in three major variants: the AGM-88B/C/F (of which the AGM-88C and F are the latest iterations). The AGM-88A was supplanted in the late 1980s by the improved AGM-88B, which featured an erasable, electronically programmable, read-only memory (EEPROM) that enabled its embedded software to be reprogrammed 'in-field' rather than having to be returned to the factory.

Introduced in 1993, the AGM-88C is the latest Raytheon HARM variant in service, and follows the same form factor as the earlier AGM-88 variants: 4.2 m (13.7 ft) long, 25.4 cm (10-inch) diameter, 1.2 m wing-span, and an 363 kg launch weight. However, the C-model incorporated a new Raytheon-developed, more sensitive guidance package capable of handling frequency-agile emitters, an instantaneous frequency-measuring receiver, improved processor, a 6 dB increase in frequency sensitivity in one of the weapon's operating bands, dual-intermediate frequency bandwidths to improve performance in dense environments, and a 5% augmentation in memory size.

A new WAU-27/B preformed tungsten casing blast fragmentation warhead included 12,845 fragments and an improved 21 kg PBXN-107 explosive charge, as well as an FMU-111/B active laser proximity fuze linked to a DSU-19/A electro-optical detector, which determined the detonation of the warhead depending on the final trajectory characteristics. The warhead upgrade effectively doubled the lethality of the C-model over previous variants, making HARM more effective against hardened structures housing radar electronics.

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