

CIWS: The Last-ditch Defence

by Kelvin Fong

The last-ditch defence against the anti-ship missile is the close-in weapon system (CIWS), which takes the form of ultra-short range light-calibre guns by putting a “wall of lead” in the path of the oncoming missile. This is after the missiles have “leaked” through the layers of hardkill and softkill defences. Systems like the American Phalanx, the Dutch Goalkeeper or the new German Millennium Gun can be operated automatically and will wait until the missile reaches a predicted point before firing.

Nearly all classes of modern warship are equipped with some kind of CIWS device. Smaller CIWS-like defences are currently being developed for main battle tanks and light armoured vehicles in the USA, Israel, China and Russia (“Drozd” and “Arena” grenade launchers in the case of Russia, TROPHY in the case of Israel). In some cases, the CIWS has taken the role as the secondary guns for bigger vessels such as frigates and offshore patrol vessels.

The anti-ship missiles are by no means the only threat but they are perhaps the most perilous to surface units. Today, surface combat is most likely to occur in near shore, littoral environments. This situation places ships and their crews at risk to an increased number of threats from small, fast gun boats, standard and guided artillery, helicopters, mines and a variety of shore launched anti-ship missiles.

This ever-increasing threat has increased the demand for new-generation close-in weapon systems to be fitted to new surface combatants that are entering service with navies of the Asia-Pacific region. In recent years, a number of CIWS have been developed or improved. The following are the more notable of the systems being offered for today’s naval forces.

Rheinmetall Millennium Gun and MLG27

Its high rate of fire makes the Millennium GDM008 Naval Gun System the perfect match for Rheinmetall’s 35mm Ahead airburst ammunition, which stands for “Advanced Hit Efficiency and Destruction”. Fired at 1,000 rounds per minute, the Millennium gun delivers a payload mass of 500kg per minute: every Ahead round dispenses 152 x tungsten alloy sub-projectiles, weighing 3.3 grams each. The sub-projectiles form a lethal cone-shaped cloud ahead of the oncoming target, destroying its control surfaces, seeker and other vital components. The Millennium gun is an unmanned, remotely controlled gun mount, compatible with both state-of-the-art sensor and fire control systems. It can be mounted without penetrating the deck, and is especially well suited to smaller surface combatants and patrol vessels.



Rheinmetall

Based on the hit probability, Millennium can defeat anti-ship missiles at ranges three to four times greater than those achieved by conventional CIWS. The stealth-design gun mount carries 252 rounds of 35mm ammunition in a magazine inside the cupola. This allows it to engage ten anti-ship missiles or 20 surface targets without reloading. The gun can also fire conventional Oerlikon Contraves 35mm ammunition (e.g. HEI, SAPHEI and TPT). As an option, the unique “ISO mount installation” (The ISO mount installation facilitates ammunition stowage and “cross decking” for warship mission module flexibility) can accommodate all the equipment usually installed below deck. This makes the gun fully independent of the ship’s compartments, and assures fast, easy installation and interchangeability between platforms. The Millennium Ahead 35mm gun mount is currently the subject of a US Navy funded programme at NSWCDD, Dahlgren to qualify it for use on the US Navy warships. The Millennium entered into service in 2007 with the Royal Danish Navy on their Flexible Support Ship, HMDS *Absalon*. The HMDS *Absalon* is equipped with two Millennium guns, one forward and one aft. The Royal Danish Navy is the launch customer for series production of the Oerlikon Millennium naval gun system, having ordered six guns in 2004 with an option for a further four. Production for other customers is also underway. *Absalon*-class final SAT for the Millennium guns commenced in April 2008 on the Danish ship *Esben Snare*.

Another latest offering by Rheinmetall is the remote controlled MLG27 light naval gun system which is designed for protecting of small surface combatants and other small craft; it can also serve as secondary armament on larger units. Based on the high rate of fire, the

BK27 revolver cannon enables effective engagement of fixed wing aircraft and helicopters, speedboats and point targets on land. The system is particularly suitable for defending against terrorist attacks involving high-speed craft. The MLG27 features an integrated EO sensor package with TV camera, thermal imager, laser range finder, tilt sensor, stabilised mirror system and video tracking system for automatic and manual target tracking. It can be easily integrated into or interfaced with existing ship systems including different types of sensors and control functions. The MLG27 design allows integration in all kinds of vessels without the need for deck penetration. The 27mm FAPDS (Frangible Armour Piercing Discarding Sabot) ammunition was designed specifically for the MLG27. The FAPDS round achieves a similar target penetration as a subcalibre kinetic energy round with fragmentation-based incendiary effects comparable to high explosive ammunition. It is currently in service with many of the world’s air forces and navies.

Raytheon Phalanx

The most widely deployed CIWS today is the Mk 15 Phalanx CIWS which is described as an integrated, self-contained unit consisting of a gun system, ammunition and radar mounted in a single cylindrical elevating platform. The system was developed in the 1970s by General Dynamics Pomona Division—purchased by Hughes Missile Systems Company in 1992 and now a part of Raytheon Systems Company (RSC). Described as being affordable, the system can fit virtually any ship without major ship alteration, the Phalanx is currently installed on all US combatant ships and on those of more than 20 other nations.

The Phalanx is armed with a fast-reaction General Electric M61A1 Vulcan six-barrelled Gatling-type gun that has a high rate of fire at 3,000 rounds per minute—or 4,500 rounds-per-minute for later models—and Ku-band radar featuring closed-loop spotting technology capable of autonomously performing its own search, detect, evaluation, track, engage and kill assessment functions. Ammunition consists of 20mm Armour Piercing Discarding Sabot (APDS) using heavy-metal (either tungsten or depleted uranium) 15mm penetrator surrounded by a plastic sabot and a lightweight metal pusher.

The initial Phalanx configuration for US Navy ships is the Block 0 that provides basic anti-ship missile defence against today's low-altitude, subsonic, non-maneuvring anti-ship missiles (ASM). The Block 1A incorporated a new computer to provide more processing power over the obsolete earlier computer, improved fire control algorithms to counter manoeuvring targets, search multiple weapons coordination to better manage engagements, and an end-to-end testing function to better determine system functionality. The Block 1B Surface Mode Upgrade builds on the existing capabilities of Block 1A with the addition of new "Optimised Gun Barrels" (OGB) which provide improved barrel life, improved round dispersion pattern and increased engagement ranges. Both Block 1A and 1B upgrades also provide increased elevation coverage, larger magazine space for increased magazine capacity from 989 rounds to 1,550 rounds, and increased the firing rate to 4,500 rounds per minute. The Phalanx can also be interfaced with virtually any ship combat system to provide additional sensor and fire-control capability, and can provide target designation for other shipboard weapons such as Raytheon's Rolling Airframe Missile (RAM).



Phalanx

In April 2006, Raytheon Company was awarded a \$57 million contract to produce 16 Phalanx Block 1B upgrade kits for the United Kingdom's Royal Navy. Today, more than 895 Phalanx systems have been built and deployed in the navies of 22 nations.

Raytheon's Phalanx and RAM Marriage

Evolved from the CIWS comprising key attributes of both the Phalanx CIWS and the Rolling Airframe Missile (RAM) Guided Weapon System, Raytheon's SEA RAM Missile Defence System provides a high level of ship self-protection with extended keep-out range capability and the ability to engage multiple targets. The SEA RAM is designed to extend the inner layer battlespace and enable the ship to effectively engage future high-performance, supersonic, and subsonic threats. Leveraged technology from Phalanx CIWS and RAM integrates elements of each system into the self-contained SEA RAM system. An 11-missile round RAM launcher assembly, loaded with RAM Block 1 guided missiles, replaces Phalanx's 20mm gun.

Combining the RAM's high accuracy, extended range, and high manoeuvrability with the Phalanx Block 1B's high resolution search-and-track sensor systems, the SEA RAM system therefore will be a complete and autonomous weapon system with its own sensor suite, combat system and weapon. And based on the Phalanx Block 1B system, the SEA RAM will include the latest version Ku-Band search and track radar, a new forward looking infrared (FLIR) imaging system and an electronic surveillance measure (ESM) receiver.

Thales Goalkeeper

The 30mm Goalkeeper CIWS developed by Thales Nederland—formerly Signaal—is an autonomous and fully integrated weapon system for short-range defence systems against missiles and aircraft. The system can automatically perform the entire process from surveillance and detection to destruction, including selection of the next priority target. When the target is detected, threat evaluation and priority are determined, the target is designated and tracked by the I- and K-band radars.

The Goalkeeper combines a search radar (high power, I-band), a tracking radar (I/K-band), a weapon control system and General Electric GAU-8/A 30mm seven-barrelled gun with a high rate of fire at 4,200 rounds per

minute in one integrated mounting. The system features automatic target indication and track initiation. Threat priority is determined automatically and is directly followed by direction of the track antenna to the "priority one" target. The Goalkeeper can be integrated with the ship's IRST system to provide a passive mode, while radar data is used to complete the engagement, and as a second source of tracking data that can reduce the risk of false targets.

In 2004, the Republic of Korea Navy signed contracts for the delivery of five Goalkeeper systems worth about EUR51 million. The first system was delivered in 2005. Two Goalkeepers was installed on the LPX (Landing Platform) *Dokdo* that was launched in March 2005 and in operation in June 2007. The other three Goalkeepers are destined for the three KDX-II Batch 2 destroyers. Three Goalkeepers were also installed onboard the ROKN KDX III Destroyers. The delivery took place between end 2006 and early 2008. The KDX III will be equipped with the AEGIS Combat System. This is the first time that a Goalkeeper will be installed on an AEGIS destroyer. The Goalkeeper will be integrated in the AEGIS Combat System as an autonomous CIWS.

For the initial CIWS procurement for the KDX Programme in the early 1990s, the ROKN evaluated Goalkeeper with its 30mm Gatling Gun versus alternative CIWS based on 20mm Gatling Guns and or modular CIWS configurations. Goalkeeper fully complied with the ROKN requirement for CIWS and after intensive competition was selected for



Thales

Goalkeeper

installation on the KDX Destroyer Programme. Taking into account the medium to long range capabilities of the S-Band AEGIS Combat System, the Goalkeeper was a good match for the KDX III last-ditch defence. In the past, Thales-NL concluded contracts for 16 Goalkeeper systems for installation onboard KDX I, KDX II Destroyers and the LPX. Nine Goalkeeper systems are already fully operational onboard KDX Destroyers to the full satisfaction of the ROK Navy.

HOW THEY SHOOT OUT

Model	Raytheon Phalanx Block 1B	Rheinmetall GDM008	Thales Goalkeeper	Tulamashzavod AK-630	Type 730
Country	USA	Germany	The Netherlands	Russia	PR China
Type	M61A1 Gatling	Single Barrelled	GAU-8/A Gatling	AO-18 Gatling	Gatling
Calibre	20mm x 6	35mm	30mm x 7	30mm x 6	30mm x 7
Rate of Fire	Dual fire rate, 3,000 or 4,500rds/min	single-shot, rapid burst up to 1,000rds/min	4,200rds/min	5,000rds/min	4,600~5,800rds/min
Engagement Range	3km	3.5-5km	1.5-2km	4km	3km
Ammunitions	Armour piercing tungsten penetrator rounds with discarding sabots	Ahead airburst inc. HEI, SAPHEI and TPT	HEI, API, TP, MPDS, FMPDS	Fixed (HE-FRAG, FRAG)	Armour piercing discarding sabots and HE

Russian CIWS

The current Russian gun-based CIWS is Tulamashzavod's AK-630M six-barrelled gun, whose AO-18 cannons can fire 5,000 rounds per minute with a muzzle velocity of 900m/s to shoot down incoming missiles out to 5km. The CIWS is fed from a 2,000 round capacity magazine, with additional 1,000 rounds in the reserve feed bin. Fire control guidance comes from the MR-123 Turel tracking radar. The gun fires HE-FRAG incendiaries or fragmentation tracer projectiles.

The effective range is up to 4,000 metres for sea-skimming anti-ship missiles and 5,000 metres for light surface targets. Systems are currently operational on the Indian Navy's *Delhi*-class, *Khukri*-class, *Kora*-class, *Godavari*-class, *Tarantul-1*-class and *Brahmaputra*-class; People's Republic of China's two *Project 956E* destroyers; and Vietnam's *Tarantul-I* missile-corvettes.

Russia is also offering the CADS-N-1 Kashtan Air Defence hybrid Gun/Missile System, first seen in 1988. The Kashtan provides self-defence for surface ships against fixed and rotary wing aircraft, high precision weapons including anti-ship and anti-radar missiles, as well as to engage small sea and coastal targets.

The modular system is developed as a modular structure comprising of a command module and combat modules—from one to six, depending on vessel displacement. The command module provides autonomous operation by detecting the threats, distributing the threat data, designating the targets to the combat modules and ensuring IFF procedures. The combat module automatically tracks the target with radar and television, calculates firing data and engages the target with missiles and guns. The combat module comprises a combined gun/missile mount, a radar and optical control system which has a range of 4.4NM; a computing system, and a power supply system. The integrated multi-channel control system provides simultaneous multi-target tracking in the radar and TV-optical modes.

The firing turret mounts two blocks of liquid-cooled, gas-operated 30mm GSh-30k six-barrel automatic guns with a link-less feeding system and autonomous evaporation-type cooling system (with 1,000 rounds capacity). Launchers for 57E6 SAM missiles are fitted to the Kashtan. The system also includes a storing and reloading system to keep 32 SAMs in container-launchers in the ship's under-deck spaces. Smaller naval vessels are fitted with a single Kashtan system; the combined missile and gun firepower can reliably engage an incoming formation of three or four missiles. On larger vessels, a mount can be fitted on either side of the ship. A single command module can control up to six Kashtan mountings, providing enough firepower for the largest naval vessels. The Kashtan is supplied by the Instrument Design Bureau and Tulamashzavod JSC in Tula. Modular design makes the Kashtan CIWS adaptable to various types of ships from missile boats (of more than 500 tonnes displacement) to aircraft carriers. The Indian Navy's three *Project 1135.6 Improved Krivak III*-class frigates were the first warships in the Asia-Pacific to be equipped with the Kashtan CIWS.

Chinese Type 730

The Type 730 is an indigenous CIWS designed to provide surface combatants with terminal defences against incoming anti-ship missiles that have penetrated other fleet defences, as well as being used against other airborne targets such as aircraft.

The Type 730 consists of a seven-barrel 30mm cannon, gun control and ammunition feeding mechanism, and fire-control system. A surface combatant should be equipped with two of such system to provide a full 360° coverage. The fully automatic seven-barrel 30mm cannon is fed by two ammunition boxes each holding 500 rounds of ready-use ammunition. One magazine would typically hold armour piercing discarding sabot and the other high explosives. The cannon is driven by external power, with a maximum cyclic rate of fire of 4,600~5,800 rounds/min. The cannon has a maximum range of 3,000m, but targets are typically engaged at a distance of 1,000~1,500m. The fire-control includes a TR47C fire-control radar and an electro-optic director, both of which are mounted on the turret roof. The electro-optic director consists of a TV tracking camera, infrared tracking camera and laser rangefinder, which provide a maximum tracking range of 5~6km. The TR47C radar has a maximum detection range of 8km against an airborne target of RCS 0.1 square metre.

The Type 730 CIWS is installed on the Type 052B *Luyang*-class DDG, Type 052C *Luyang-II*-class DDG, Type 051C *Luzhou*-class DDG, and Type 054A *Jiangkai-II*-class FFG. A land-based air defence system known as LD-2000 has been developed based on the Type 730. The Type 730 development reportedly commenced in the early 1990s. The system bears some resemblance to the Thales Nederland Goalkeeper. The Type 730 has replaced the Type 76A dual-37mm automatic AAA guns to become a standard air defence weapon on some PRC-built surface combatants, while other combatants are fitted with the Russian-built AK-630 CIWS. ■

