[10.0] Antiship Missiles (2)

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* This chapter discusses the US "Harpoon" antiship missile, Soviet-Russian antiship missiles, and a few international types. The SLAM missile series is also discussed here, even though they are not antiship weapons, since they are direct derivatives of the Harpoon.

RGM-84 HARPOON LAUNCH FROM USS SHILOH
USN photo by Photographer's Mate 1st Class Chris Desmond

[10.1] AGM-84 HARPOON

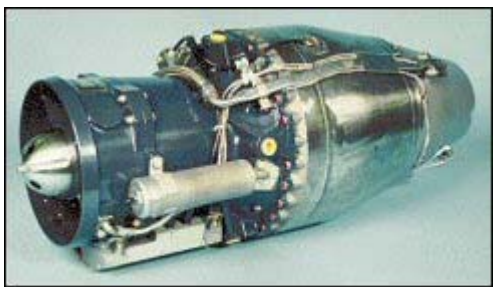
* The US Navy's Harpoon began with studies performed in the late 1960s for an air-launched antiship missile. These studies congealed in 1971 in a requirement for a weapon that could also be launched by submarine or surface vessel. McDonnell Douglas was awarded a preliminary development contract in 1971, leading to a prototype flight test in December 1972, followed by a full development contract in 1973. Extensive prototype flight tests in 1974 and 1975 led to initial production in 1976.

The first operational version of the Harpoon was designated "AGM-84A" for the air-launched version, "RGM-84A" for the ship-launched version, and "UGM-84A" for the submarine-launched version. The AGM prefix is used as the default in the following discussion. The basic configuration went through a number of revisions, under a series of confusing revision level numbers and block numbers. The current operational variant is the "Block 1C", or "AGM-84D", which features an improved guidance system. Due to the purchase of McDonnell Douglas by Boeing, this is now the *Boeing* Harpoon.

In US Navy service, the Harpoon is operated with the P-3 Orion maritime patrol aircraft, the S-3 Viking antisubmarine aircraft, and the A-6 and F/A-18 attack aircraft. One particularly interesting air launch platform is the US Air Force B-52, which can carry from 8 to 12 Harpoons on its external pylons. 30 B-52Gs were modified to carry the weapon in the mid-1980s. When the last B-52Gs were retired in the 1990s, all B-52Hs were modified to carry the missile.

The Harpoon can be carried by any attack submarine, and is carried by cruisers, destroyers, frigates, and patrol craft. Ground-launch systems have been developed for coastal defense.

* The Block 1C Harpoon is a torpedo-like missile, with four short wings mounted in the midbody and four shorter tailfins for control. The missile is fitted with a SAP warhead, and is powered by a Teledyne CAE J402 turbojet engine, with 2.94 kN (300 kgp / 660 lbf) thrust.



TELEDYNE CAE J402 TURBOJET

AGM-84 HARPOON (AIR LAUNCHED):

spec	metric	english
wingspan	0.90 meters	3 feet
length	4 meters	13 feet
diameter	33 centimeters	13 inches
total weight	550 kilograms	1,200 pounds
warhead weight	225 kilograms	500 pounds
speed	1,050 KPH	650 MPH / 565 KT
range at altitude	120 kilometers	75 MI / 65 NMI

When fired from a ground battery, ship, or submarine, the Harpoon is launched into the air with a solid rocket booster that generates 53.9 kN (5,500 kgp / 12,000 lbf) thrust for just under three seconds. The booster adds 75 centimeters (29 inches) to the missile's length and 160 kilograms (350 pounds) to its weight.

For shipboard launch, the Harpoon can be fired from a ship's existing ASROC (Anti-Submarine Rocket) launcher, or some types of Tartar SAM launchers. If the ship or patrol boat has no built-in missile launchers, Harpoons are carried in and fired from free-standing canister launchers. There are different classes of canister launchers, depending on requirements, but the general configuration is a pair of launcher assemblies, one on each side of the ship, with four tubes per assembly in a 2x2 arrangement. Of course, Harpoons fired from canisters have folding airfoils. The Harpoon has not been qualified for canister launch from a vertical-launch system (VLS) missile array, but it would be easy to implement, and some users have expressed interest in the capability.

When launched from a submarine, the Harpoon is shot out of a torpedo tube in its canister. When the canister leaves the torpedo tube, a lanyard causes the canister to pop out fins, and it then glides upward towards the surface of the water. Once the canister breaches the surface, it blows off its tail and cap and fires the Harpoon on its solid-fuel booster.

No matter how the Harpoon is launched, it is directed to a preprogrammed target area by an INS, where it conducts an autonomous search for a naval target. A number of different search patterns can be programmed into the missile, which not only increase the probability of detecting the target but make it harder to trace the missile's flight path back to its launcher. In any case, the Harpoon sweeps through the pattern while hunting for a target using a radar seeker. When the Harpoon finds a target, it drops down to wave height and homes in on it. The missile can strike the target broadside or perform a popup attack. While the guidance system is sophisticated, it is also

indiscriminate, and the Harpoon cannot be launched into a target area where friendly forces are operating.

* A contract for a "Block 1D" Harpoon was awarded by the US Navy in 1989. This version was to have been designated the "A/RGM-84F", and would have been "stretched" like the SLAM, described following, for greater range. It would have also had an improved guidance system that would have given it a "re-attack" capability: if it missed the target ship, it would be able to fly in a cloverleaf pattern for another attack.

The Block 1D upgrade was cancelled due to the defense drawdown of the mid-1990s that followed the collapse of the Soviet Union. A "Block 1G" Harpoon was introduced instead that incorporated the new guidance system of the Block 1D, but not the extended-range stretched fuselage. Deliveries of the Block 1G began in 1997.

Boeing is proposing a new "Block II" variant that will incorporate the GPS-INS system developed for the Joint Direct Attack Munition (JDAM) glide bomb, described in a later chapter, along with the GPS antenna and software developed for SLAM, described below. This new guidance system will allow the Harpoon to attack ground-based targets, as well as reduce the risk of "fratricide" when attacking ships. Boeing hopes to offer retrofit kits to the US Navy to allow them to upgrade the existing inventory of Harpoons. The Block II Harpoon will be compatible with existing support equipment.

The Harpoon's initial combat use was in 1986. On the night of 24 to 25 March, 1986 US Sixth Fleet A-6E Intruders used them to sink three Libyan patrol vessels in the Mediterranean. One pilot commented: "I doubt the Libyans even saw it coming." It was also apparently used against the Iranians during the Gulf convoy operations in 1988, but was not used in the Gulf War out of fear of hitting friendly forces.

Well over 6,000 Harpoons have been built, and the weapon is in service with dozens of military forces.

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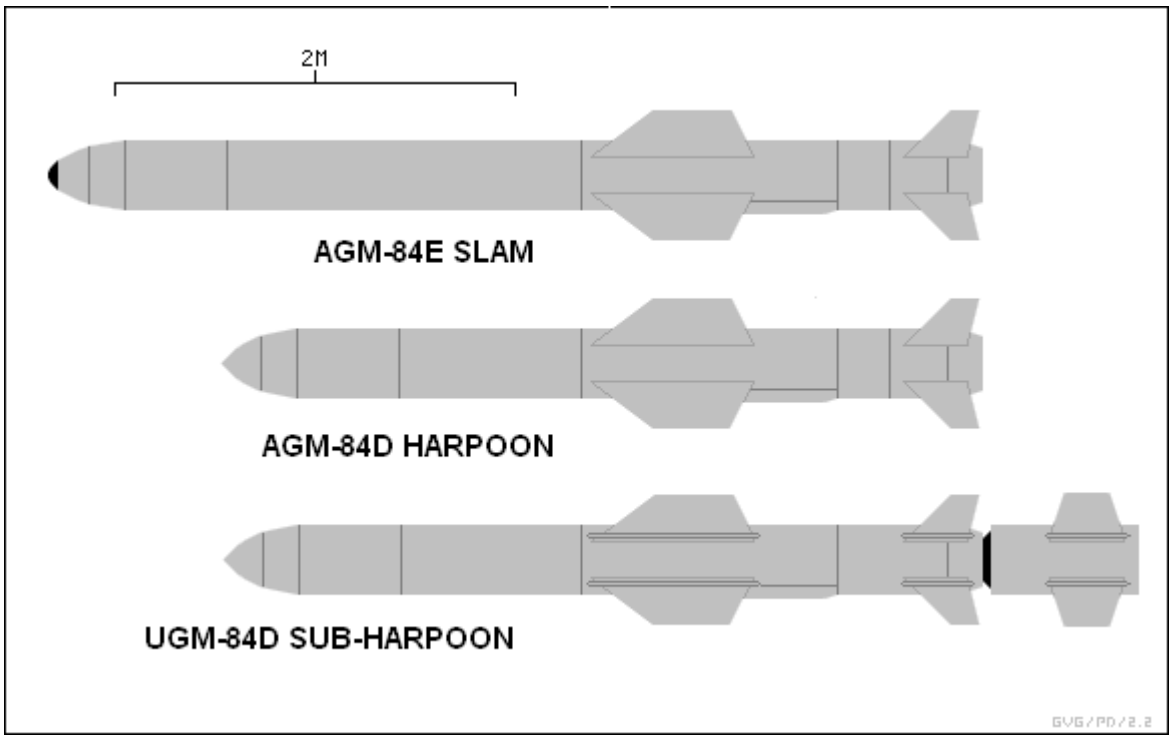
[10.2] SLAM / SLAM-ER

* When the US Navy wanted to obtain a stand-off air-to-ground missile in the mid-1980s, they went to the Harpoon a proven design to work from. The result was the "Stand-Off Land Attack Missile (SLAM)". SLAM has the same basic dimensions of the Harpoon, except that it has been "stretched" 70 centimeters (2 feet 4 inches), to a total length of 4.4 meters (14 feet 6 inches), along with an increase in weight of 70 kilograms (150 pounds).



SLAM is directed through flight cruise after release by its carrier aircraft by a GPS-INS system. Targeting uses an infrared imaging system obtained from the Maverick, in conjunction with a video communications link system obtained from the Walleye. A controller aboard an aircraft views the infrared image on a TV display and guides the missile to its target using crosshairs on the display.

SLAM can be fired by A-6E or F/A-18 aircraft and can be controlled from these aircraft. Unlike the Harpoon, it is strictly an air-launched weapon. While McDonnell Douglas demonstrated a booster-launched "Sea SLAM" in 1990, it provoked little interest and was abandoned.

Seven preproduction SLAMs were launched by Navy carrier aircraft in January 1991, to make strikes on Iraqi targets during the Gulf War. The missile achieved full operational capability in 1993, with about 700 built to date.

The usefulness of SLAM has been enhanced by an automated mission planning system that was introduced in 1996. The new system allows a strike to be planned in 30 minutes, in comparison with the three hours required by old "manual" methods.

* After the Gulf War, the US Navy decided that it needed a better standoff capability, and so decided to come up with an improved "SLAM-ER" (where "ER" stands for "Enhanced Response"), awarding a contract for the new variant to McDonnell Douglas in 1995. SLAM-ER was given the designation "AGM-84H".

SLAM-ER's most visible difference to its predecessor is that the four stubby wings have been replaced by a pair of long swept gull wings, with a span of 2.2 meters (7 feet 2 inches). The wings are stowed pointed back under the fuselage before launch and pivot forward after release. The warhead is the same size as before, but has a titanium casing to improve hard target penetration. Range is extended to over 280

kilometers (172 miles).


SLAM-ER (BOEING)

The SLAM-ER retains the GPS-INS guidance system and infrared-imaging targeting approach used in SLAM. The targeting system has been enhanced to allow the missile operator to "freeze" the image returned by the missile, set crosshairs on a particular aim point on the image, and then instruct the missile to seek that aimpoint.

The first SLAM-ER flight took place in 1997. It was first used in combat in late 1999, when a Navy F/A-18 fired one at an Iraqi military facility in the southern "No-FLy" zone.

Although SLAM-ER is not optimized as an antiship weapon, a ship's just another target for a precision-guided weapon, and in January 2000 the US Navy performed a live-fire test on a decommissioned cruiser, the USS DALE. Warhead effectiveness "exceeded expectations", according to Boeing, which took over the missile after absorbing McDonnell Douglas. Unfortunately, other tests did not give as much credit to SLAM-ER, with one series of eleven test launches only scoring five hits, poor performance for a precision-guided weapon. Corrective actions were taken and performance in tests dramatically improved.

An improvement to SLAM-ER, the "SLAM-ER+", is now in development. SLAM-ER+ will include an "automatic target acquisition (ATA)" capability, in which the missile will identify and attack a specific target on its own by comparing its seeker image with a stored reference image. The Navy hopes to update the existing stock of about 700 SLAMs to the SLAM-ER configuration at the rate of about 56 per year.

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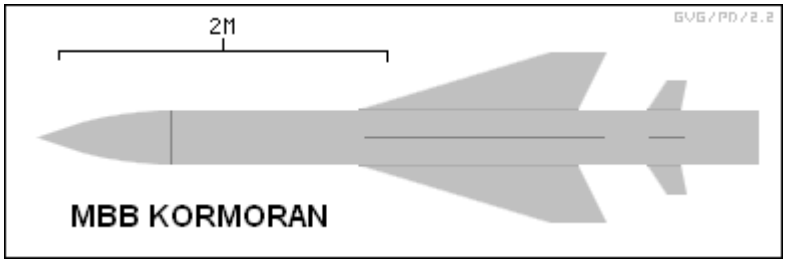
[10.3] KORMORAN / ASM-1, ASM-2 / GABRIEL / HSIUNG FENG

* A number of nations have built antiship missiles for use by their own forces, but have not exported them widely, if at all. These include the German "Kormoran", the Japanese "ASM-1" and "ASM-2", the Israeli "Gabriel", and the Taiwanese "Hsiung Feng".

* Development of the German Kormoran antiship missile was begun in the late 1960s by Boelkow, now part of MBB, and Nord, now part of Aerospatiale / EADS, and the

Kormoran has a certain broad resemblance to other Nord missiles such as the AS-30. A production contract was delayed for some years for various reasons, but initial prototypes flew in 1976, followed by production deliveries in 1977.

The initial launch aircraft was the Lockheed F-104G Starfighter of the MarineFlieger, the Germany Navy's air arm. A Starfighter could carry two Kormorans. It is now carried by MarineFlieger Tornado IDS strike fighters, with each Tornado carrying four Kormorans.



The Kormoran is a mid-sized antiship missile, with triangular sweptback cruciform wings mounted on its midsection, and cruciform tailfins. It is powered by a boost-sustain solid fuel rocket motor and fitted with a SAP warhead. It is guided to its target by an INS, skimming over the wavetops under control of a radar altimeter. An active radar seeker is used in the terminal attack phase.

KORMORAN:

spec	metric	english
wingspan	1 meter	3 feet 4 inches
length	4.4 meters	14 feet 6 inches
total weight	630 kilograms	1,390 pounds
warhead weight	55 kilograms	120 pounds
speed	high subsonic	
range at altitude	44 kilometers	27 MI / 24 NMI

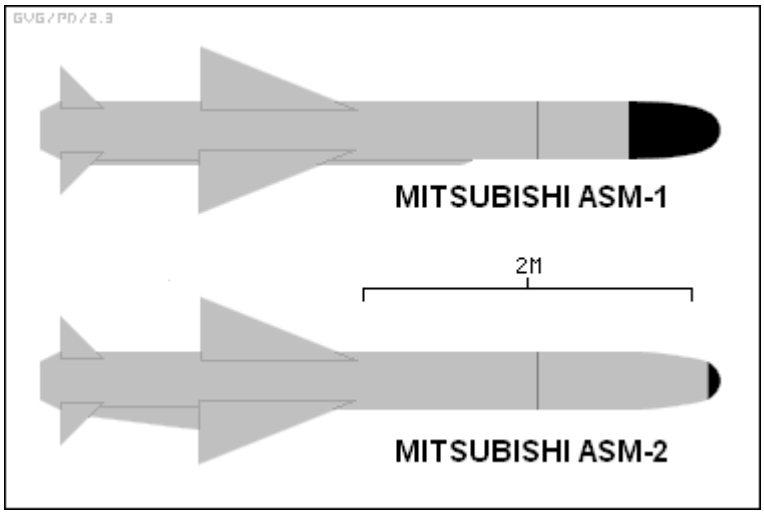
* As a footnote to the Kormoran, in 1972 MBB began work on a large standoff missile named "Jumbo" for attacking bridges and other hard targets. Jumbo resembled a scaled-up, fatter Kormoran, powered by a turbojet engine, with the intake under the wings. The German government cancelled Jumbo in 1975 after international cooperation on development of the weapon fell through. MBB and McDonnell Douglas later performed studies on reviving the project, but nothing came of them.

MBB JUMBO:

spec	metric	english
wingspan	1.25 meters	4 feet 1 inch
length	5.24 meters	17 feet 2 inches
total weight	1,150 kilograms	2,535 pounds
speed	subsonic	
range at altitude	40 kilometers	25 MI / 22 NMI

* The Japanese have developed their own series of antiship missiles, the "ASM-1" and its successor, the "ASM-2". The Type 80 ASM-1 defines the baseline for this series of weapons. Development was begun by Mitsubishi in 1973, with initial prototype flights in 1977 and initial operational introduction in 1980.

The ASM-1's configuration is typical of the earlier generation of antiship missiles. It is a sea-skimming weapon with an INS for mid-course guidance, a radar altimeter for altitude control, and a radar seeker for terminal guidance.



The ASM-1 has triangular cruciform wings mounted in the midbody and small triangular cruciform tailfins. The missile is propelled by a solid rocket motor, and is fitted with a SAP warhead weighing 150 kilograms (330 pounds).

MITSUBISHI ASM-1:

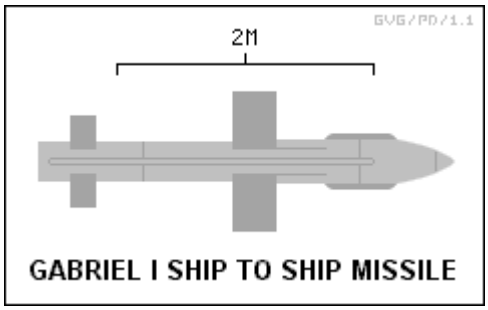
spec	metric	english
wingspan	1.2 meters	3 feet 11 inches
length	4 meters	13 feet
total weight	600 kilograms	1,320 pounds
warhead weight	150 kilograms	330 pounds
speed	subsonic	

range at altitude	50 kilometers	31 MI / 27 NMI

The ASM-1 has been deployed with Japanese Mitsubishi F-1 strike aircraft and Lockheed P-3C maritime patrol aircraft. An improved variant of the ASM-1 was developed, the "Type 91 ASM-1C", with a longer range of 65 kilometers (40 miles), as well as an improved digital guidance system with enhanced ECCM capabilities.

Development of the Type 91 ASM-2 was begun in 1988, with deliveries beginning in 1993. The ASM-2 is very similar in size and appearance to the ASM-1, except that it is turbojet powered and has an underslung air intake. Although many details are classified, the turbojet engine gives it extended range of about 100 kilometers (60 miles), and it has an imaging infrared terminal guidance seeker rather than an active radar seeker. It is believed to incorporate stealth features. The Japanese are now working on an "ASM-3" that will incorporate a ramjet engine for improved performance and range.

* The Israelis have developed their own series of "Gabriel" ship-launched and air-launched antishipping missiles. The Israel Aircraft Industries (IAI) "Gabriel I" ship-launched weapon was used extensively in the 1973 Yom Kippur War, being credited with the sinking of nine Arab vessels.



The Gabriel has been successively updated to the current "Gabriel III" missile, with twice the range and a substantially different external appearance from the Gabriel I. It is available in both ship-launched and air-launched versions, with the air-launched version known as the Gabriel III "A/S" (Air to Surface).

The Gabriel III A/S is powered by a stubby cruciform wings fitted to the midsection and cruciform tailfins for guidance. It has boost-sustain solid rocket motor and is fitted with a SAP warhead.

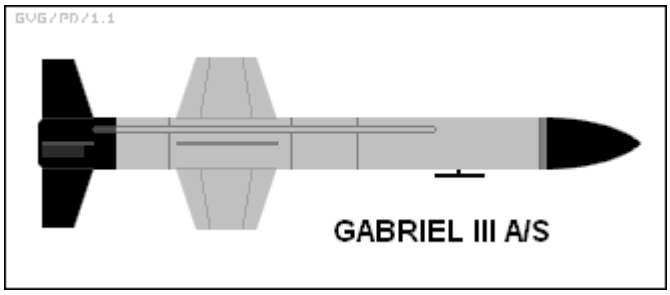
GABRIEL III A/S:

spec	metric	english
wingspan	1.1 meters	3 feet 7 inch

length	3.84 meters	12 feet 7 inches
total weight	600 kilograms	1,320 pounds
warhead weight	150 kilograms	330 pounds
speed	subsonic	
range at altitude	60 kilometers	37 MI / 32 NMI

While the Gabriel I used a semiactive radar homing seeker that required the launch platform to keep the target illuminated by radar, the Gabriel III has a dual-mode seeker that can be operated in "fire and forget" or "fire and update" modes.

In the "fire and forget" mode, the Gabriel III is guided by an INS into the target area, with altitude maintained by a radar altimeter. It then turns on its active radar seeker to lock onto and attack the target after a search. In the "fire and update" mode, the missile can receive course corrections from the launch aircraft while it is cruising towards the target, allowing it to keep its radar seeker off until the last moment.



The seeker has sophisticated ECCM capabilities. There is apparently a new long-range turbojet-powered version of the Gabriel, the "Gabriel IVLR", and some sources state that Denel of South Africa has also built a 150 kilogram (330 pound) submunition warhead for the Gabriel. This unusual warhead has a main charge and 35 fragmenting submunitions that detonate in sequence at 5 millisecond intervals, with the fragments heavy enough to penetrate bulkheads.

* If the information available on the Gabriel is sketchy, it is positively a flood compared to the Taiwanese "Hsiung Feng (Brave Wind)" antishipping missile. The Hsiung Feng 1 is said to have been derived from the Gabriel II, and led to the current Hsiung Feng 2, which began development in the mid-1980s and reached operational status in the mid-1990s.

The Hsiung Feng 2 resembles a Harpoon. It is powered by a small turbofan engine, has an INS for mid-course flight, and appears to have both imaging infrared and radar terminal guidance, with the infrared imager mounted on a fairing above the missile fuselage. It is said to weigh 520 kilograms (1,145 pounds), with a 225 kilogram (500 pound) warhead, and with a range of 80 kilometers (50 miles).

Taiwan is now introducing the new "Hsiung Feng 3", which appears to be a different

beast from its predecessors, with Mach 2 speed and much greater range. Once again, details are sketchy, though press releases indicate that it can be vertically launched from shipboard "silo" tube.

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[10.4] P-15 TERMIT (SS-N-2 STYX) / SILKWORM

* The Soviets were forward-looking and aggressive in development of antiship missiles, generally because the Red Navy was no match for Western naval power and needed an equalizer. This led to development of two classes of antiship missiles: long-range cruise missiles and air-launched standoff weapons, both of which were generally also used as strategic nuclear weapons; and smaller antiship missiles more in the class of those developed in the West. The large long-range weapons are discussed in the companion document on cruise missiles, while the smaller weapons are discussed here.

The first Soviet antiship missile to reach full operational status was developed by the MiG bureau, OKB-155. The "P-15 Termit" (NATO codename "SS-N-2" Styx) was a stubby fat missile with clipped delta wings and a conventional tail assembly. It was fired out of a hangar-launcher box by a RATO booster and cruised to the target using a liquid-fuel rocket engine burning storable propellants.

STYX / PERMIT ANTISHIP MISSILE (GVG / PD)

The P-15 cruised at an altitude of about 150 to 300 meters (500 to 1000 feet) under the direction of a gyroscopic stabilization system and a barometric altimeter. Speed was about Mach 0.95 and range was about 40 kilometers (25 miles). It performed its terminal attack with an active radar seeker, using a 450 kilogram (1,000 pound) conventional warhead. (A coastal defense version of the P-15 was also produced, with the NATO designation of "SSC-3", but details are unclear.)

Initial test shots were performed on the Black Sea in 1957. Testing went very well, and the weapon went into service in 1960. Its first launch platform was the KOMAR-class missile boat, which could carry two P-15 missiles, as well as radar and optical targeting units and a fire-control system. In the mid-1960s, the KOMAR-class boats were followed in production by the OSA-II-class boats, with both these types of boats exported to Soviet client states in good quantities.

* The Soviets developed improved versions of the P-15. In 1958, tests began of a P-15 variant with a passive infrared seeker. The seeker, which would emerge as the "Snegnir", had a range of about 10 kilometers (6.2 miles) in daylight and 5 kilometers (3.1 miles) at night, and had a field of view of 2.5 degrees. Along with improved seeker development, various improvements were made to the basic weapon, such as improved systems and folding wings. The folding wings permitted use of a more compact hangar-launcher. The modernized missile was introduced in the late 1960s, with missiles fitted with a passive infrared seeker designated "P-15U" (export designation "P-21") and missiles fitted with an active radar seeker designated "P-15T" (export designation "P-22").

The P-15U and P-15T were carried on OSA U-class and MOLNIYA missile boats, and were also refitted to some KYNDA and KASHIN-class destroyers. In 1970 the P-15U and P-15T were replaced in Soviet service by the generally improved "P-15M" (export designation "P-26") and "P-15TM" (export designation "P-27") weapons respectively. These missiles featured a true gyroscopic INS; their range was extended to 50 kilometers (31 miles), and the cruise altitude was reduced to 15 meters (50 feet) by using a radar altimeter.

P-15 (4K-40) TERMIT / P-20 RUBEZH (SS-N-2 STYX):

spec	metric	english
wingspan	2.75 meters	9 feet
length	5.8 meters	19 feet
diameter	75 centimeters	2 feet 6 inches
total weight	3,000 kilograms	6,615 pounds
speed	subsonic	
range at altitude	40 kilometers	25 MI / 43 NMI

* The Termit / Styx has seen a fair amount of combat use. Their first combat action was after the Six Day War in 1967, while the Arabs and the Israelis were taking pot-shots at each other. The Egyptians drew blood on 21 October 1967, when the Israeli destroyer ELIAT approached Port Said, Egypt. Two Egyptian KOMAR-class missile boats, each armed with two P-15 Termit missiles, fired their loads at the destroyer.

Three of the missiles scored hits, and the destroyer broke in half, quickly sinking with substantial loss of life; the fourth missile arrived too late to pick up the target.

This was the first effective use of a guided antiship missile in combat. The whole incident was not only a shock to the Israelis, it made Western navies sit up and take notice of developments in antiship missiles. However, the Egyptians didn't get lucky with the P-15 again, since the Israelis quickly developed countermeasures that rendered it ineffectual. There is a rumor that the Egyptians did sink an Israeli SIGINT vessel with the Styx in 1968, but no Western sources confirm this.

In any case, during the Yom Kippur War in 1973, 54 P-15s were fired, with Western sources claiming they made no kills at all. Eastern sources claimed they scored seven kills, but the targets were all small vessels -- trawlers, missile boats, and patrol boats -- and even with those losses taken at face value, it wasn't much of a return on the investment. Worse, the Israelis retaliated against the missile launches and sank seven Egyptian and Syrian vessels with Gabriel I antiship missiles. Both Western and Eastern sources agree on this number of kills. The Israeli countermeasures against the Styx included flying helicopters low and slow over the water so they looked like surface vessels. When missiles were launched they would climb and break radar lock while Israeli missile boats returned fire.

* India employed both these updated P-15U and P-15T versions of the Termit during the 1971 was with Pakistan to good effect. On the night of 3:4 December 1971, Indian Navy OSA-class missile boats were towed to the proximity of Karachi by trawlers. The missile boats fired a total of 11 missiles -- seven P-15Us and four P-15Ts -- sinking the Pakistani (ex-British) destroyer KHAIBAR and a trawler.

The Indians also used the P-15Ts against land targets, firing a number of them against the (warm) oil tanks of the refinery at Keamari on 4 and 8 December 1971. The second attack included radar-guided P-15Us, which hit three merchantmen, the British vessel HARMATTAN being sunk and the other two badly damaged.

* Guidance system updates seem likely to keep the Termit missile in service and even make it something of a real threat. The Termit still remains in production in China. with the designation of "Type 601 HY-1 / HY-2 Silkworm". The Chinese went so far as to develop an air-launched version, with the missile carried in pairs by large bomber aircraft, such as Chinese derivatives of the Tupolev Tu-16 Badger.

The Chinese have exported Silkworms to a number of countries, including Iran. The Iranians built their own Silkworms as well. The US Navy was worried about Iranian Silkworms during the "Tanker War" in the Persian Gulf in the late 1980s, but as it turned out the Silkworms weren't used.

In 2004, the Iranians announced that they were developing a long-range version of the Silkworm, the "Raad", that had a stretched fuselage and a turbojet or possibly turbofan engine. The Iranians have developed their own small turbojet, the "Tolloue 4".

Although details of the Raad are unsurprisingly scarce, it is believed to have triple the range of the Silkworm, and very plausibly may be used for attacks on surface targets as well as ships.

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[10.5] P-70 AMETIST (SS-N-7 STARBRIGHT)

* Early Soviet submarine-launched antiship missiles were large cruise missiles that had to be launched from the surface, where the vessel was highly vulnerable. Vladimir Chelomei's OKB-52 bureau, which had pioneered Soviet antiship missiles, was ordered to begin work on an underwater-launched missile in 1959, with this weapon emerging as the "P-70 Ametist" (AKA "4K66", NATO codename "SS-N-7 Starbright"). A nuclear-powered submarine was to be developed in parallel, the PAPA class, which could carry ten P-70 missiles.

The P-70 was pencil-like in shape, with a prominent duct running under the belly. There are short folding swept wings mid-mounted towards the rear of the missile and three backward-facing cooling duct near the wing leading edge. The P-70 was powered by a solid rocket motor and had a small delta wing; it was launched from depths of up to 30 meters (100 feet) using four small RATO boosters, organized in pairs along each side of the tail.

The P-70 was strictly submarine-launched. It featured a programmable INS guidance system with an active analog radar seeker that incorporated some counter-countermeasures capability. It had a small frontal radar cross-section, making it difficult to detect until it was too late. It could be fitted with either a 500 kilogram (1,100 pound) conventional warhead, or a nuclear warhead with a yield of hundreds of kilotonnes. Maximum range was about 80 kilometers (50 miles) if the submarine was cued to the target by another platform, or less if it was cued by the submarine's sonar system. The weapon cruised to the target at an altitude of roughly 50 meters (165 feet) and performed its terminal attack in a shallow dive.

P-70 / 4K66 AMETIST (SS-N-7 STARBRIGHT):

spec	metric	english
wingspan	1.2 meters	4 feet
length	6.7 meters	22 feet
total weight	3,375 kilograms	7,440 pounds
warhead weight	500 kilograms	1,100 pounds
speed	subsonic	
range at altitude	80 kilometers	50 MI / 45 NMI

The P-70 was accepted into Red Navy service in 1968. Only one PAPA-class submarine was actually built. The type had a titanium hull and was simply too expensive. A cheaper solution, the CHARLIE class submarine, was designed instead, with 11 built to serve up to the collapse of the USSR in the early 1990s. The CHARLIE class had eight vertical-launch silos for P-70 missiles and a long range "Kerch" sonar system for self-targeting. The CHARLIE class could also link into the "Uspekh" aircraft-based or "Legenda" satellite-based targeting systems.

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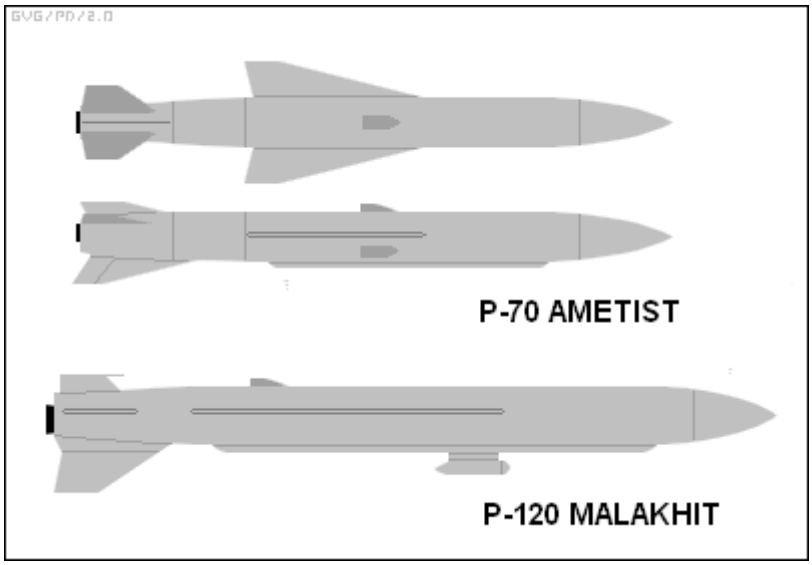
[10.6] P-120 MALAKHIT (SS-N-9 SIREN)

* Even as the P-70 system was being developed, it was obvious that its range was too short. In 1963, the order came down to Chelomei's OKB-52 to design an antiship missile with longer range.

Soviet planners decided that approaching a US carrier group any closer than 100 kilometers (62 miles) was suicide, and so the minimum range of the missile was specified as 120 kilometers (75 miles). The result was the "P-120 Malakhit" (NATO "SS-N-9 Siren"), which was more or less a scaled-up P-70 Ametist. The P-120 Malakhit, like the P-70 Ametist, was powered by a solid-rocket motor, but it featured a large "universal" RATO booster scheme that allowed it be launched from both surface vessels and submarines. It could be launched underwater from a depth of 50 meters (160 feet); it flew to its target at high subsonic speed at an altitude of about 40 meters (130 feet).



The overall guidance scheme of the P-120 was similar to that of the P-70, except that the P-120 had dual terminal attack seekers: one active radar, as with the P-70, and one infrared homing. The dual seeker complicated adversary defensive countermeasures. Unlike the P-70, the P-120 could accept midflight course corrections from the control

platform. The P-120 could be fitted with either a 500 kilogram (1,100 pound) conventional warhead, or a nuclear warhead with a yield in the range of hundreds of kilotonnes.

P-120 / 4K85 MALAKHIT (SS-N-9 SIREN):

spec	metric	english
wingspan	2.5 meters	8 feet 2 inches
length	8.84 meters	39 feet
total weight	3,000 kilograms	6,600 pounds
warhead weight	500 kilograms	1,100 pounds
speed	high subsonic	
range at altitude	110 kilometers	70 MI / 61 NMI

Improved sonar systems were designed to allow targeting from longer range if the Uspekh or Legenda systems were not available. The P-120 Malakhit was accepted into Red Navy service in 1972, though at first only on surface vessels, the NANUCHKA-class fast corvettes. Some sources claim the P-120 was also carried by SARANCHA-class missile boats. The P-120 was accepted into service for submarines in 1977, the carrier platform being the CHARLIE II-class submarines, of which six were build.

The CHARLIE II submarines had eight missile tubes, usually carrying a mix of six missiles with conventional warheads and two with nuclear warheads. Late-model NANUCHKA corvettes remain in service with the Russian Navy, but the CHARLIE II submarines have been retired.

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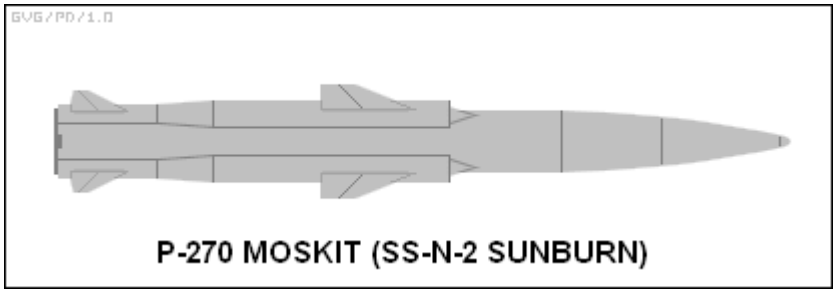
[10.7] P-270 MOSKIT (SS-N-22 SUNBURN)

* By the early 1970s, the P-15 Termit was clearly out of date, lacking range and the ability to penetrate adversary defenses. The Raduga developed a ship-launched supersonic sea-skimming antiship missile, the "P-270 (3M80) Moskit" (NATO "SS-N-22 Sunburn"), sometimes also known by the "Kh-41" designation. The Moskit not only featured higher speed and longer range than the P-15, it also had a much improved terminal attack seeker that provided both active and passive radar targeting. In passive mode, it would home in on the target's radar or jammer emissions.

The Soviets were very fond of ramjet-powered missiles and the Moskit is a good example of their design philosophy for such missiles. The Moskit has a dartlike body with four ramjet inlets around the center, plus cruciform mid-mounted trapezoidal

wings and cruciform all-moving tail control surfaces. It is booster to flight speed by an integral solid-rocket booster, carried in the ramjet exhaust, which burns for four seconds. The same general configuration is used by the Kh-31 (AS-17 Krypton) series of weapons, discussed previously under anti-radar missiles, and the Kh-31 is sometimes called the "Mini-Moskit".

The standard Moskit has a range of 120 kilometers (75 miles) in a HI-LO flight profile or 80 kilometers (50 miles) in a LO-LO flight profile, with midcourse flight directed by an INS. Its high-altitude speed is from Mach 2.6 to Mach 3 and its low-altitude speed is Mach 1.5. It was designed for salvo launch, with the missiles maneuvering over differing flight paths to confuse target defenses. It could be fitted with a 320 kilogram (705 pound) SAP conventional warhead or a nuclear warhead with a yield of hundreds of kilotonnes.



P-270 MOSKIT (SS-N-2 SUNBURN)

Work on the Moskit was initiated in 1973, leading to service introduction in 1981. The initial "3M80" missile variant only had a maximum range of 100 kilometers (62 miles), with the "3M80M" variant with 120 kilometer (80 mile) range introduced in 1984; a "3M80E" export variant was also manufactured. A "Moskit-M" variant with 160 kilometer (100 mile) range was introduced later and remains in production. The Moskit has been carried on SOVREMENNY-class destroyers, with eight missiles per vessel; MOLNIYA M-class missile boats, with two missiles per boat; and on BORA-class hovercraft, which can carry eight missiles each.

P-270 (3M80) MOSKIT / 3M-80 (SS-N-22 SUNBURN):

spec	metric	english
wingspan	2.1 meters	6 feet 11 inches
length	9.74 meters	32 feet
total weight	4,500 kilograms	9,920 pounds
warhead weight	320 kilograms	705 pounds
speed	Mach 3	
range	90 kilometers	55 MI / 45 NMI

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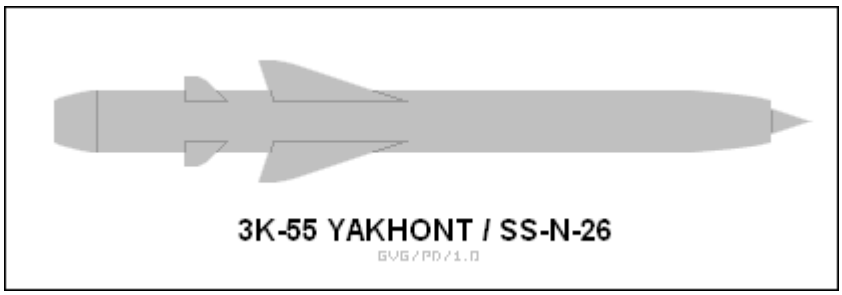
[10.8] P-100 ONIX / YAKHONT / BRAHMOS

* In the late 1970s, NPO Mash began work on a medium-range antiship cruise missile for smaller vessels. The specifications for the new weapon included both surface and submarine launch of highly compatible versions, over-the-horizon targeting, "fire and forget" operation, flexible flight trajectories, and incorporation of stealth features to help frustrate adversary defenses. The result was the "P-100 Onix", which was given the NATO codename of "SS-N-26", and featured the "3M55" missile.

Trials of the missile didn't start until 1987, and full development was unsurprisingly complicated by the collapse of the USSR: the weapon wasn't introduced to service until the late 1990s. The weapon was carried on ten SCORPION-class corvettes built for the Russian Navy, as well as on some of the 28 vessels of this class built for export, which used the "Yakhont", the export version of the Onix. It is also carried on the new multirole submarine, the SEVERODVINSK, at last notice still under construction; this vessel will carry 24 missiles. The Onix can be carried on truck launchers as well.

The Onix is a clean, straightforward design, a simple cylinder with a ramjet inlet and cone in the nose, clipped cruciform delta wings in midbody, and cruciform control fins on the tail. It is launched by an integral RATO booster in the ramjet exhaust. It carries a 300 kilogram (660 pound) SAP warhead, has a coating of radar-absorbent material to help it penetrate adversary defenses, and carries a radar warning system to tell it to initiate evasive action.



The guidance system of the Onix is sophisticated, able to direct it on a variety of trajectories. On a HI-LO trajectory, with the missile cruising to the target area at an altitude of about 14,000 meters (46,000 feet), the maximum range is about 300 kilometers (185 miles), while on a LO-LO trajectory the maximum range is about 120 kilometers (75 miles). Maximum speed is about Mach 2.6 at high altitude and about Mach 1.5 at low altitude.

Guidance during midcourse flight is by a programmable autopilot with INS. The missile carries an active / passive radar seeker. At a distance of about 80 kilometers (50 miles) from the target area, the active seeker is turned out. When the target is located, at a distance of about 25 kilometers (15.5 miles), the active mode is turned off and the missile proceeds at high speed toward the target using passive homing. The

Onix can be launched in salvos, with one missile operating in active mode to cue the others operating at passive mode. The Onix flies at an altitude of about 15 meters (50 feet) in low altitude operation, dropping to about half that altitude during terminal attack phase.

ONIKS / YAKHONT (SS-N-26):

spec	metric	english
wingspan	1.4 meters	4 feet 7 inches
length	8.9 meters	29 feet 2 inches
body diameter	70 centimeters	28 inches
launch weight	3,000 kilograms	6,600 pounds
warhead weight	300 kilograms	660 pounds
speed	Mach 2.5	
range (HI-LO)	300 kilometers	155 MI / 135 NMI
range (LO-LO)	120 kilometers	155 MI / 135 NMI

The Russians have been collaborating with the Indian Defense Research & Development Organization since 1998 to build an improved export version, the "PJ-10 BrahMos", the name being a composite of the Brahmaputra and Moscow rivers. Initial launch was in 2001. The BrahMos is similar to the Onix / Yakhont externally, but has improved systems, and BrahMos can be fired from shipboard vertical-launch silos, not the angled launchers used for the Onix / Yakhont. Ground and air-launched versions of the BrahMos are in development. The BrahMos features a secondary ground-attack capability.

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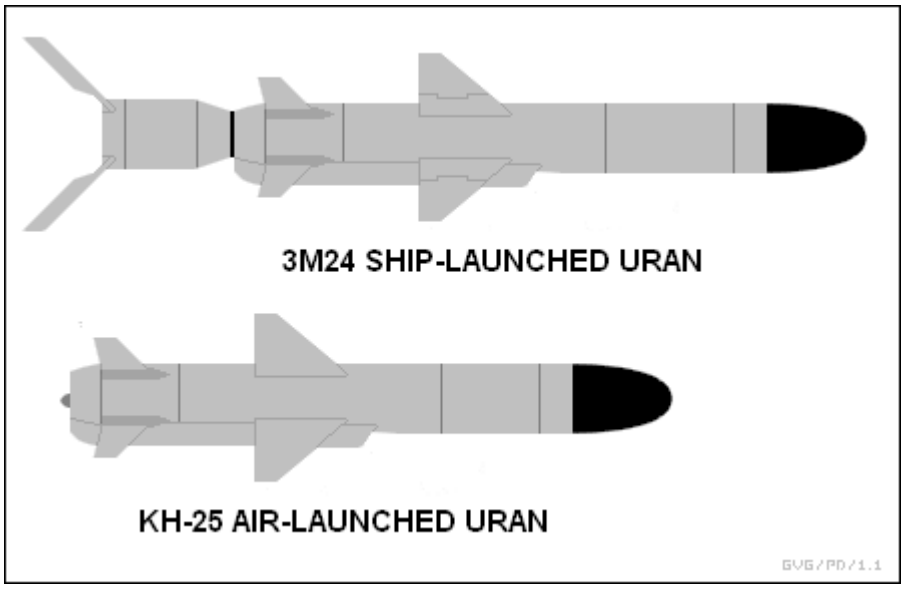
[10.9] KH-35 URAM (SS-N-25 SWITCHBLADE)

* In 1984, the USSR began work on a "universal" antiship missile that could be launched by ships, submarines, aircraft, or coastal-defense sites to attack smaller vessels. The result was the "Uran", known as "Kh-35" in its air-launched version and "3M24" in its sea-launched version. It looks so much like the US Harpoon that it has been nicknamed "Harpoonski".

The Kh-35 air-launched variant has a range of about 150 kilometers (95 miles) when launched from altitude. It is not intended for attacks on heavily-defended targets and is relatively cheap and unsophisticated. It uses a INS for midcourse guidance, flying at an altitude of 15 meters (50 feet), and an active radar seeker for terminal attack, at an altitude of about 5 meters (15 feet). The seeker has "home on jam" and counter-countermeasures capability. The missile carries a fragmentation-incendiary warhead

with a weight of 90 kilograms (200 pounds). There are some rumors of a "Kh-37" variant for land attack, with a TV or possibly infrared imaging seeker.



The 3M24 sea-launched variant is fired using a RATO booster and has a range of about 130 kilometers (80 miles). It is carried on TARANTUL-class missile boats, some of which have been exported to Vietnam. The Indian Navy also operates four DELHI-class destroyers, with 16 Uran launchers each, and four P-25A-class corvettes, with 16 launchers each as well. A land-attack version of the 3M24 is in development, with the designation of "3M24M" (or "3M24E1" for the export variant). It uses GLONASS satellite navigation for midcourse guidance, and reports indicate both active radar and imaging infrared seekers have been developed. This variant carries more fuel, stretching its range to about 250 kilometers (155 miles).

KH-35 URAM (SS-N-25 SWITCHBLADE) / AIR LAUNCHED VARIANT:

spec	metric	english
wingspan	93 centimeters	3 feet
length	3.75 meters	12 feet 4 inches
total weight	480 kilograms	1,060 pounds
warhead weight	90 kilograms	200 pounds
speed	subsonic	
range at altitude	130 kilometers	80 MI / 70 NMI

The 3M24 ship / submarine launched variant has a length of 4 meters (13 feet 1 inch), not counting its solid-rocket booster, and has an overall launch weight of 600 kilograms (1,325 pounds).

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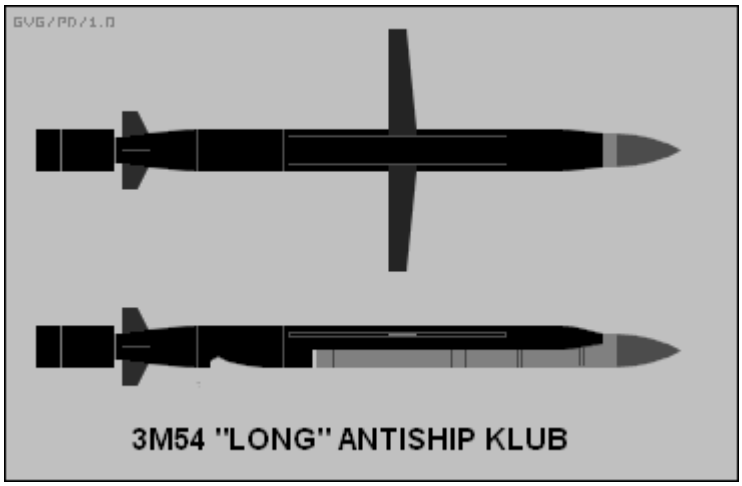
[10.10] 3M54 KLUB (SS-N-27)

* In the late 1980s, development work began on a "one size fits all" family of submarine and ship-launched medium-range missiles for antiship, antisubmarine, and land-attack roles. This family emerged as the "3M54 Klub" series and was designed by NPO Novator, better known for development of SAMs.

All the Klubs are airbreathing missiles with popout wings and turbojet engines, launched with RATO boosters. Submarine launched variants are known as "Klub-S" and are fired from a torpedo tube, while ship-launched variants are known as "Klub-N" and are fired from a vertical-launch tube. The main difference between the two subclasses is, not surprisingly, different booster technology.



There are five members in each subfamily. Two of these have "long" configurations, about 8.2 meters (27 feet) in length, while the other three have "short" configurations, about 6.2 meters (20.3 feet) in length. The long missiles can be fired from Russian subs, but Western subs have shorter torpedo tubes and can only fire the short missiles. The five types include:

- 91RE1 antisubmarine missile, a supersonic long variant carrying a homing torpedo. It has a range of about 50 kilometers (31 miles) flies a ballistic trajectory to the target area using an INS.
- 91RE2 antisubmarine missile, a short variant, much like the 91RE1 but with a range of 40 kilometers (25 miles).
- 3M14 land-attack missile, a subsonic short variant, with a range of about 300 kilometers (185 miles). It uses an INS with terrain-following for midcourse guidance and has an active radar seeker for terminal attack.
- 3M54 antiship missile, a supersonic long variant, with a 220 kilometer (135 mile) range. It can be launched from a torpedo tube, a vertical launch silo, or an angled launcher. It cruises towards its target area at an altitude of about 15 meters (50 feet). At a range of about 40 kilometers (25 miles) from the estimated target

location, the missile pops up and turns on its active radar seeker to get a target fix.

At a range of about 20 kilometers (12.5 miles), the missile releases its terminal attack "upper stage", which proceeds to the target at Mach 2.9 at an altitude of about 5 meters (15 feet) and hits the target using a 200 kilogram (440 pound) SAP warhead. The missile is capable of maneuvering to confound adversary defenses. The export variant is designated "3M54E".

- 3M54E1 antiship missile, a subsonic short variant, with a 300 kilometer (185 mile) range. Its flight profile is similar to that of the 3M54, but the missile flies at subsonic speeds throughout, and there is no "upper stage" -- the entire missile performs the terminal attack. It has a larger warhead, with a weight of 400 kilograms (880 pounds).

At last notice, the Klub had not reached service with the Russian Navy, but it is used on the three TALWAR-class frigates sold by Russia to the Indian Navy, with eight vertical-launch silos on each ship. The Russian Navy will probably use the Klub on the new LADA-class submarines, which is also being built for India in an export variant known as the AMUR class. YASENI-class submarines are also expected to use the Klub, along with Onix.

3M54 KLUB "LONG" ANTISHIP (SS-N-27):

spec	metric	english
length	8.22 meters	27 feet
body diameter	53.3 centimeters	21 inches
total weight	2,300 kilograms	5,070 pounds
warhead weight	200 kilograms	440 pounds
speed	subsonic (*)	
range	220 kilometers	135 MI / 120 NMI

3M54 KLUB "SHORT" ANTISHIP (SS-N-27):

length	6.20 meters	20 feet 4 inches
body diameter	53.3 centimeters	21 inches
total weight	1,780 kilograms	3,925 pounds
warhead weight	400 kilograms	880 pounds
speed	subsonic (*)	
range	300 kilometers	185 MI / 160 NMI

(*) Some antiship variants of the Klub have a Mach 2.9 terminal attack stage.

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[10.11] CHINESE ANTISHIP MISSILES

* Along with the Silkworm, the Chinese have also developed an air-launched ASM similar to the Exocet, designated the "C-801". In fact, rumors have it that it is largely a copy of the Exocet.

C-801:

spec	metric	english
wingspan	1 meter	3 feet 4 inches
length	5.2 meters	17 feet
total weight	1,000 kilograms	2,200 pounds
speed	subsonic	
range at altitude	65 kilometers	40 MI / 35 NMI

The Chinese also developed a smaller antiship missile more in the class of the Sea Skua / Penguin, the CATIC "FL-8", for launch by helicopters and small surface attack vessels. The FL-8 is a straightforward design, with solid propulsion; cruciform tailfins; and cruciform clipped delta wings, set well back. It has a length of 2.5 meters (8 feet 2 inches), a diameter of 18 centimeters (7 inches), a launch weight of 105 kilograms (232 pounds), and a range of 15 kilometers (8 NMI). Iran is working on their own derivative of this weapon, designated the "Kosar".

There are rumors of a scaled-up variant, the CATIC "FL-9", with a launch weight of 360 kilograms (794 pounds) and a range of 27 kilometers (14.5 NMI). The Iranians are also working on a derivative of this weapon, designated the "Nasr".

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[10.12] WESTERN SUPERSONIC ANTISHIP MISSILES

* No supersonic antiship missile has yet been fielded in the West. Vought designed a ramjet-powered "Supersonic Tactical Missile (STM)" for the US Navy that had a top speed of Mach 2.7, but though test flights were performed beginning in 1979, the STM was apparently regarded as a pure research effort. In any case, it did not lead to an operational weapon.

In fact, although it would seem that such a weapon would give a target vessel less time to react, supersonic performance has drawbacks. A weapon with supersonic performance is more expensive and has less range than a subsonic weapon. A supersonic antiship missile also cannot fly as low over the waves and has a more prominent infrared signature than that of a subsonic antiship missile, and the warning time for a subsonic missile is short enough. The current thinking seems to be that stealth technology and clever guidance system do more to improve missile effectiveness at lower cost than supersonic performance.

The French and West German governments collaborated in an investigation into such a weapon in the early 1980s, under the designation "ANS" (for "Anti-Navire Supersonique", or "Supersonic Anti-Ship"). Investigations were protracted and the ANS program fell apart when the Germans pulled out for budgetary reasons.

The French began development of another supersonic antiship missile in the late 1990s under the designation "Future Antiship Missile" ("ANF" in its French acronym), with Aerospatiale as the prime contractor. The ANF and ANS were similar, with both envisioning a ramjet-powered vehicle with a top speed of Mach 3 and a range of up to 200 kilometers (125 miles). The ANF was clearly related to the French ASMP nuclear stand-off weapon, though whether the ANS had any relationship to the ASMP is unclear. In any case, work on ANF was suspended in early 2000, though it is expected to be revived.

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