MILE STONES

Soviet cruise missiles post World War II

Dr Carlo Kopp

Soviet cruise missile designers began developing technology after 1945, from much the same baseline as Western designers, and with similar imperatives: to provide bombers with standoff weapons, allowing them to launch from outside the defensive coverage of an opponent. By the mid 1950s Soviet imperatives and design strategies began to diverge strongly from their NATO opponents, resulting in a great many designs, which had and still have no Western equivalents.

A major factor in the divergence between Soviet and Western designs was the Soviet Voenno-Moskiy Flot (Navy), which in the absence of proper aircraft carriers capable of challenging the US Navy and Royal Navy, invested increasingly in large, fast and highly lethal Anti-Shipping Cruise Missiles (ASCM) as the primary weapon for sea control and maritime interdiction. The result of this divergent evolution were parallel missile families, involving air launched and ship/sub launched missiles. Many of these missiles were built for strategic or tactical nuclear applications, with concurrently manufactured conventionally armed ASCM variants.

The threat of large supersonic cruise missiles drove the development of many Western air defence weapon designs, especially fighters and Surface to Air Missile systems, which might have been very different had it not been for the need to reliably intercept these very fast weapons.

The first Soviet cruise missile to enter limited production was the air launched KS-1 Kometa or AS-1 Kennel. Development was initiated in 1947 resulting the first missiles entering service during the Korean War period, carried by the Tu-4 Bull, a reverse engineered Boeing B-29. The Tu-4KS variant was equipped with the K-1M X-band radar and provided beam riding midcourse guidance for the Kometa ASCM. Once the Kometa was near enough to the target, guidance switched to the K-2 semi-active homing seeker in the nose of the missile, relying on illumination from the K-1M radar. The Kometa was integrated on the early Tu-16K Badger bomber, and later exported to Badger users including Indonesia.

The development of the KS-1 series was paralleled by the development of the V-MF's P-1 / KSShCh or SS-N-1 Scrubber, which in turn led to the first two significant Soviet naval ASCMs, the NPO Mashinostroyeniya P-5/P-6/P-35 or SS-N-3 Shaddock series, and the P-15/21 Termit or SS-N-2 Styx series.

The P-1 / SS-N-1 entered service in 1957 and was deployed in rail launcher equipped hangars, launched by solid rocket booster and using a turbojet sustainer engine. A number of larger Soviet destroyers and cruisers were equipped with

Loading a P-15 Termit launcher.

the weapon. It was rapidly replaced by the much more effective Shaddock, entering service in 1957, and modeled largely on the US Navy's Regulus II supersonic cruise missile.

The Shaddock and Styx dominated Soviet warship armaments through most of the 1960s. The heavyweight long range Shaddock with a complex guidance system armed submarines and major capital ships, while the short range Styx armed fast missile boats, corvettes, frigates andsome destroyers, with a later adaptation for the 4K51 Rubezh coastal missile battery system. The Chinese reverse engineered the Styx to produce the Silkworm family of ASCMs, and the unique air launched CAS-1 Kraken carried by the H-6D Badger.

The first Shaddock variant to enter service was the P-5 / 4K48 variant in 1959, soon followed by the improved P-35 / 4K44 variant, with the P-6 / 4K88 entering service during the eartly 1960s. This massive ASCM was armed either with a 2,000 lb class conventional shaped charge 4G48 warhead or a 350 kilotonne nuclear warhead. A TRD 4D48 turbojet was used, with a pair of 66 klb thrust solid rocket boosters for launch.

The Shaddock was initially deployed on Project 58 Grozny and then Project 1134 Sevastopol class cruisers, and by the mid 1960s also on the Project 651 Echo SSGN and 675 Juliet SSGs, these submarines needing to surface in order to raise the large launchers.

After launch the Shaddock would climb to cruise altitude following datalink steering commands, with the missile's position tracked using a beacon transponder by the Front Door/Front Piece radars (SSG/SSGN) or Scoop Pair (DDG/FFG). Once the Shaddock had line of sight to the target, a video datalink was engaged which relayed the seeker image to an operator on the launch vessel. The operator would select the intended target and use the datalink to lock the seeker on that target. The missile would then transition to terminal homing and descend to impact, losing datalink contact as it fell below the radio horizon.

P-35 / Shaddock.

P-15 Termit / Styx.

Tu-95RTs Bear D targeting platform with Uspekh / Big Bulge X-band radar located under the centre section.

Over the horizon targeting required an airborne surveillance and acquisition system, which was implemented with X-band radar, the large MTsRS-1 Uspehkh / Big Bulge carried by the Tupolev Tu-95RTs Bear D maritime reconnaissance and targeting aircraft.

During this period the Soviets developed tactics for saturation ASCM attacks, with multiple submarines or cruisers positioning for launches and using targeting outputs from the Bear D. The principal drawback of the Shaddock was that it required submarines remained surfaced for up to 30 or more minutes until the Shaddock seekers lit up, a major vulnerability. The heavy dependence on datalinks also provided opportunities for jamming.

The P-15 / SS-N-2 Styx was a far simpler and very different weapon. It was powered by an Isayev P-15 liquid rocket rated at 1.213-0.554 tonnes thrust, using toxic AK-20K/TG-02 propellant based on the Luftwaffe's Wasserfall fuel. This highly toxic and corrosive fuel presents serious handling problems in fuelling up the missile, the propellant mix comprising AK-20K oxidiser and TG02 fuel. The Styx is armed with a 4G15 1,100 lb (513 kg) shaped charge warhead and mostly fitted with a conically scanning active radar seeker. The 2 – 2.5 tonne launch weight Styx was subsonic, with a range of up to 50 nautical miles, flying a shallow climb/dive profile. Midcourse guidance used an inertial autopilot, with two terminal seekers available, The P-15TG infrared homing seeker was supplanted in production P-27 / SS-N-2D missiles by the Snegir M seeker, and the widely deployed active radar seeker was used for all weather operations.

The P-15 Styx was deployed on Osa and Komar class fast missile boats, later replaced by improved P-15M rounds. Later P-15U and P-27 Styx variants were carried by Tarantul Corvettes, Kashin destroyers, and Koni class frigates.

Soviet air launched cruise missiles also rapidly evolved during this period. The supersonic Raduga K-10S Luga-S / AS-2 Kipper turbojet ASCM was developed for the Tu-16K-10 Badger C. When the Badger C acquired its target at a range of up to 160 nautical miles, the Kipper was launched and steered toward the target using a command link and tracking beacon. The Badger would then turn to fly a wide circle around the target, slewing the radar antenna sideways to maintain track. The missile would then descend in a shallow 15 degree dive until it settled at a cruise altitude of 1200 – 3000 ft AMSL, the ES-2 active radar seeker locking on at around 10 nautical miles with the Kipper descending in a shallow dive to impact.

Concurrent with the development of the Kipper, the Soviets also engineered the large Kh-20 or AS-3 Kangaroo as a strategic cruise missile for the Tu-95KD/KM Bear B/C missile carrier. The missile was based on the MiG-19 Farmer airframe but powered by the Al-7F engine developed for the Su-7BM Fitter bomber. At a launch weight of 12 tonnes, and cruising at Mach 2, the Kangaroo was a heavyweight, armed with a nuclear warhead of up to 3 Megatonnes. It proved slow to load, and inaccurate unless a datalink was used to steer it to impact. Entering service in 1960, the Kangaroo was replaced in the late 1970s by the much better Raduga Kh-22 Burya.

The Soviet Navy liked the Kipper but wanted a shorter ranging, lighter and cheaper weapon to replace the Kennel. This weapon was the Raduga KSR-2 or AS-5A Kelt, an Isayev S5.6.0000 liquid rocket powered design with a range of around 100 nautical miles, armed with a 1 tonne class warhead.

The Kelt was supplied as a land attack variant with a 1 Megatonne warhead, an ASCM with a Ku-band active radar seeker, and evolved into the KSR-11 or AS-5B anti-radiation missile. All variants typically flew a level cruise profile descending into a 25-degree dive to impact.

By the mid 1960s Soviet planners recognized that the second generation of cruise missile would suffer increasing losses due to improving NATO air defence weapons, and sought a third generation of weapons intended to improve survivability of the weapon and the launch platforms.

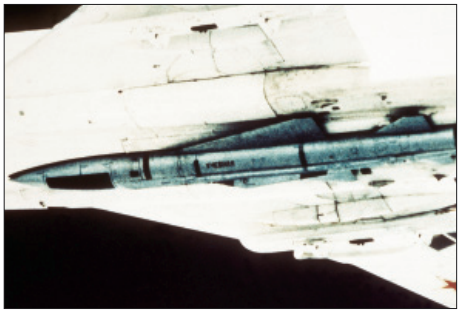
The Navy thus initiated development of the subsonic NPO Mashinostroyeniya P-70 Ametyst or SS-N-7 Starbright, the subsonic P-120 Malakhit or SS-N-9 Siren, and the supersonic P-500 Basalt or SS-N-12 Sandbox.

The P-70 / 4K66 Ametyst was important as it introduced the capability to be launched from a submerged SSGN, using a battery of ten slanted launch tubes. It used a 293P liquid propellant sustainer burning LTS-2KM propellant, with solid rocket boosters used for launch. A 1 tonne shaped charge warhead was used, and an active radar or according to US sources, an anti-radiation terminal seeker. In operation, the Project 670 / Skat Charlie I class SSGN would either ambush or stalk its quarry, launching the fire-and-forget Ametyst from 40 nautical miles, this taking up to three minutes for a complete salvo. The missile would cruise at 200 ft AMSL subsonic, diving for impact. A nuclear warhead was optional.

The P-120 / 4K85 Malakhit was developed as a larger and longer ranging sibling to the P-70, with the intention of arming the Papa class SSGN, with the Project 670M Skat M or Charlie II SSGN taking its place. It was first deployed on the Nanuchka and Tarantul corvettes during the early 1970s, replacing the Styx. The P-120 followed the concept of the P-70, but used a much better active radar seeker and could hit targets at 80 nautical miles. Russian sources claim that an adjunct infrared seeker was employed to improve countermeasures resistance during terminal homing. A P-120 was apparently fired successfully at a Georgian naval vessel earlier this year.

In a sense the P-70 and P-120 reflect the NATO Exocet/Harpoon concept, but using airframes modeled on the Regulus II. The P-500 on the other hand was a deep upgrade to the basic design of the Shaddock ASCM.

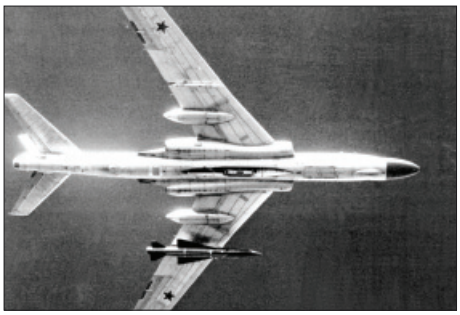
While P-500 / 4K80 Basalt resembled the P-6/P-35 series, it was very different under the skin. An improved turbojet engine increased cruise speed



Kh-22 Burya / Kitchen on Tu-22M2 Backfire.

P-70 Ametyst / Starbright

Charlie I SSGN armed with P-120 Malakhit / SS-N-9 Siren ASCMs.



The Badger C was built to carry the Kipper, but later retrofitted for the KSR-5 Kingfish.

P-500 Bazalt / Sandbox launchers on a Slava class cruiser.

KSR-5 Kingfish on a Tu-16K-26 Badger G.

and extended range to 300 nautical miles. The guidance system employed datalinks built for jam resistance, and allowed the launch vessel to selectively guide the missiles against eight targets. An important innovation was an active internal electronic countermeasures package, intended to jam the fire control system of a target warship. Off board targeting was provided by aircraft, but also the MKRTs Legend Radar Ocean Reconnaissance SATellite system. Compared to its predecessors, a much longer low altitude terminal flight profile was used to deny early warning and defensive missile fire.

The P-500 entered service in 1975. It was carried by the Slava class cruiser, and a number of other warships. It also armed nine Echo II SSGNs replacing legacy Shaddocks.

These second generation Soviet ASCMs led to the final generation of Cold War ship/sub launched ASCMs, the heavyweight NPO Mashinostroyeniya P-700 / 3M45 Granit or SS-N-19 Shipwreck intended to replace the Sandbox/Shaddock family of weapons, and the NPO Mashinostroyeniya P-1000 / 3M70 Vulkan or SS-N-21 Sampson, intended to replace the Starbright/Siren family of weapons. The contemporary Raduga 3M80 Moskit or SS-N-22 Sunburn, and NPO Mashinostroyeniya 3M55 Yakhont or SS-N-26 Stallion are direct offspring of these weapons.

Soviet Long Range Aviation (DA-VVS) followed a very different path to the V-MF in pursuing second generation cruise missiles. The Kangaroo proved to be troublesome and clearly would have difficulty penetrating NATO defences, the DA-VVS coveted a missile similar to the British Avro Blue Steel which was being developed for the V-bombers.

Raduga developed the Kh-22 Burya or AS-4 Kitchen to meet this need. The Kitchen was a bigger, faster and longer ranging equivalent to the Blue Steel, initially armed with a 1 Megatonne nuclear warhead and equipped with inertial guidance. The AV-MF instantly took an interest in the Kh-22 and ASCM variants with active radar and anti-radiation seekers eventually emerged.

The Kh-22 is a formidable weapon. Powered by an Isayev R-201-300 / S5.44 liquid rocket delivering 83 kN full thrust and 5.9 kN cruise thrust, it is claimed to exceed 4.6 Mach in cruise at 80,000 ft AGL. Around 3 tonnes of TG02 fuel and AK-20K oxidiser are carried providing a cited range between 145 NMI (270 km) and 300 NMI (550 km. Not unlike Lockheed with the A-11/YF-12A, Raduga experienced numerous problems with materials and the high airframe temperature during Mach 3+ cruise.

While the Kh-22 was intended to replace the Kangaroo, it was first deployed in the Tu-22 Blinder, which used the PN or Down Beat acquisition radar to target the missile. By the early 1970s the ineffective Blinder was being replaced by the more capable Tu-22M2 Backfire B, capable of carrying up to three Kh-22s, but usually armed with one on the centerline BD-45 adaptor. The final 1980s Tu-22M3 Backfire C variant had the performance to carry three Kh-22s to 2,500 nautical miles, with underwing rounds on BD-45K adaptors – this weapon system remains in Russian service today.

The integration of the Kh-22 on the Tu-95K-20 Bear C proved to be protracted and troublesome, but eventually resulted in upgrades running through the 1980s to convert all Bear B/C bombers into the Tu-22K-22 Bear G equipped to carry the improved PNA Down Beat radar and up to three Kh-22s, for use as a nuclear armed defence suppression or maritime strike system.

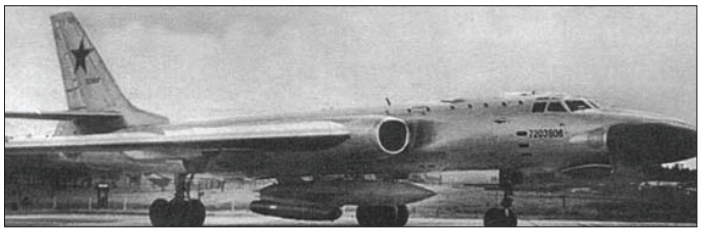
The Backfire/Kitchen armed the 'sharp end' of Soviet naval and tactical nuclear strike forces, but the AV-MF wanted a supersonic replacement for the increasingly less survivable Badger/Kelt weapon system. The result was the Raduga KSR-5 or AS-6 Kingfish.

The Kingfish was essentially a scaled down Kitchen, with less range and launch weight, but similar performance and lethality. It used the Isayev S5.33 engine, based on the S5.44 in the Kitchen, and similar airframe construction and inertial, active radar and anti-radiation guidance systems. Some Badger Gs were retrofitted with the Rubin-1M or ME with a much enlarged antenna/radome assembly under the engine inlets, this arrangement doubling search range to 240 nautical miles. The KSR-5 was carried under the wing on the BD-487 adaptor, the missile being that much heavier than the Kelt that only one could be carried on a typical profile.

With the Kh-22 and KSR-5 the AV-MF had the weapons it had always sought, and developed tactics for massed saturation attacks against NATO surface fleets. Once targets were acquired, either by Bear D or RORSAT, Backfires and Badgers would launch to deliver waves of these supersonic ASCMs, in concert with ASCM firing submarines, intended to saturate the defensive systems of their quarries with hundreds of inbound targets. To support such attacks, the AV-MF also developed and deployed the Tu-16Ye/YeR/P/PN/PP Azaliya or Badger L and Tu-16P Buket or Badger J support jammers, intended to saturate NATO warships with intensive radar jamming in the L/S/X-bands used for missile targeting and guidance.

Happily, the Soviet Union collapsed bankrupt before this formidable arsenal could be used operationally. What it does present is an excellent example of how good ideas like the Regulus II and Blue Steel could be adapted and evolved to provide entirely new capabilities of strategic significance. The Russians still manufacture the most lethal and survivable ASCMs in the global market, for which there are no Western equivalents. Matching this technology will be difficult, given that Russia's industry has fifty years of unchallenged experience in this area.

KS-1 Kometa / Kennel, carried by Tu-4 (B-29) Bull and Tu-16K Badger B.



K-10S Luga / Kipper carried by Badger C aircraft.

KSR-2 / Kelt carried by Egyptian Badger G aircraft.