



## Sunburns, Yakhonts, Alfas and the Region (*Australian Aviation*, Sept 2000.)

Carlo Kopp, BE(Hons), MSc, PhD, PEng,  
Defence Analyst and Consulting Engineer

Email: [Carlo.Kopp@aus.net](mailto:Carlo.Kopp@aus.net)

© 2000, Carlo Kopp

March 5, 2001

**The current force structure debate has seen numerous strong public statements by Australia's naval warfare lobbyists for a substantial and immediate growth in the RAN's Anti-Air Warfare capabilities. There are strong underlying reasons for such statements, since recent deployments of advanced Russian built anti-ship cruise missiles (ASCM) in effect threaten to make the RAN's surface combatants unusable in any escalated regional confrontation.**

The recent leaking of a RAN sponsored study for up to four 30,000 tonne class CTOL or STOVAR aircraft carriers, each equipped with up to 20 F/A-18 Hornets or other fighters in the same weight class, supported by shipboard fixed wing AEW&C aircraft, as well as the RAN's desperate efforts to persuade the government to acquire several Kidd class destroyers, are both symptomatic of a realisation that the RAN's relative ranking in the regional naval power game is rapidly declining.

To best appreciate these circumstances, it is necessary to explore these new Russian missiles in some detail.

## 1 Russian ASCMs

During the Cold War the Soviet Navy was devoid of large deck aircraft carriers, and thus invested heavily in the development of large supersonic anti-ship cruise missiles. These were initially designed for launch from warships, with variants and new types later developed for launch by submarines and aircraft.

The most capable of these weapons remained only in the Soviet arsenal until the collapse of the Soviet Union. Over the last decade many of the most advanced missiles have been exported to both China and India.

The Chinese PLA-AF and PLA-N have to date used subsonic ASCMs of domestic design. The C-601 series are an indigenous development of the Russian P-15 and P-20/21 series (SS-N-2 Styx), evolved via the coastal defence HY-2 Silkworm Styx clone. The subsonic weapon is carried in pairs by the H-6 Badger, itself a clone of the Tupolev article.

A more sophisticated and recent Chinese product is the C-801 and its sibling, the C-802. These missiles correspond to the French Exocet and US Harpoon, respectively. The C-801 uses a rocket sustainer, the C-802 a turbojet. The C-601, C-801 and C-802 are available in ship launched, ground launched and air launched variants, and offer ranges between 20-55 NMI. There are no reports as yet of the Zvezda-Strela Kh-35/3M-60 Uran (SS-N-25 Switchblade) or "Harpoonski" being offered to the PRC.

The PLA-N is now in the process of fielding an additional two 956E Sovremenny class destroyers, bringing the total up to 4 vessels. These are a Russian equivalent to the Kidd class. Each is armed with eight supersonic 3M-80 or 3M-82 Sunburn ASCMs.

India has pursued a far more aggressive naval power projection force buildup. The centre-piece of this program is the deployment of the Russian 3M-54 Alfa family of ship, sub and air launched ASCMs. Initial launch platforms for the Alfa will be Russian supplied Krivak warships and Kilo class diesel electric patrol submarines. Reports in the Indian press indicate that the intent is to also arm India's fleet of Tupolev Tu-142M Bear F maritime aircraft with this family of weapons, although other sources suggest the less capable Kh-35 Harpoonski may be used instead. The planned new Project 75 submarine replacement is to carry the supersonic (frequently referred to as hypersonic) Alfa variant.

India is currently in the process of having its 6 Bear Fs and 5 Il-38 Mays upgraded with a new

avionics package, and is reported to have ordered another 8 Bears to more than double the fleet size. Several Tu-22M3 Backfires are being leased while the Bears are being retrofitted, and reports from India would suggest the Russians are pressuring India to buy the aircraft. Indian sources claim that the Kh-31A (AS-17 Krypton) is being considered as a weapon for the Backfire. Backfires are typically armed with either one or two 7 tonne Raduga Kh-22M Buran (AS-4 Kitchen) Mach 3 / 300 NMI ASCMs.

It would appear that Indian attempts to integrate the BAe Sea Eagle on the Bear have not proven successful.

Earlier this year, the Indian Navy trialed its Dhanush ship launched land attack ballistic missile, presumably derived from the Prithvi tactical ballistic missile. Reports in the Indian press indicate that there is some argument as to the relative merits of the Dhanush, against a land attack variant of the Alfa cruise missile.

These developments in China and India parallel their massive investment into fleets of the Su-27/30 fighter aircraft. Air launched version of the Sunburn and Alfa are on offer for the Su-30 and the larger Su-32FN/34 variant.

At this time India is leasing two Beriev A-50 AWACS aircraft for evaluation, while China is still smarting from the cancellation of its widely publicised A-50I/Phalcon AWACS buy, following US pressure on Israel. We can reasonably surmise that the PLA-AF will now directly acquire the basic Russian A-50 model instead.

China attempted to acquire the Tu-22M3 Backfire in 1993 but the Russians declined under alleged pressure from the US and Japan. Should they again request this aircraft it is unlikely the request would be denied, after the Kosovo disagreement between Russia and NATO.

The Sunburn, Alfa, and their cousin, the Yakhont, are all very capable missiles with potential for further growth in capability, and role expansion to land attack missions where such variants do not exist already.

## **1.1 The Raduga 3M-80, 3M-82 and Kh-41 Moskit**

The Raduga 3M-80, 3M-82 and Kh-41 Moskit (SS-N-22 Sunburn) are all variants of the same 4.5 tonne supersonic rocket-ramjet missile. This weapon is the primary armament of the 956E Sovremenny class destroyer used by China and is credited with a range between 50 and 120 nautical miles.

Unlike subsonic Western anti-ship missiles such as the Harpoon and Exocet, the Moskit is a supersonic sea-skimmer. It can be programmed to fly a high altitude trajectory at Mach 3, or

a sea-skimming trajectory at Mach 2.2. If the sea skimming mode is chosen, the missile will be first detected by a warship under attack when it emerges over the horizon at a distance of about 15 to 25 nautical miles. This provides the defences on the ship with about 25-60 seconds of warning time before impact. Moreover the speed of the Moskit makes it a challenging target for many shipboard defences.

## **1.2 The OKB-52 3K-55/3M-55 Yakhont.**

The OKB-52 3K-55/3M-55 Yakhont (SS-N-26) is like the Moskit a complete family of supersonic rocket-ramjet missiles. Ship, submarine, air and ground launched variants exist. The missile weighs 3 tonnes at launch, and uses a liquid propellant for the ramjet which propels it at speeds between Mach 2.0 and 2.5. The Yakhont typically cruises to the target area at high altitude, and then descends for a sea skimming attack from under the horizon. The distance at which it begins its descent can be programmed before launch, this determining the achievable range which is between 65 and 160 nautical miles( Refer Tsarev V., Melnikov V., "Yakhont - New Generation Antiship Missile", Military Parade, Exclusives, 2000.).

## **1.3 The Novator 3M-54 Alfa.**

The third advanced missile is the new Novator 3M-54 Alfa or Club (SS-N-27) which like the preceding missiles, comprises a complete family of ship, submarine and air launched weapons. Unlike submarine launched Moskit and Yakont variants, the Alfa is designed for launch from a 533 mm torpedo tube, or a vertical launch tube( Refer Military Parade, 2000-1 Exclusives Issue, Kamnev P., "The Club Missile System").

Five distinct variants of this missile exist. The basic 3M-54E1 and 3M-14E most closely resemble either a winged Harpoon or the US Navy's anti-ship Tomahawk missile. This weapon has a range of 160 nautical miles and is subsonic. The 3M-54E1 uses an ARG5-54 active radar seeker and Glonass satellite and inertial guidance, the 3M-14E Glonass satellite and inertial guidance alone.

The more advanced 3M-54E combines the subsonic cruise airframe of the 3M-54E1/3M-14E with a Mach 2.9 rocket propelled guided payload. Like its subsonic sibling, it approaches from under the horizon using the same radar seeker to detect its target. Once locked on, it discards the cruise airframe, fires its rocket motor, and accelerates to Mach 2.9 at a sea skimming altitude of 15 feet. Novator claim the missile follows a zig-zag flightpath to defeat defences.

Both the 3M-54E1 and 3M-54E are small weapons which are difficult to detect on radar, especially should even basic radar signature reduction techniques be applied to them. The use

of a bandpass radome and minimal absorbent coatings could push the weapon's head on radar cross section down to that of a large grapefruit (Refer Knott, Schaeffer & Tuley, Radar Cross Section, Ch.14).

The 91RE1 and 91RE2 are rocket boosted homing torpedoes, most closely resembling the US ASROC and Sea Lance weapons. All five weapons in this family share a common launch system and thus any ship, submarine or aircraft equipped for these weapons can carry an arbitrary mix.

All of these sea skimming missiles outclass the Harpoon used by the ADF and other nations in the nearer region, both in terms of range, and in the instance of the Moskit, Yakhont and supersonic Alfa also speed. For all practical purposes, the RAN's surface fleet is outgunned. In the absence of any comparable Western missiles, this situation cannot be easily remedied. Since the USN, Royal Navy and French Navy all rely on carrier based air power, they are not under strong pressure to develop such missiles.

## **2 The Tu-142M Bear F**

The baseline Bear F long range maritime patrol aircraft was originally armed only with depth charges, sonobuoys and homing torpedoes. The aircraft has considerable growth potential as a carrier of anti-shiping or land attack cruise missiles, a role performed by its sibling Bear G and H models during the Cold War. The SRPE MKU-5-6 rotary launcher for the Bear H and Kh-55SM cruise missile can be readily adapted to the Bear F, and its size easily permits the carriage of the 3M-54E, 3M-54E1 and Kh-35. The weight of the 3M-54E may limit the load to 4 or 5 rounds. The common wing root pylon used on the Bear G and H is rated for the 7 tonne Kh-22 missile, and could accommodate single rounds or pairs of the 3M-54E, 3M-54E1, Kh-35, Kh-41 and possibly the Kh-22 or KSR-5. A best case loadout of the supersonic 3M-54E could be as large as ten rounds.

Another issue of some concern is that once the basic version of such a missile is deployed operationally, the incremental cost of deploying more advanced versions is very modest indeed. Moreover, land attack versions using satellite navigation are becoming available and could also be fielded with little additional effort. The Russians have developed optical scene matching guidance hardware similar to that used on the US Tomahawk cruise missile( Refer Solunin V., Gursky B., "OPTRONIC MISSILE GUIDANCE SYSTEMS:ACCURACY, LOW SIGNATURE AND SIMPLICITY", Military Parade, Jan-Feb, 1999. The system described resembles in principle the US Scene Matching Area Correlator used on the land attack Tomahawk). Therefore submarine launched cruise missiles similar to the US Tomahawk, based on the 3M-54E1, are now technically feasible and would be compatible with the launch systems being fielded by India.

The Bear F has the operating radius, unrefuelled, to penetrate well into Western Australian and Northern Territory airspace from its home base at INS Rajali. The Tu-22M3 has the operating radius to cover an arc between Learmonth and Darwin if sortied from INS Port Blair, and it can use any runway capable of taking an extended range 767 airliner. Should China acquire the Backfire, it can provide almost identical coverage operating from the former Flanker base on Hainan Dao.

### **3 Defending Against Supersonic ASCMs.**

The difficulty presented to a defending warship by the latest Russian ASCMs cannot be understated. While Australia's naval lobbyists will argue that the Evolved Sea Sparrow Missile (ESSM), supported by Nulka and radar absorbent mats will defeat these weapons, or that the damage produced by a Harpoon or Tomahawk sized warhead cannot be fatal to a modern warship, or that the supersonic speed of the ASCMs prevents them from properly acquiring their targets, the reality is a little more complex than they would have us believe. Indeed, the effort being poured by the naval lobby into promoting the purchase of Aegis warships and CTOL/STOBAR carriers would suggest a measure of doublethink which is a little difficult to grasp !

A defending warship can be attacked at ranges between 80-160 NMI which places the launch platform well below the horizon, and outside the range of virtually all SAMs and the Harpoon ASCM. The Moskit, Yakhont and Alfa are all designed for a sea skimming regime of attack, the first two flying a high altitude midcourse phase, with the Alfa flying a subsonic sea skimming midcourse phase.

The first warning a warship will get is when these missiles emerge from behind the radar horizon at about 20-25 NMI, depending on factors such as the height of this ship's radar and ESM antennas, the cruise height of the ASCM and the sea state. Whether it is an ESM alarm or a radar track, warning time between detection and intended impact is between 50 and 60 seconds for the Moskit or Yakhont, and 37 to 46 seconds for the supersonic Alfa. In this time frame the warship must either shoot down or decoy the missile.

The first line of defence are SAMs, such as the ESSM or Standard. For these missiles the radar must acquire and track the inbound ASCM, upon which a SAM is launched and under datalink control steered toward the ASCM. Once close enough, an engagement radar such as the SPG-60/61/62 must illuminate the ASCM for several seconds for the semi-active radar homing SAM to guide itself to impact. If we make the assumption, favourable to the warship, that the SAM can almost instantaneously accelerate to around Mach 3, and it is launched within 3 seconds of ASCM detection, the ASCM will hopefully be destroyed at a distance somewhere around 10 to 12 NMI from the ship.

What happens if there are two ASCMs fired in a salvo ? Then the warship has to first paint one ASCM for several seconds to impact, and then quickly slew the illuminator antenna to the second ASCM to kill it. The launch of the second SAM must be delayed by the time it takes to illuminate for the first SAM since otherwise the second SAM will miss without guidance. If we assume 5 seconds of illumination to kill the first SAM and 2 seconds to slew the antenna, the second ASCM is killed at a distance around 2.8 to 3.8 NMI closer to the ship.

Let's now assume an increasing salvo size of ASCMs. With 3 ASCMs, the distance for the last missile kill is 5.6 to 7.6 NMI closer, or around 3.5 to 5 NMI from the warship. This is of course getting problematic, since SAMs have a minimum engagement range inside of which they do not have the energy to manoeuvre effectively to kill a supersonic target. That range is figure which is seldom publicised, but usually falls inside 2 to 5 NMI. So the fourth ASCM cannot be stopped by a SAM since the illuminator is 'saturated' with ASCMs.

At this point it is strictly a contest between the decoys, onboard jammers, radar absorbers, Phalanx CIWS if fitted, and the quality of the seeker design and its signal processing smarts. A dumb seeker is likely to be decoyed, a smart one less likely. A CIWS gun is usually effective out to around 1-2 NMI and may bag the fourth SCM. If it doesn't then the ship is in dire trouble.

Of course, if 5 or 6 ASCMs are salvoed, odds are the ship will be hit.

Is there anything else the ship can do ? If it has two illuminators on either beam it can turn into the ASCMs to bring a second illuminator to bear. Then it becomes an issue of how many ASCMs can be salvoed at the ship. Odds are that eight supersonic ASCMs will take out even a warship with a very modern AAW package, simply by saturating the fire control system. Even an Aegis cruiser with four SPG-62 engagement radars/illuminators can at best bring three radars/illuminators to bear against a single sector.

What we have described is not a vital and critical secret, the publication of which will irreparably compromise the ADF. It is nothing less than absolutely standard Cold War era Soviet anti-shiping strike doctrine ! Shoot off enough supersonic ASCMs and one or more will get through the saturated air defences of a warship and either kill it, or wound it well enough for a follow-on 'coup d'grace' shot. The Soviet investment in more than 120 Kh-22M Kitchen firing Backfires was no accident.

How difficult is it to deliver a saturation missile attack ? A Sovremenny can shoot 8 SS-N-22 Sunburns, a Charlie SSGN 8 SS-N-7 Starbrights, and even a Kilo SSK can push up to six SS-N-27 Alfas out of its torpedo tubes, if it is not equipped with a vertical launch tube package.

If you are using Bears, then depending on the configuration of the aircraft you could shoot up to 10 Alfas. A Backfire could deliver between 4 and 8 Alfas on external hardpoints, depending

wholly on the launcher design used. If you are using the Su-27 or Su-30 as a delivery platform, then 2 to 4 Alfas, or 2 Yakhonts could be carried per aircraft. This means that a maritime strike package of 2 to 6 Su-30s could deliver a saturation strike against most modern warships. If the ship is better defended, more fighters can be sortied. Even if the SAMs bag every ASCM, then an attacking air force merely needs to keep throwing ASCMs until the SAM magazines on the defending warships are exhausted. Warships cruising at 20-30 KT cannot outrun aircraft which fly at 400-500 KTAS, once contact is made aircraft can keep revisiting the target until they achieve the desired effect.

Even expending twenty 1 million dollar ASCMs is an excellent return on a warship kill.

## 4 Implications for the ADF.

The regional proliferation of late generation Russian supersonic ASCMs means that all navies in the nearer region, including the RAN, would be operating at a very high risk in any situation where India or China is involved as an adversary. Moreover, other regional players may follow suit and shop in Russia.

The best defence against such ASCMs is to nail the launch platform before it shoots, or even gets into shooting range. If the launch platform is a surface ship or aircraft, then this is a job best performed by a tanker supported package of fighters armed either with a hefty load of Harpoons or AAMs. If the launch platform is a sub, then coordinated use of ASW assets such as the AP-3C and Collins SSKs is a less risky approach. Hence the RAN's interest in CTOL/STOVAR carriers, SPY-1F Aegis for frigates and Kidd class ships.

Curiously, we have not seen any public proposals to add further illuminator/engagement radars (eg SPG-60 series) on either the FFGs or the ANZACs. Adding an additional pair to either class would double the ships' capacity to handle a saturation attack, and also increase the likelihood of successfully killing a 2 round Alfa salvo. However, it would also weaken the case for a SPY-1 Aegis system, and bigger ships to carry it, which perhaps explains its lack of attractiveness.

*The big question which must be asked is a simple one. At what point does the massive expenditure on SAMs and radars required to get any measure of survivability from a surface warship outweigh the operational usefulness of the vessel itself? If tanker supported fighters, which are capable of performing many other roles, can survivably destroy opposing ASCM shooting warships and aircraft, is not air power a better investment for blue water ASuW and AAW?*

The naval lobby frequently likes to argue that air power is an adjunct and thus a supporting



capability in the blue water ASuW and AAW roles. Perhaps it is time for them to finally accept that technology has overtaken the small surface warship, and that without prohibitive investments in AAW/SAM capabilities, it is best used as a niche asset for specialised roles such as ASW, patrol, escort and fire support in lower threat level environments.

As for some of the other implications of a region armed with cruise missile capable strategic power projection assets, that is best left for future discussion.

**Tu-142M Bear F  
ASM Loadout Growth Options**

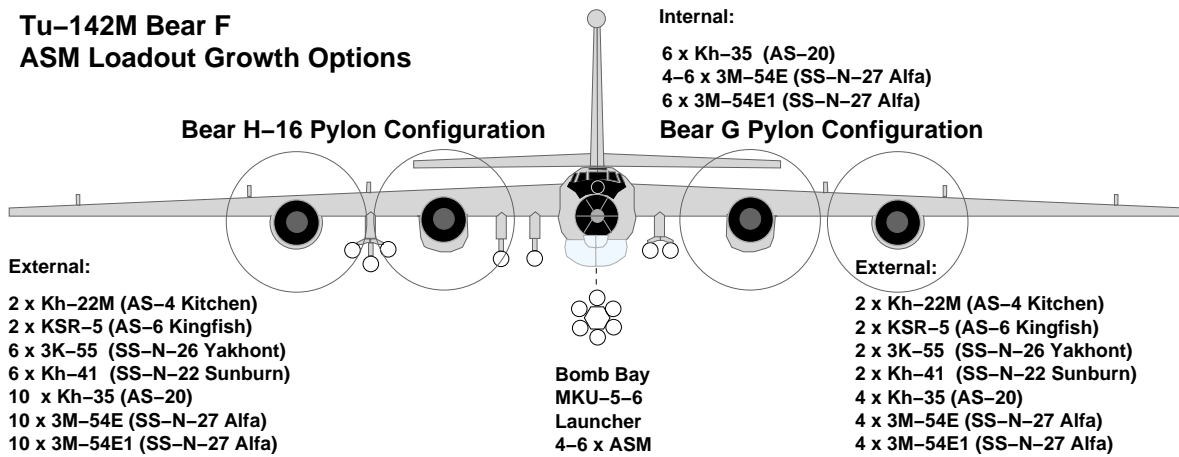


Figure 1: *Tu-142M Bear F* ASCM loadout options (Author).



Figure 2: *India is currently in the process of refitting its 6 strong force of Tu-142M Bear F with a new avionic package, reported to include either the 3M-54E/E1 Alfa or Kh-35 Uran ASCMs. It would also appear that India has signed for another 8 Bears to bring the total force up to 14 aircraft. With an unrefuelled radius of up to 4,000 NMI, the Bear becomes a formidable maritime power projection asset (Bharat-Rakshak).*



Figure 3: *India is currently leasing several Backfires C strategic strike aircraft, with the likelihood of a purchase being discussed. In its basic configuration it carries either one or two Mach 3 Kh-22M Kitchen cruise missiles (depicted). Flying from INS Port Blair, the Backfire can cover the WA and NT coastline between Learmonth and Darwin (FAS).*

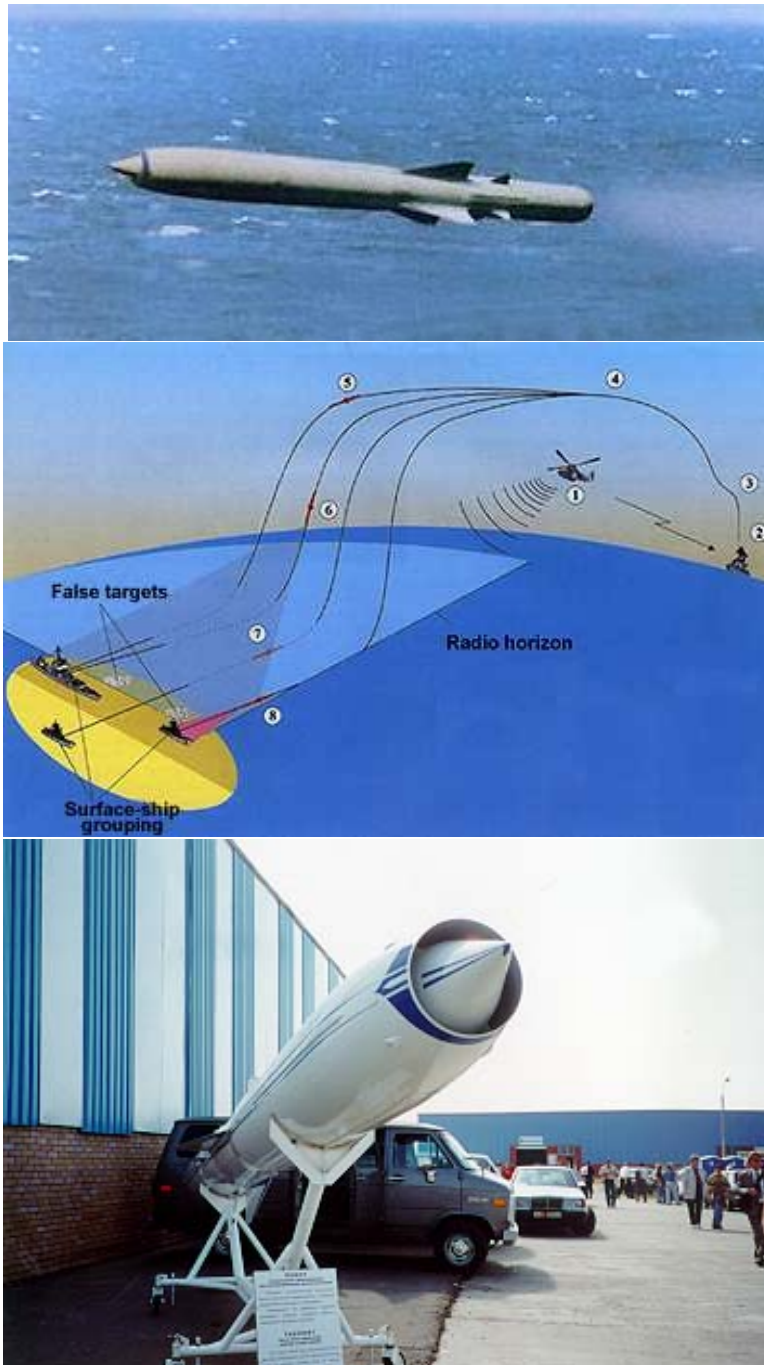


Figure 4: *The 3K-55 Yakhont is a Mach 2 seaskimming ramjet ASCM which is available in air, ship, sub and ground launched versions. The weapon can be programmed for high altitude profiles, low altitude profiles, or combined profiles with a sea-skimming terminal phase (Rosvooruzheniye).*



Figure 5: *The most sophisticated of the current crop of Russian ASCMs is the 3M-54 Alfa series. Left to right: 91RE2 rocket propelled torp, 3M-54E 'hypersonic' ASCM, 3M-54E1/3M-14E subsonic ASCM/SLCM (TASM/TLAM-ski), 91RE1 rocket propelled torp. The 3M-54E uses a Tomahawk style cruise stage and a Mach 2.9 rocket propelled warhead section (Rosvooruzheniye).*



Figure 6: *The massive Moskit/SS-N-22 Sunburn is available in ship, sub and air launch versions, the latter compatible with the Su-30 and Su-32FN/34 Flanker variants. This Mach 2 ASCM is carried by the PLA-N's four Sovremennyy class DDGs, each of which is armed with 8 rounds (Rosvooruzheniye).*