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India's Missile Power: Which Way Are We Headed?



Lieutenant General (Dr.) VK Saxena, PVSM, AVSM, VSM (Retd), is a Visiting Fellow at CLAWS. General Saxena was the Former Director General of the Corps of Army Air Defence. He is also a Distinguished Fellow at VIF. He has authored 5 books and publishes regularly across defence media. He is also a familiar face on TV, speaking on multiple issues in his core competency domain.

Abstract

Boosted by the positive policies and many a bold initiatives of the Government, the Defence and Aerospace sector of the country is on the upswing. In this, the two verticals that are surging well ahead of all others are the 'Drone Power' and the 'Missile Power'.

Sensing the Current Sentiment

Not long ago, the very mention of the word 'indigenous' portrayed a picture of minimalistic capabilities tagged to the lower/middle rung of technological prowess and generally lagging behind in the time perspective of readiness with respect to global reference.

However, in the contemporary world, the things are changing. Driven by the power of Indian intellect and Government's positive attitude, the private defence industry is showing new colours of 'strength and capability'—"we can do it here" is the new and nascent flavour. There is also some flux visible in the once passive, low-performing and ever lagging public sector.

Key Points

- Our missile power is growing steadily along many verticals.
- A stage has come today wherein the country is becoming nearly self-reliant in all its missile requirements—be it on Land, Sea or Air.
- Besides this, the missiles are also providing export opportunities.
- We however need to fill some of the voids that exist in our missile arsenal as well as, hasten the pace in operationalisation of the developed capabilities.



As stated, the Government must be given credit for making some bold moves and facilitating many a positive initiatives— Make II, sustenance support to Micro Small and Medium Enterprises (MSMEs), iDEX initiative, Defence India Start Up Challenges, Positive Indigenisation Lists and many more. Rhyming with the theme of 'Make InIndia' and Atmanirbhar Bharat, the private sector has been scoring some successes in winning global tenders in their own steam (like Vajra K9).

Though miles to go, but the current sentiment is one of positivity.

Verticals that are Surging Ahead

Complementing the current mood, the two Indian capability verticals which are surging well ahead of others are the 'drone power' and the 'missile power'. This work aims to take the reader on a search meant to check out the pulse of our indigenous missile power and assess whether we are correctly headed. Since the overall missile domain is huge, it is intended to visit some salient checkpoints only. The continuing new strides in the domain of long range Surface-to-Surface Missiles (SSMs) must qualify as an abiding tribute to the eternal source of all inspiration, Dr. APJ Abdul Kalam, Former President of India. Following points are stated:

- Starting out as a first generation of SSM, Prithvi with a single-stage liquid propellant engine giving a lowly range of 150 km and carrying a unitary warhead (only conventional) of 1000 kg, we have come a long way. Some developments are briefly captured:^{1,2}
 - The range vector has gradually gone up from 150 Km (Prithvi I) to 250-350 Km (Prithvi II) to 350-750 Km (Prithvi III).
 - The later versions (II and III) use state-of-art two stage solid propulsion systems.
 - The Circular Error of Probability (CEP) {basically a measure of accuracy} of <10 m, with strap down inertia navigation system for I and II can be termed as 'gold class' if world standards are to be followed.
 - The diversity of payload now spans the entire continuum (HE, cluster, thermo baric, chemical and tactical-nuclear).
 - While I and II continues to be the subsonic range, Prithvi III is a supersonic (Mach 2.5) ballistic missile interceptor.
 - Prithvi I, later upgraded to Prahar SSM, features solid fuel technology, supersonic trajectory (Mach 4) and enhanced strike range (200 km).³

- The growing strike arm of Agni series of SSMs, reaching ‘well inside and beyond the gut’ of our potential adversary, is actually reflective of our growing national pride. Some latest developments are as mentioned:
 - Spanning the entire range bracket from 700 Km to 5000 plus km, the Agni series of SSMs are the bedrock of our credible minimum deterrence anchored on the stated policy of ‘No first Use’ (Agni I: 700 km, II: 2000 km, III & IV: 2500-4000 km, V: 5000 Km).⁴
 - As of October 2021, the demonstrated capability in Agni V featured its range as well as a host of other state-of-art technologies (like 3 stage solid fuel, capability to carry Multiple Independently targetable Re-entry Vehicles or MIRVs) that has been included in it. The capability is well matured and has been repeatedly tested.⁵

Figure 1: India launches Nuke-Capable AGNI-IV Missile



Source: Hindustan Times, 07 June 2021

- Another variant of Agni that requires special mention towards capability enhancement is Agni Prime or Agni P. While keeping the range to just about 2000 km (keeping actual targeting requirements in view), the emphasis has been on achieving high accuracy (CEP < 10 m), reduced time to launch (being canister based) and carriage of single/2 MIRVs. Kind of ‘tailor made’ for the requirement at hand!
- That BrahMos Missile has been a huge success story. However, having established its credentials as the “world’s fastest supersonic cruise missile” (Mach 3+) based on

ramjet propulsion, “world’s fastest sea skimming missile” (3-4 m from sea-surface) and an unmatched accuracy of 1m CEP⁶, Agni is gold class. Some inputs which represents few recent developments over last few months are presented:

- Starting March 2022, the extended range version of BrahMos ER (from 290-350 Kms) has been under test fire run. The successful fire on 24 March from the Andaman was re-validated with another launch in 22 May. The first launch was land attack while the next one was from SU-30 MKI.^{7,8}

Figure 2: New Range BrahMos



Source: <https://www.google.ca/search?q=launch+of+brahMos++missile+May+2022&tbm>

- April 2022 saw the latest successful launch of the anti-ship version of BrahMos from a stealth destroyer in the Indian Ocean.
- It is reported that the development of BrahMos II hypersonic version (speed up to Mach 8, planned range up to 1000 km) is proceeding forward, albeit with delays. The missile is now likely to reach operational status in the between 2025-2028 (4-5 years behind schedule).⁹
- BrahMos Aerospace has reported that it is developing a smaller, more manoeuvrable and a smarter version of BrahMos called BrahMos NG (New Generation) deployable on large number of ground, air, sea and sub-surface platforms. Keeping the original range (290 km), the BrahMos NG will be able to do 3.5 Mach. Also, besides the SU-30 MKI, the

- weapon, due to its size, can be deployed on other aircrafts as well (LCA, LCA Mk II and AMCA).
- A manufacturing centre for BrahMos NG is coming up in Lucknow (foundation stone laid in December 2021). It will be ready in another 2-3 years and will have a capability of producing approximately 80-100 missiles per year.¹⁰
 - BrahMos received its first export order, of USD 375Mn from Philippines for three batteries of anti-ship version of the missile, on 28 January 2022—each battery consists of two launchers with a radar and command & control centre.¹¹
 - Experts opine that this deal is not only about the missile sale but also establishes India as a reliable and capable net security provider in South East Asian Region. It is believed that other countries like Vietnam and Indonesia have also made an appeal for similar purchases.¹²
- Another missile in the niche capability domain is the Anti-Radiation Missile (ARM) called Rudram -1. Following points are stated:
 - ARMs are considered deadly weapons since these have the capability to home on to, and destroy all radiating systems like radars or command, control, communication and intelligence (C3I) centres. Radars could be early warning, fire control, missile guidance, counter-rocket and counter-mortar, battle field surveillance. C3I could relate to any general command centres or air defence control centre.
 - ARMs can thus blind the enemy's air defences by taking out their sensors. This operation is referred to as SEAD (suppression of enemy air defences) or DEAD (destruction of enemy air defences). These greatly enhances the success of one's air operations.
 - Rudram-1 is gold class as it is equivalent to the best in the world like the US AGM 88E (also referred to as High Speed ARM or HARM), its advanced version called the Advanced Anti-Radiation Guided Missile or AARGM and AARGM (ER), Brazilian MAR 1 and the Russian ARMs in the Kh series (22, 25 MP, 31 P) etc.
 - As to its technical muscle, Rudram-1 has several advantages. Its vintage (2016-20) competes favourably with others (1983-2012). It has better range (100-250 kms) as compared to AGM 88E - 150 km, MAR 1 - 60-100 km and KH 31 - 60-110 km. It also does better in speed (0.6 to 2 Mach) to AGM 88E (1.84 Mach). Being of later vintage, it has better target

acquisition capability (dual seeker both active and passive) as compared to earlier vintage ARMs (having only one passive seeker).^{13,14,15,16,17}

- Another cutting edge feature of Rudram-1 is its capability to continue homing on to the radiating target even if the latter has switched off its radiation source, provided initial lock-on is achieved and target signatures recorded by the missile threat library.¹⁸
- Rudram-1 was launched from SU MKI on 11 October 2020. After the launch, the DRDO Chief stated that while the current test achieved full success, few more test would be required to mature the capability.¹⁹ The improved version of Rudram-1 is NGARM (new generation ARM). Another test is planned in June 2022.²⁰

Figure 3: Rudram-1



Source: Times of India, 09 October 2020

- India finds its place amongst the select few nations that are moving steadily forward in hypersonic missile capability domain. Following points are stated:
 - Simply put, hypersonic weapons are those weapons that fly at speeds equal to or in excess of Mach 5 (approx. 5000 Km/h). This relates to about 1.6 Km/sec. At this speed, such weapons can strike anywhere in the world in less than one hour.
 - At this speed, such weapons beat the reaction time cycle of any conventional air defence weapons and are thus considered unstoppable by such weapons.



- There are two types of hypersonic weapons in existence/under development today—Hypersonic Cruise Missiles (HCM) and Hypersonic Glide Vehicles (HGV).
- In HCM, quite unlike the conventional cruise missile which, upon initial boost to speed and attitude, maintains a steady course to the target, HCMs are powered 'all the way' thus making speeds, that possible which are in excess of Mach 5.
- HGVs are carried on booster missiles and rockets which upon launch, boost them to such speeds and altitudes where the shock waves generated by the boost flight itself start to act as lifting surfaces. This tremendously enhances the lift-to-drag ratio of the HGV which gets propelled at tremendous speeds. This phenomenon of 'riding the shock waves' is called the 'wave rider' phenomenon. HGVs are thus 'wave rider' weapons.
- India has made forward strides both in HCM as well as HGV vertical.
- In HCM, there are already two proud entrants:
 - The first is the Shaurya hypersonic missile capable of doing 7.5 Mach (9187.8 km/h) with a range of 700 km. It can carry a payload of one ton which could either be conventional or nuclear. It is fairly accurate with a CEP of 20-30 m.
 - The last test of Shaurya reported in the open source dates back to October 2021 wherein the missile flew at Mach 5 and demonstrated a precise hit. This validation is extremely significant considering the fact that, the missile is capable to carry nuclear arsenal at hypersonic speeds.

Figure 4: Shaurya Missile

Source: PTC News Digital Edition, 09 October 2020

The other hypersonic arsenal as stated earlier is BrahMos II, capable of flying at Mach 8 to cover a range of 1000 km. This weapon has been enumerated earlier.²¹

- As to HGV, India has started taking baby steps with the development of Hypersonic Technology Demonstration Vehicle (HSTDV). This was successfully tested on 12 June 2019. The carrier vehicle for HSTDV was Agni-I missile which boosted it to an altitude of 32 km in just 20 seconds after the wave-rider phenomenon was set in. The vehicle then ejected at a whopping Mach 6. The mission, being the first in its series, saw partial success.²²

Figure 5: HSTDV



Source: Imperia by News Information Centre, June 2019

- Apart from the above, the exo-atmospheric as well as the endo-atmospheric interceptors (AD 1 and AD 2) planned for Phase 2 of the indigenous Ballistic Missile Defence Programme of India (Codenamed Programme AD), is likely to be in the hypersonic domain.

Another missile capability worthy of mention is the Beyond Visual Range Air to Air Missile (BVRAAM). They say that in an aerial combat, the “one who shoots first lives to shoot another day” meaning that, the combat pilot who is able to get his adversary on his cross wires earlier and who can shoot by keeping out of the latter’s strike range will emerge as the winner.

BVRAAMs thus find relevance in providing the ‘killing edge’ to our air warriors. Astra BVRAAM developed indigenously is equivalent to the gold class in the world like the French Meteor (MBDA and Thales) or the US AIM 120C. In fact it is a shade above than the Russian R 73 and R 76. Following additional points are stated:²³

- Tested 29 times in the period 2003-2019, Astra has come of age. Another test is probably planned in June 2022.²⁴
- Can be carried by a number of strike platforms such as Mirage 2000, Tejas Mk 1, Mig 29 etc.



- While Astra I can do 4.5 Mach with a range of 110 km , Astra II has a better range of 160 km. The missile is in its final stages of development and is planned to be operationalised this year.²⁵
- One of the niche technologies in use in Astra is the Solid Fuel Ducted Ramjet (SFDR). It features a nozzle-less missile booster and a thrust modulated ducted ramjet engine. In this arrangement, the flow of hot escaping gases from the engine is controlled dynamically, providing a very high degree of mobility to the missile. Besides this, SFDR boosts the performance of the missile by enhancing its strike range and improving its kill effectiveness.²⁶

That Akash SAM has been a success story. Despite having being realised, after nearly two decades of time and cost overruns, the missile has proved to be a sturdy warhorse in the arsenal of our Forces. Some recent developments are stated:

- While the Army already has the basic version of the weapon inducted in May 2015, the Government has approved two more regiments of 'Akash Prime' (with better range of 27-31 km, better accuracy and more reliable performance).²⁷
- Post the export clearance of Akash in September 2020, the likely countries to which exports may happen are Philippines, UAE and Vietnam.²⁸

Some Reflections

While all that has been stated above may paint the most ideal picture, there are many a slips and sub-optimalties still. A few are captured:

- Barring a few, most of the missiles has been realised after decades of delay involving time and cost overruns.
- The missile story has been mainly resident in the public sector. The prowess of the private sector is yet to be fully realised in this arena, though some big players are already in the fray (L&T, Tatas).
- There are some gaping voids where our development must catch up.

It is the experience of the author that while our development reaches 99 in some time frame (albeit with some delay), it seems to rest there taking inordinate time in reaching the 100 mark (i.e. full operationalisation with the Forces). The most glaring case in this has been the operationalisation of the indigenous Ballistic Missile Defence System. This aspect must be placed focus on and solution needs to be evolved.



There is a need to usher an attitudinal change wherein, the missile capability so developed must change hands from the scientists to the soldiers in a quicker time frame.

While we have a huge range and depth of the missile, the following two missile type needs urgent indigenous development:

- **Man-portable SAMs (MANPADs).** We cannot remain perpetually dependent for MANPADS on the foreign players. The operational need for this type of missile, in warding off the air threat, especially from deadly attack helicopters cannot be over-emphasised. If the inescapability of this weapon requires to be assessed, one needs to only look northwards to the battlefields of Ukraine wherein the deadly Stinger MANPADS are playing merry hell into the mighty Russian Air Force.
- **Quick Reaction SAM (QRSAM).** This missile system is also yet to be operationalised. It is for the production agency (BEL) to ensure that all the identified snags are addressed sooner than later.

Finally, in realisation of the fact that the Centre of Gravity of the air threat is northward bound, the future missile capabilities have to ensure that weapon platforms are made lighter with adequate mobility as to remain viable for deployment in the northern sector.

Notwithstanding all the above and more, where is the doubt that India is a reckonable missile power (and counting) capable of giving a befitting reply to the evil designs of her potential adversaries.

End Notes

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CENTRE FOR LAND WARFARE STUDIES (CLAWS)

RPSO Complex, Parade Road, Delhi Cantt, New Delhi 110010

Tel.: +91-11-25691308, Fax: +91-11-25692347, CLAWS Army No. 33098; Email: landwarfare@gmail.com

Website: www.claws.in