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NUCLEAR WEAPON DELIVERY SYSTEMS :
INDIA'S ACHIEVEMENT IN MISSILE
DEVELOPMENT AND SPACE RESEARCH
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NUCLEAR WEAPON DELIVERY SYSTEMS: INDIA'S ACHIEVEMENT IN MISSILE DEVELOPMENT AND SPACE RESEARCH

One of the fundamental differences between a nuclear potential and nuclear capacity is the ability to deliver nuclear weapons. There are several ways in which nuclear weapons can be delivered as missile warheads, free fall bombs, or as nuclear shells. Arguably India has always possessed a nuclear delivery capability in the form of Canberra fighter bombs procured from UK in the 1950s. Other nuclear capable aircraft in the Indian inventory included the Jaguar and the Mirage 2000. Both were often touted as nuclear capable systems but few analysts make it clear whether they were really so or not as the exporting countries denied India the software for toss bombing which was present in the twin seater Jaguar and Mirage used by France and UK. However considering that India's nuclear weapons capability depends on its delivery systems, an analysis of the same is essential to understand nuclear deterrence and India's security problems. A study of characteristics of delivery systems, weapon devices, hit probabilities, vulnerability of the retaliatory nuclear forces and the levels of damage that need to be inflicted will be dealt with in this chapter.¹

Characteristics of Weapons Delivery Systems

The deterrent triad concept calls for a trio of strategic delivery systems of different capabilities and operational characteristics to provide optimum survivability and offensive capabilities.² The triad essentially comprises of manned nuclear capable aircraft, land based missiles and submarine launched ballistic missiles.

¹ Smith Chris, 'India's Adhoc Arsenal', p-200.
² Chant Christopher and Hogg Ian, 'Nuclear War File', Ebury Press, London, p-20
Manned Bombers:

Initially, aircrafts were the sole means of delivering nuclear weapons over long distances with any degree of certainty. The five decades after the Second World War have seen a quantum jump in the qualitative increments in all forms of delivery systems and air defence systems which brought the efficacy of the manned bomber into question and suggested a decline in the leading role of the bomber in nuclear operations. The debate endures to date, but by and large, all nuclear regimes continue to place a fair amount of confidence in this means of delivery.

Advantages of Manned Bombers:

Once executive orders have been passed and the mission has been launched, there is a considerable time delay before the attacking aircraft arrive at the weapons release points. This allows time for crises management. In the event a need arises to reverse or alter the decision to launch nuclear weapons, it is still possible, as crew is capable of reacting to orders to that effect. Manned bombers are recallable.

Aircraft can be configured to carry and deliver flexible payloads, both in size or type [conventional/nuclear]. This not only provides flexibility in strategic options but also substantially reduces the overheads in creating and maintaining force level.

The accuracy levels realized by this delivery system have proved to be significantly high along with reasonable levels of confidence that targets have been identified before weapons release.

Unlike, other delivery systems that are slaved to the war head, aircraft, once having released their weapons loads can be reused on subsequent missions. They are
therefore, essential ingredients for a second strike which forms the core of a deterrent strategy.

There is ample scope to provide multiple communication modes directly to command centers, through ground or airborne relay stations and indirectly via satellite. Therefore C3I [command, control, communications and intelligence] imperatives can be readily met.

Disadvantages of manned aircraft:

Delay between orders issued and action taken can cause irreparable damage to the strategic facilities by the enemy. Aircraft have limited endurance and as such circumscribes the ranges to which nuclear munitions can be targeted. While with the latest technological innovations, it is possible to extend these ranges by mid air refueling or by using stand off weapons systems such as air launched cruise missiles, the survivability factor of flying tankers, the additional logistics, inadequate technological expertise and phenomenal cost penalties would place these force structures beyond the reach of the developing countries.

Aircraft require complex bases from which to operate. These are essential as aircraft have limited endurance and must return to base for changes in crew, maintenance of aircraft and to take on fuel and armaments. These bases are large, well mapped with expensive and sensitive facilities and stores. These are attractive targets in their own right. Enemy’s counter air measures, both nuclear and conventional could seriously jeopardize the force structure retained at these ground bases. Such a glaring vulnerability reduces the efficacy of a second strike potential and dictates alternate means be made available.
The costs to provide a minimum inescapable number of aircraft at perpetual operational readiness are abnormally high. To start with the high capital cost of aircraft, would restrict the number of nuclear capable aircraft in the inventory of a developing country like India.

The inherent accident risk factor and vulnerability to inimical air defence measures are high. Therefore, the number of nuclear weapons in the planning factor would have to be increased in proportion to the risk factor to provide the required assurance level that the targeting policy lays down. Over and above, planners would have to take into account the susceptibilities of the system to climatic factors, and human errors that could offset the mission.

Nevertheless of all the modes of nuclear weapon, the manned aircraft stands out as the singular means by which the political leadership can flex its muscles by demonstrating a 'show of force' with out actually initiating an irretrievable nuclear exchange. This one factor makes the manned aircraft a critical component of any nuclear force structure.

**Land based Ballistic Missiles:**

Today all nuclear regimes, except the UK, field a wide array of land based ballistic missiles designed to cover the entire spectrum of targeting compulsions, which includes the battle field, regional terrestrial or extra terrestrial. There are numerous categories of ballistics missiles categorized according to their reach or role. These are:

- **Short Range Ballistic Missiles (SRBMs)**. These have range up to 800kms and can carry nuclear warheads designed to be applied against proximity targets usually
related to battlefield missions. While their range restriction suggests tactical use against military targets, the nuclear warhead has strategic ramifications.

- **Medium Range Ballistic Missiles (MRBMs)**. This class of missile has a reach from 800 km to 2500 km. Designed for a strategic role and for destruction of military related targets in the hinterland.

- **Intermediate Range Ballistic Missiles (IRBMs)**. Has a range extending from 2400 kms to 6400 kms. It has essentially a strategic role.

- **Intercontinental Ballistic Missiles (ICBMs)**. The ICBM can engage targets beyond 6400 kms and is essentially an extra regional strategic weapon system.

- **Anti Ballistic Missiles (ABMs)**. A defensive system intended to intercept and destroy incoming nuclear delivery systems before they detonate over the designated target.\(^3\)

Land Based Ballistic missile design parameters are applicable to all other missile systems, be they subsurface launched or cruise missiles. However there are substantial differences that make their inclusions in the overall deterrent force mandatory.

**Advantages of land based ballistic missiles:**

The speed of the flight of the ballistic missile is much greater than that of aircraft. The extremely short time reduces reaction time for acquisition, identification and crisis management. For example time of flight from Soviet Union to Washington would be between 20 to 25 minutes as against many hours required by manned bombers to carry

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3. Chant and Hogg, p-68
out similar mission. This makes these delivery systems potentially destabilizing factors in
the security equation between antagonistic nuclear powers.

Yet another major advantage of the missile over the manned aircraft lies in its
enhanced ability to penetrate hostile air space and deliver war head to designated
target. The most glaring example was demonstrated in the gulf war. Unsophisticated and
technologically unreliable first generation soviet SCUD missiles of Iraq were able to
penetrate air space defended by the most formidable air defence systems even put
together in the world (i.e. of US and its allies). Besides a surfeit of air defence aircraft
and missilery, a quantum generational boost was provided by the much acclaimed
Patriot Surface to Air Missile [SAM] system. Yet the Scud missile achieved 50 percent
penetration in spite of a large numbers having disintegrated in the air without being hit by
any defensive system. Iraqi aircraft on the other hand were unable to penetrate this air
defence screen. This makes the ballistic missiles an inescapable and complimentary
part of a force structure designed to project a credible deterrent factor. 4

The ballistic missile can carry large payloads which give it the capacity to take on board
sophisticated navigational aids to achieve exceptionally high accuracy levels in all three
dimensions - longitude latitude and altitude. This gives the missiles the potential to
destroy its target with a comparatively low yield war head, and if necessary, destroy
hardened targets also. In conjugation with its enhanced penetrative properties the
overall kill potential of the ballistic missile is higher than that of air craft delivered system.
The increased kill probabilities would allow for a smaller force to meet the objectives of
the declared policy, with an obvious spin off in the cost factor. 5

4 Brig. V. K Nair: 'Nuclear India', p-158
5 ibid, p-158
Disadvantages:

While missile can carry large payloads unlike the manned bombers, the throw weight of the war head is not variable thereby reducing targeting options and flexibilities of plans. As the political leadership governing nuclear forces need to have a wide variety of options for the projections of nuclear diplomacy, it becomes essentials for the ballistic missile force to be complemented by aircraft delivery system that would cater for different contingencies.

Missile forces are comprehensive units with the operators located within the silo complex. They do not have to the assembled and arrived at specified release points before they are ready to use. These systems lend themselves to a quick response to full alert.

Being ground based and detectible, pre launch survivability has been contentious issue with the existing nuclear regimes. Security against a first strike counter force attack is usually provided by installing missiles in underground silos with concrete shafts hardened to 2000psi or even 2500psi (pounds per square inch). "However the exact location of missile silos can be determined by reconnaissance satellites, and attacking ICBMs targeted with great accuracy..... This disturbing fact introduces a new and dangerously destabilizing element in the design, deployment and control of strategic forces" 6. However in the Indian context where a straight forward strategy of proportional deterrence is to be achieved against regional nuclear regimes of Pakistan and China, the issue is not as acute as China would take at least a decade if not more to create and deploy appropriate surveillance means and incorporate precision guidance system into

her nuclear forces. Pakistan of course, would require many decades. Therefore, if any defensive measures are to be taken these should be based on: mobile missile systems that could be based on the existing comprehensive rail network. Hardening of concrete silos to protect them from strikes in the general deployment of forces beyond the range of Pakistan’s strike range.  

"State of the art" missile systems in the West as also China have a multiple war head capability and therefore, threaten more than one target per launch. This characteristic flows from space technology and the Multiple Independently Targetable Re-entry Vehicles [MIRVs]. While India may not initially need an MIRV capability, she would have to start creating these assets by the turn of the century to establish a full fledged nuclear deterrence vis-à-vis China which has already developed the MIRV technology.

Submarine Launched Ballistic Missiles [SLBMs]:

The third and last leg of the triad comprises of the sea based missile systems. The US first induced some nuclear powered SSBNs (Sub Surface Ballistic Naval assets) into its strategic nuclear forces following growing apprehension of Soviet capability to neutralize fixed land based assets such as missile silos and launch air fields. All the five original nuclear powers have SLBMs based on SSBNs. The UK is unique in that it is the only nuclear power to bank entirely on SLBMs for its strategic designs which may be due to its restricted real estate for the deployment of land based missile systems. Currently the best possible mix of operational capability and survivability is to be found on board the sea based component of the nuclear force structure. Its comparative immunity to a preemptive strike makes it an ideal element to deliver retaliatory or second strike.

8. Ibid, p-160
A strategy based on deterrence, requires that India should possess certain number of the SLBMs despite its problems, to create an assured potent second strike capability. In view of the fact that the SSBNS requires an expensive infrastructure a third world country like India should at best be restricted to two or three such facilities. Two in the pacific region deployed as deterrents against China and one or two in the Indian Ocean to provide an assured second strike capability against Pakistan is the immediate requirement. The long term strategy should be to develop a force level of six SSBNs during decade and half. Another serious problem area is that the possibility of contamination hazards at sea port which will require highly sophisticated counter measures like specialized recovery and decontamination wherewithal.

Not withstanding its short comings the mobility of launch vessels provides policy makers and crises managers a wide variety of options. This result in enhanced flexibility of mission goals and gives ample manoeuvre space to governments.

India’s Missile Development Programme and the question of missile race in the subcontinent:

The origins of the indigenous ballistic missile programme are officially rooted in the establishment of Integrated Guided Missile Development Programme (IGMDP) in 1983.

Numerous reasons have been provided for the DRDO undertaking a high profile and stand alone project such as IGMDP. One view instinctively links its creation to the Chinese programme which started in the 1960s. This view gives credence to the security environment in which India operates which necessitates a matching response to Chinese advances. But by the time the IGMDP was created in 1983 the Chinese

programme had reached criticality, being several decades ahead. The second view believes that IGMDP was solely driven by efforts of Indian scientist to indigenously develop missiles. These views contrast with the official reasoning provided at the time of establishment of IGMDP. The Indian government had noted “that the continued armed proliferation in the region and the revival of tension between USA and the USSR.... It was therefore apparent that India would have to develop its missile capability indigenously in order to ensure its national security.” But over the years this argument has undergone change with greater emphasis on the regional security Scenario in South Asia. The 1995-96 Annual Report of the Ministry of Defence cites sale of missile from China to Pakistan and the development of three medium and long range ballistic missiles by China, which are to become operational by mid and late 1990s as the compelling reasons for India for “undertaking the technology demonstrator project so as to acquire a technology for future if required.

In the west it is generally assumed that the IGMDP is essentially a derivative of the space technology programme which however, is denied by the Indian Government. In an article, in the respected journal Scientific American in 1990, Janne Nolan and Albert Wheelon had written that “the missile called Agni was derived from space technology provided by France and the Soviet Union”.

(While it is true that the core group of scientists, including Dr. APJ Abdul Kalam Poplarly known as India's Missile Man were connected with the satellite launch vehicle programme which received assistance from western countries there is a growing feeling

12. ibid, p-843
that the programme in time has come to sustain itself, independent of the space programme.)\(^\text{13}\)

In an article on non-proliferation published by the Carnegie Endowment for International Peace, India's missile programme has been linked to its space programme. According to the article India began investment in space programme as early as 1970. It has since developed both space launch vehicles and satellite and is beginning to launch its own heavy satellite payloads. The design and engineering of space rockets has provided India with many of the essentials for developing nuclear capable ballistic missiles. India has been testing two such missile types – the Prithvi short-range missile (150-250km) and the Agni medium range missile (1500 – 2500 Km) for several years. It is now testing space launch vehicles of sufficient range and capacity for converted versions to become prototypes of long range ballistic missiles. India is not an adherent to the Missile Technology Control Regime (MTCR) guidelines. Indeed the Indian Space Research Organization (ISRO) actually was a target of related US sanctions in 1992-94. According to the same report separate organizations were created for civil space and military missile programs and they are separately budgeted but the same rocket technology has been accessible to both organizations, key personnel (notably the head of the space and later of the military rocket programs Dr. APJ Abdul Kalam) have shuttled between them.\(^\text{14}\) Gary Milhollin traces back the basis of most of India's space

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13. This view is reflected in Abha Dixit's article, 'Missile Race in South Asia: Linear Progression required to cap-race. Strategic Analysis, September 1997 and Jasjit Singh in his book 'Nuclear India', p-133
launch vehicles and military ballistic missiles to foreign training, technical assistance and space launch hardware or technology.\textsuperscript{16}

It is interesting to note that in the same article it has acknowledged that India has never as a policy encouraged nuclear proliferation elsewhere. It has been generally cautious in its approach to nuclear exports.\textsuperscript{16} Thus there can be no denying of the fact that India is alone in having adhered strictly to non-proliferation norms, and has never been accused of either seeking diplomatic or economic gains. Thus though western critics may be right in pointing out that India's missile programme is not totally indigenous but it definitely goes to the credit of our scientists that they were able to develop all advanced technology needed for building cryogenic engine and launching of GSLV. It means that India has the capacity to deploy missiles of greater pay loads and greater range like the ICBMs despite sanctions from US on Russian Glavkosmos Company. Thus it is absurd to label charges that India took advantage of foreign assistance to its space program to develop its missile programme since the two departments cannot be water tight compartments and no nation can afford to turn a blind eye to its security imperatives (i.e. the missile proliferation in Asia especially of the two hostile neighbors -- Pakistan and China). In its 17-18 year existence the IGMDP has earned accolades from even its most trenchant critics. With a total expenditure of $ 260 million spread over a 15 year period the IGMDP was mandated with the task of design,

\textsuperscript{15} Gary Milhollin, 'India's Missiles- with a little help from our friends', Bulletin of the Atomic Scientist, November 1989, pp-31-35.

\textsuperscript{16} Carnegie Endowment for International Peace, p-113
development and production of four missile systems. It was also given an additional charge of developing the long range Agni missile which officially continues to remain a "technology demonstrator".17

The five missile systems include:

(a) Prithvi – A surface to surface ballistic missile (SSM) with a range of 150-250km capable of carrying both conventional and nuclear payloads from 500 to 1000Kg. This missile which has undergone extensive field trials has attracted the most attention because of Pakistani preoccupation with the deployment along the Indo- Pak border by the Indian Army. Prithvi the short range missile which began testing in 1989 is a liquid fuelled, single stage missile designed to be fired from a mobile launcher and comes in two versions. Prithvi I, the Army version is said to have a range of 150Km with a 1000Kg. warhead. The other version for the Indian Air Force is designed to carry a 500Kg. warhead to a range of 250km which could strike most of urban Pakistan especially in the north.

(b) Akash – A Surface to air missile (SAM) with a range of 25Km. This system has been further refined to handle multiple targets by using phased away radars. It has new features like command guidance system and active homing in the terminal stage. Several test flights of the missile have been conducted and the missile entered user trials in 1996.18

(c) Trishul – A short range surface to air missile (SAM). It is expected to be used by all the three services. The missile is designed to counter a low level attack with a very quick

17. Abha Dixit, 'Strategic Analysis', September 1997, IDSA, p-843
18. ibid, p-844
reaction time and has an all weather capability. The missile uses single stage propulsion system with composite propellant and command guidance.

This missile has been extensively tested and has already been inducted into service. The missile has also been flight tested twice in a sea skimming role and against moving targets. 19

(d) Nag – An anti tank missile with a range of 5 Km, is considered a third generation variant with shoot and scoot features. Like Akash, where the IGMDP scientists appear to be testing indigenously developed technologies on a wider scale compared to the Prithvi and Trishul, the Nag is designed to tackle new reactive armour and has infrared or millimetre wave type of guidance. Like Akash it entered into user trials in 1996.

(e) Agni – The fifth task given to IGMDP related to development of a long range missile. This missile Agni was termed as “Technology demonstrator” which its critics argue was meant to dilute any pressure that would have been generated from the US for developing a missile that crossed the physical threshold of security threat to India. But supporters of IGMDP in the Indian government believe that the concept of Technology demonstrator is valid because in the case of the 2,500 Km range Agni missile, the several indigenous developed technologies were sought to be validated. These included maneuvering re-entry of the Reentry Vehicle (RV) structure by using multimode auto check systems and multistage propulsion technology including stage separations among others. They believe that Agni has remained a technology demonstrator because of enormous pressure brought to bear on New Delhi by western

19. ibid, p-845.
countries. While two of the three Agni test flights (till 1997) went of according to plan, the fall out from the success saw pressure being generated on the Narasimha Rao and Deve Gowda Government by US. In April 1997, however a BJP influenced parliamentary panel fought back demanding that the government revive the Agni programme as essential to Indian National Security.

Recently India test fired a shorter variant of Agni (Agni III of 800 Km range) on 25 Jan 20.05.02.

Among other missiles India is supposed to be developing a submarine launched ballistic missile (SLBM) known as Sagarika apparently based on Prithvi. There have been reports that India began development in 1994 of an Inter Continental range Ballistic Missile ICBM called Surya. An ICBM capability can be derived from the solid fuel stages of PSLV and GSLV. Dr. A.P.J. Abdul Kalam the then head of Indian Missile development program told the Indian press in the fall of 1997 that India is also developing cruise missiles i.e. unmanned air vehicles (UAVS) that can carry warheads. One type of UAV known as Lakshya is used as target drone. Another is the Nishant is designed with sensors as cross border surveillance and target acquisition platform.  

Conclusion:

Although India first tested a nuclear explosive device in 1974 it did not become a nuclear weapon state in the sense of having the ability to deliver nuclear weapons until 1986-88,

20. Rahul Bedi, 'Political Pressure may change India’s Course on Disarmament', Janes Defence Weekly, January 31st, 1996.
21. According to office of Secretary of Defence, Proliferation : Threat and Response 1997 op.cit.pp-19-20, India has the capability to convert space launch vehicles into either IRBMS (3000-5000 Km) range or ICBMS (5000 Kms or greater) range.
when according to Dr. Sanjay Badri Maharaj, Author of "The Armageddon Factor", a rudimentary delivery system was in place.\textsuperscript{23} The capability of the fighter planes like Jaguar, Mirage and MiG to carry nuclear war heads was extremely limited not only in terms of size but also in terms of its penetration ability into enemy territory. We have discussed the short comings of the aircraft bombers in this chapter. It was not until the development of the missile system that the Indian nuclear policy could be called credible in the true sense. It is not thus surprising that, the US used sanctions under the Missile Technology Control Regime as an instrument to curb India's missile development programme.

The sale of cryogenic engines by Glavkosmos, a Russian company to Indian Space Research Organisation was denied by imposition of sanctions on both organizations. This was supposed to give India the technological know-how of launching nuclear missiles. In any case such hurdles did not cause much concern as it was only a matter of time before India could develop its own indigenous technology to launch missiles. The test firing of the long range Agni-I missile, also known as a 'technology demonstrator' for the rest of the world, took place on May 22\textsuperscript{nd} 1989 from Chandipur in Balasore. It used the Satellite Launch Vehicle Technology used in satellite launches, thus demonstrating that India could develop missile technology on its own. It has now a host of missiles to cater to its diverse strategic requirements. The ICBM and the MIRV are on the agenda of our missile programme as a long term defence requirement.

\textsuperscript{23} The Indian Express, 18\textsuperscript{th} June 2000.