BABUR-3—PAKISTAN'S SLCM: CAPABILITY AND LIMITATIONS

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On January 9, 2017, Pakistan carried out the flight test of a 450-km range Submarine Launched Cruise Missile (SLCM), the Babur-3. This was followed by another test on March 29, 2018. Apart from claiming advanced technical features, reports appearing in the Pakistani media claimed that with the launch of the Babur-3, Pakistan had achieved second strike capability. Based on the publicly available materials, the capability of the missile has been examined and the assessment shows that the missile range is shorter than the claimed one, and is about 250 km. This paper looks into the implications of the fielding of the Babur-3 on strategic stability and deterrence. The paper also reflects on the future direction that Pakistan may take to reinforce its second strike capability.

INTRODUCTION

The 2017-18 period has seen new advances in the Pakistani missile development scenario. The missile developments broke new ground with the introduction of the Multiple Independently Targeted Reentry Vehicle (MIRV) capable Ababeel, the submarine launched cruise missile Babur-3, and the improved short-range ballistic missile Nasr. The press releases

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accompanying these launches indicate a shift from credible deterrence to full spectrum deterrence in the Pakistani military circles. The Babur-3, according to the Inter-Services Public Relations (ISPR) press release, is aimed towards providing Pakistan with second-strike capability, and to quote from the press release, "it is a manifestation of the strategy of measured response to nuclear strategies and postures being adopted in Pakistan's neighbourhood". The paper attempts to gauge the technical capabilities of the Babur-3 submarine launched cruise missile and the strategic implications of fielding this system.

BABUR-3 FLIGHT TESTS

Two flight tests of the Babur-3 have been reported: one in January 2017, and the second in March 2018. The Babur-3 was claimed to be a variant of the ground launched Babur-2, which has a range of 700 km. The claimed range of the Babur-3 is 450 km and summary details from media reports are provided in Table 1.

Table 1: Babur-3 Missile Tests

Missile	Launch Date	Performance	Remarks
Babur-3	January 9, 2017	Range: 450 km	Submarine launched cruise missile[1]
Babur-3	March 29, 2018	Range: 450 km	Launched from underwater dynamic platform[2]

1. ISPR Press Release Number PR- NO-10/2017, https://www.ispr.gov.pk/press-release-detail.php?id=3672. Accessed in May 2018.
2 ISPR Press Release Number PR-NO-125/2018 https://www.ispr.gov.pk/press-release-detail.php?id=4660. Accessed in May 2018.

TECHNICAL PARAMETERS OF THE MISSILES

Only limited open source information is available on the Babur-3 cruise missile. The images available also are not clear and distinct to derive meaningful information relating to the missile's features and dimensions. An attempt is, however, made using the available information, ISPR press release, and imagery, along with some standard features of torpedo tube launched weapons to obtain an understanding of the missile system.

The Pakistan Navy possesses two Agosta 70 (Hashmat class) and three Agosta 90B (Khalid class) submarines. The former are equipped with the UGM-84 Harpoon, while the latter field the French SM-39 Exocet anti-ship missiles. Pakistan has, therefore, adequate experience with torpedo tube launched cruise missiles.

The Babur-3 is a submarine launched subsonic cruise missile, launched from the torpedo tube of the Agosta-90B (Khalid class) submarine in service with the Pakistan Navy. Fig 1 (reproduced from the ISPR press release) depicts the missile in flight after emerging from under water.

Fig 1: Babur-3

The Pakistan Navy possesses two Agosta 70 (Hashmat class) and three Agosta 90B (Khalid class) submarines. The former are equipped with the UGM-84 Harpoon, while the latter field the French SM-39 Exocet anti-ship missiles. Pakistan has, therefore, adequate experience with torpedo tube launched cruise missiles and the emergence of the Babur-3 from this consideration should not be surprising.

The press release[3] issued by the ISPR in connection with the Babur-3 launches as well as the related video provide some details. And as the missile is launched from the submarine torpedo tube, some inferences can be drawn from the study of the Exocet SM-39 missile, launched in a similar manner. According to the ISPR press release, in the January 2017 launch, the missile was fired from an underwater mobile platform, while for the March 2018 launch, the missile was fired from an underwater dynamic platform.

It would appear that the mobile platform refers to a pontoon launch, wherein the pontoon can be towed to the required location and submerged to the required depth and the missile launched in the simulated torpedo tube environment. The underwater dynamic platform could also signify a pontoon or an actual submarine. All the development tests need to be done using the pontoon to demonstrate the safety and reliability of the system before it can be integrated with the submarine.

Some technical parameters of the Babur-3, based on ISPR information, are explained in Table 2.

Table 2: Babur-3 Technologies

Extract from ISPR Press Release	Explanation/Comment
Missile range is 450 km	
Missile was fired from an underwater mobile platform	Pontoon/Khalid class submarine.

3. n.1.

The Babur-3 is a sea-based variant of the Babur-2 ground launched cruise missile	Modifications of the Babur-2[4] for sea-basing will involve reduction in diameter to house inside the torpedo tube and wrapping of the fins around the missile body. The length of the missile will also be constrained by the dimensions of the torpedo tube. The same turbojet/turbofan engine could power both the Babur-2 and Babur-3.
Incorporates underwater controlled propulsion.	The missile may incorporate a propelled and guided underwater vehicle similar to the one used with the Exocet. This, however, would take up space and have a bearing on the onboard fuel quantity and, hence, the range. Alternately, the missile could be floated to the surface, where a surface sensor will command the ignition of the booster
Other technologies include global navigation augmented guidance and navigation, terrain and scene matching, terrain hugging, sea-skimming and stealth technologies.	These technologies are common and relevant for any cruise missile.

For expelling a torpedo from the submarine tube, three methods are in vogue, as explained below:

- 'Swim out', in which the torpedo propels under its own power.
- Gas/air ejection, which requires a dedicated system to vent the exhaust air inboard, to avoid detection of the bubble on the surface, leading to compromise of the submarines position.
- Hydraulic or mechanical ram, which is silent and effective, and gives the exact momentum required.

4. In an earlier National Institute of Advanced Studies (NIAS) study, the Babur cruise missile diameter was estimated as 560 mm. See Rajaram Nagappa and S Chandrashekar, "Assessment of Pakistan's Babur-Hatf-7 Cruise Missile", NIAS Report number R5-07, NIAS, Bangalore, 2007.

The *swim out* and the *gas/air ejection* methods require extra length of the torpedo tube to provide speed and stability to the torpedo as it exits the tube. The torpedo expulsion in the Agosta 90B works on the ram principle.The Exocet underwater propulsion module, *Véhicule Sous Marin* (VSM)[5] is not a missile performance augmentation unit, though it does provide a velocity of 20 m/second to the VSM. Its function includes obfuscation of the submarine platform location. For this purpose, the VSM can manoeuvre[6] underwater at up to 90° on either side of the launch direction with a turning radius of 100 m; further underwater manoeuvres can be carried out using electromagnetic deflectors in the rocket motor nozzle. Pakistan manufactures the Agosta 90B submarine under licence and possesses operational experience. Pakistan can, therefore, be expected to possess the competency to replicate an appropriate system for the Babur-3.

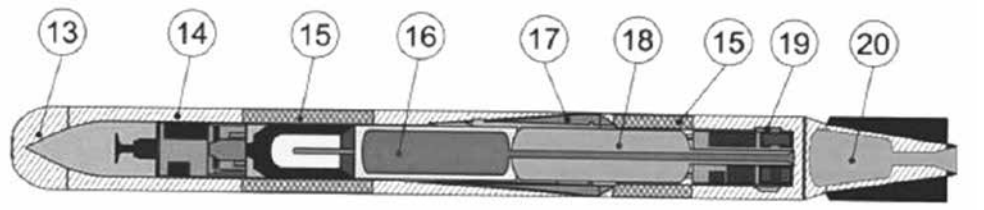
MISSILE DIMENSIONS AND PERFORMANCE

One could arrive at the dimensions of the missile if a good image is available. The images and the video currently available in the public domain cannot be used for determining the missile dimensions. In the absence of a good image, an attempt is made to obtain the dimensions through other means. The dimensions of the submarine torpedo tube would be one useful source. The Agosta 90B submarine employs the standard 533 mm diameter torpedo tube and further, it is seen from the literature[7] that the submarine fields the ECAN F17 Mod 2 torpedo, which is 5.62 m long. The Mod 1 version of the torpedo used against surface ships was 5.9 m long and the actual length of the torpedo tube can be expected to be longer by 1m, i.e. 6.9 m. In essence, the maximum length of the Babur-3 cruise missile + booster + VSM should be $\leq$ 6.9 m. The standard practice is to encapsulate submarine launched cruise missiles in an encapsulating shell, which will protect the missile from sea water as also the water pressure at operating depths.

5. "Exocet Anti-Ship Missile", see http://docfoualier.free.fr/exocet.pdf. Accessed on April 19, 2018.
6. "Surface-to-Surface Missiles", France, *Jane's Naval Weapon Systems*, http://www.vif2ne.org/nvk/forum/arhprint/417564 . Accessed on June 12, 2018.
7. "F-17 Torpedo", Archived 5/2003, https://www.forecastinternational.com/archive/disp_old_pdf.cfm?ARC_ID=1731. Accessed on April 15, 2018.

Making allowance for the encapsulation shell housing, release mechanism and clearance between the shell and the missile, the maximum length for the missile that can be housed in the torpedo tube will be 6,650 mm. The cross-sectional scaled sketch of the Exocet SM-39, shown in Fig 2[8] along with missile's dimensional details provided in the company literature, permit us to determine the length occupied by VSM and the permissible diameter for the Babur-3.

Fig 2: Inner arrangement of Exocet



Legend:
13: VSM Cover *14: VSM Body* *15: Launcher Shoes* *16: Lift/Cruising Engine*
17: Folded Wings *18: Acceleration Motor* *19: Folded Fins* *20: VSM Motor*

The following information is derived on the basis of Fig 2:

- Encapsulation shell inner diameter 516 mm
- Encapsulation shell outer diameter 533 mm
- Shell thickness 8.25 mm
- Encapsulation shell length 4,920 mm
- VSM length 968 mm

Assuming that Pakistan's design of the VSM is similar to that of the Exocet, it will be 968 mm long. This dimension can be rounded off to 970 mm—that leaves a length of 5,680 mm for the solid booster and cruise part of the missile. The encapsulation shell is designed to withstand the external pressure exerted by water at the operational depths of the

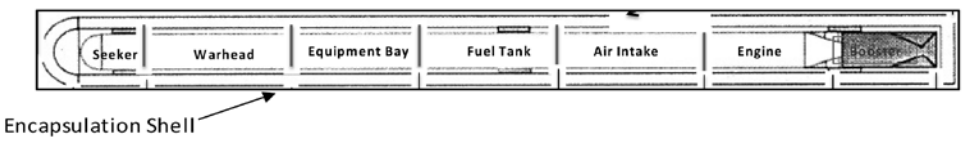
8. "Exocet Anti-ship Missile", Details reproduced from http://sistemasdearmas.com.br/asv/exocet1historia.html . Accessed on July 16, 2018.

submarine. It can, therefore, be assumed that the encapsulation shell for the Babur-3 will have the same thickness of 8.25 mm, as the one used with the Exocet. The wings, fins and the air intake are deployed in flight for the Babur-3. The main wings and the air intake are stowed inside the airframe till deployment. The fins are movable and control the missile in flight. While in the ground launched version of the Babur, the fins need not be stowed, for the submarine version, the fins need to fit into the encapsulation shell and have, therefore, to be folded or wrapped around the airframe. Keeping the thickness of the fin and its folding/ wrapping requirement in mind, the maximum diameter of the Babur-3 can be expected to be 510 mm.

Rough measurement from the Babur-3 video indicates that the solid booster length is about 1/6 of the total (booster + cruise) length, which approximates to 1 m. A booster configured within this dimension is able to provide 5-6 g type of acceleration. If we take off another 300 mm for accommodating the separation system and fin actuation system, we will have a length of 4,380 mm for the cruise missile sub-systems.

The essential sub-systems of a cruise missile are shown in Fig 3. Based on the data of cruise missiles, engine manufacturer's catalogue and domain knowledge, the length and mass of the sub-sections can be estimated and are depicted in the figure.

Fig 3: Inner Details of Typical Cruise Missile



The warhead, equipment bay, power plant and the air intake occupy a good percentage of the space and there is little scope for minimising their volume. The seeker can be dispensed with for the strategic land attack roles; consequently, the fuel tank has to be accommodated in the remaining length. This will dictate the quantity of fuel onboard and, hence, the range of the

missile. The sub-system length arrived at for the Babur-3 in this fashion is shown in Table 3.

Table 3: Babur-3 Estimated Sub-system Length and Mass

Sub-system	Length, m	Mass, kg	Remarks
Equipment bay	0.8	76	The length and mass are computed for land attack mode, thus, dispensing with the need of a seeker (the corresponding numbers with a seeker will be 1.1 m length and 105 kg mass)
Warhead	1.0	400	
Airframe		260	
Air intake	1.0	50	
Fuel	0.68	100	With seeker included, the tank length and fuel mass reduce to 0.38 m and 57 kg respectively
Cruise engine	0.9	100	
Cruise-booster interface	0.3	–	Included in the airframe mass
Cruise missile	4.68	986	
Booster Propellant		240	
Motor hardware	1.00	20	
Total Babur-3	5.68	1,246	
Total at launch		1,966	

In this apportionment, the tank length is limited to 0.68 m and the consequent fuel mass is only 100 kg. The mass of the 6.9-m-long encapsulation shell is estimated to be 720 kg. From the video[9] released by ISPR for the March 29, 2018 launch, the encapsulation shell is seen to separate at approximately 1.2

9. "Surface-to-Surface Missiles", France, *Jane's Naval Weapon Systems*, 36, posted November 29, 2001. Available at http://www.vif2ne.org/nvk/forum/arhprint/417564. Accessed on January 29, 2018.

The choice for Pakistan will be between longer missile range and platform survivability. Common sense suggests platform survivability as the primary choice and this necessitates the use of VSM. From this consideration, it can be concluded that the range of the Babur-3 is of the order of 250 km only.

seconds after emerging at the sea surface. This timing compares quite well with the VSM separation height of 20 m, which is equivalent to 1 second for the Exocet missile. The paint markings on the airframe indicate that the missile is spinning at about 5 revolutions per second (RPS). The spin will help in stabilising the missile in this phase of flight.

The missile range is estimated using engineering judgement values of missile velocity and engine specific fuel consumption. With fuel mass of 100 kg, it is found that the missile range is limited to 250 km. This range is in line with most of the operational Anti-Ship Cruise Missiles (ASCMs) as shown in Appendix 1. For ground attack purposes, there will be further erosion in the direct range value as the missile flight path will be programmed to avoid air defence and radar installations. The only way the range of 450 km becomes feasible, is to increase the length of the fuel tank by sacrificing the need for VSM. The choice for Pakistan will be between longer missile range and platform survivability. Common sense suggests platform survivability as the primary choice and this necessitates the use of VSM. From this consideration, it can be concluded that the range of the Babur-3 is of the order of 250 km only. The non-availability of the notice to mariners/airmen pertaining to the launch dates precludes a separate estimate of the missile range.

SECOND STRIKE PERSPECTIVE

After the first test of the Babur-3 on January 9, 2017, the ISPR[10] release stated, "*Babur-3 SLCM in land-attack mode is capable of delivering various types of payloads and will provide Pakistan with a Credible Second Strike Capability, augmenting deterrence. While the pursuit and now the successful attainment of a second-strike capability by Pakistan represents a major scientific milestone, it*

10. n.1.

is manifestation of the strategy of measured response to nuclear strategies and postures being adopted in Pakistan's neighbourhood".

The press release[11] after the second test of the Babur on March 29, 2018, is more forthright and connects the test to the nuclearisation of the Indian Ocean Region (IOR). The relevant extract from the press statement reads, "*SLCM Babur provides Pakistan Credible Second-Strike Capability, augmenting the existing deterrence regime. Development of this capability also reflects Pakistan's response to provocative nuclear strategies and posture being pursued in the neighbourhood through induction of nuclear submarines and ship-borne nuclear missiles; leading to nuclearization of the Indian Ocean Region. Pakistan eyes this landmark development as a step towards reinforcing the policy of Credible Minimum Deterrence through indigenization and self-reliance*".

Pakistan, no doubt, realises that a credible second-strike capability comes from long-range submarine launched ballistic missiles. The answer lies in possessing submarines equipped with vertical launch systems and capable of launching the Shaheen-2 class of ballistic missiles. It is to be expected that Pakistan would be working towards acquiring such a capability.

It is evident that Pakistan aims for a credible second strike capability, however relevant or otherwise its reasons to attain this capability are. As early as 2015, retired Gen Khalid Kidwai, in an event[12] organised by the Carnegie Endowment for International Peace, is said to have stated that "assured second strike capability comes from being sea-based". Pakistan has in, the past, suggested that the Indian Ocean be declared a nuclear free zone. The Pakistani reasoning, in the present context, for the introduction of the Babur-3 as a response to "happenings in the neighbourhood leading to nuclearization of the Indian Ocean" is hollow – the US, in all probability has stationed nuclear weapons in Diego Garcia[13] for years; in recent times, Chinese nuclear

11. n.2.
12. "A Conversation with Gen. Khalid Kidwai", Carnegie Endowment for International Peace, 23 March 2015. See http://carnegieendowment.org/files/03-230315carnegieKIDWAI.pdf. Accessed May 17, 2018 .
13. "Diego Garcia: A Thorn in the Side of Africa's Nuclear-Weapon-Free-Zone", https://thebulletin.org/diego-garcia-thorn-side-africas-nuclear-weapon-free-zone. Accessed on May 30, 2018.

submarines have been active in the IOR, ostensibly on anti-piracy patrols; and further, a Chinese Type 093 Shang class nuclear-powered attack submarine (SSBN) was at Karachi for a prolonged period during 2016-17.

Pakistan, no doubt, realises that a credible second-strike capability comes from long-range submarine launched ballistic missiles. The answer lies in possessing submarines equipped with vertical launch systems and capable of launching the Shaheen-2 class of ballistic missiles. It is to be expected that Pakistan would be working towards acquiring such a capability. There are reports that Pakistan may be negotiating with China for the lease of a Han class attack submarine. On the other hand, the NDTV[14] report of January 10, 2017, speculates that Pakistani naval officers were taken aboard the Shang class SSBN, which docked in Karachi, and Pakistan may be in discussions with China for the leasing of this class of submarine. China, however, will weigh its options seriously prior to leasing the SSBN to Pakistan, even for training purposes. Such a gesture is certain to raise an intense international reaction due to considerations of proliferation and Pakistan's rather poor proliferation history.

Riaz Haq's blogsite[15] as early as February 2012, had claimed that Pakistan was working on the indigenous development of a nuclear powered submarine. It is difficult to gauge the progress on Pakistan's indigenous nuclear submarine programme, but in view of the technological challenges, financial constraints, safety/reliability issues and acquisition priorities of the Pakistan Navy, it would be fair to assume that this is, at best, a distant goal.

Consequently, as Manpreet Sethi states, Pakistan is stuck with a *jugaad*[16] solution to building sea-based deterrence, as reflected in the limited capability nuclear-tipped Babur-3 employment in the Agosta 90B/Khalid class diesel submarines of the Pakistan Navy. Sethi goes on to say, "Pakistan is seeking notional survivability through an essentially non-survivable platform". Pakistan would, therefore, be trying for a better than *jugaad* solution; with the SSBN

14. Vishnu Som, "Pakistan Likely to Acquire Chinese Nuclear Attack Submarines: NDTV Exclusive", *NDTV*, January 10. Accessed on June 27, 2018 https://www.ndtv.com/world-news/pakistan-likely-to-acquire-chinese-nuclear-attack-submarines-ndtv-exclusive-1647370
15. Riaz Haq, "Pakistan to Build Nuclear Submarines?' http://www.riazhaq.com/2012/02/pakistan-to-build-nuclear-submarines.html. Accessed on June 15, 2018.
16. Manpreet Sethi, "Pakistan's Jugaad at Building Sea Based Deterrence", Expert View, Centre for Air Power Studies, May 5, 2018.

option out of the reckoning at this time, Pakistan may explore other options; and the Chinese diesel electric submarines may offer a slightly better prospect. Pakistan has ordered and committed funds for the acquisition of eight Chinese submarines. The China State Shipbuilding Industrial Corporation (CSIC) is the principal contractor for the boats. Media reports indicate that the Type 039 /Type 041 Yuan class diesel electric attack submarines[17] (SSK) have been finalised. The Yuan class submarines are believed to be the quietest in the People's Liberation Army Navy (PLAN) fleet and are fitted with state-of-the-art MTU manufactured 396SE84 diesel engines[18]. The submarine hulls of this class are supposed to be clad with anechoic tiles to minimise return echoes. The acquisition cost is speculated to be in the region $ 4-5 billion. Four of the boats are expected to be delivered by CSIC by the end of 2023, while the remaining four will be produced at the Karachi Shipbuilding and Engineering Works Ltd, for delivery by 2028. These submarines will be equipped with the Air Independent Propulsion (AIP) system, which will enable them to stay submerged for longer durations. According to *The Diplomat*,[18] it is speculated that some of the Chinese submarines of the Yuan class may be fitted with the Vertical Launch System (VLS) and employ newer YJ-18 anti-ship cruise missiles. Is it possible that Pakistan may opt for VLS for the boats it is purchasing and modify it for the Babur-3 launch? At this stage, it is difficult to guess if the contract with CSIC allows for this change and the implication on cost and the delivery schedule. Based on available dimensions of the Yuan class submarines, a VLS system may allow an increase in length of 0.5 m and consequent increase in range of the order of 450 km.

WEAPON SYSTEM: NUMBERS AND RELIABILITY

Pakistan claims to have miniaturised the weapon systems to fit into smaller delivery vehicles comprising cruise missiles, tactical nuclear missiles and potential MIRVs. In an earlier study, one of the authors[19] had estimated a

17. "China Resumes Production of its Quietest Attack Submarine", report in *The Diplomat,* January 6, 2017. See https://thediplomat.com/2017/01/china-resumes-production-of-its-quietest-attack-submarine/. Accessed on June 1, 2018.
18. Ibid.
19. Rajaram Nagappa, Arun Vishwanathan and Aditi Malhotra, "Hatf-IX/NASR – Pakistan's Tactical Nuclear Weapon: Implications for Indo-Pak Deterrence", NIAS Report No. R17-2013, July 2013.

Pakistan would have stockpiled 138 kg of plutonium by 2013. This quantity was estimated to be sufficient for 23 miniaturised weapons, and annually 5-6 weapons could be added to the inventory. At this rate, by the end of 2017, Pakistan would have accumulated 45-50 miniaturised weapon systems.

requirement of 6 kg of plutonium for a miniaturised weapon and the annual production of such miniaturised warheads. The assessment in the report was based on the known annual uranium production of 40 tonnes per annum in Pakistan and assumed that progressively all the uranium was used for conversion to plutonium. With this assumption, Pakistan would have stockpiled 138 kg of plutonium by 2013. This quantity was estimated to be sufficient for 23 miniaturised weapons, and annually 5-6 weapons could be added to the inventory. At this rate, by the end of 2017, Pakistan would have accumulated 45-50 miniaturised weapon systems. The question is: how is Pakistan going to apportion this small number among its delivery platforms?

The number of weapons available and the number of platforms available are mismatched and equipping all the platforms with nuclear weapons will be sub-critical. Pakistan will have to prioritise the platforms which will be equipped with nuclear weapons. It is logical to assume that the operational systems will be the current priority; the priority may change as other missiles graduate from development to operational status. The platforms needing miniaturised weapons are listed in Table 4.

Table 4: Pakistan Miniaturised Weapon Carrying Missiles

Name	Type	Status
Babur-2	Land attack cruise missile	Operational
Ra'ad	Air launched cruise missile	Operational
Hatf-9/NASR	Tactical nuclear weapon	Operational
Babur-3	Submarine launched cruise missile	Development
Ababeel	Multiple independently targeted reentry vehicle	Development

The Khalid class submarines have four bow-mounted torpedo tubes. The weapons complement will include torpedoes, Exocet SM-39 missiles and Babur-3 cruise missiles. As the mixed weapon load of torpedoes and missiles for the submarine is 16, it is surmised that four Babur-3 cruise missiles with nuclear warheads may find a place in each submarine. The level of reliability of the missile system for employment on a submarine is high and would call for a large number of proving and qualification tests before integration with the submarine. Even when a demonstrated reliability number for the missile may be available, the reliability of the nuclear warhead, with no record of testing, is open to question.

If major hostilities break out, the Indian Navy will endeavour to confine the Pakistani surface and sub-surface platforms to the Pakistani territorial waters. From these confines, the 250 km range of the Babur-3 is hardly of any consequence, as all major Indian cities will fall out of its range.

STRATEGIC BALANCE

Does the Babur-3 change the strategic balance? One can accept that a sea-based strike capability should add to the strategic stability. However, the Babur-3 falls short of this objective from the following considerations:

- Indian surveillance capabilities can keep track of submarines in port and their ingress and egress from port.
- If major hostilities break out, the Indian Navy will endeavour to confine the Pakistani surface and sub-surface platforms to the Pakistani territorial waters.
- From these confines, the 250 km range of the Babur-3 is hardly of any consequence, as all major Indian cities will fall out of its range.
- The short range will again prove to be of little consequence, even if the submarines venture out of the territorial waters.
- Even if Pakistan manages to increase the range of the cruise missile to 450 km, major cities of western India like Ahmedabad and Mumbai will be out of the reach of a missile fired from within the Pakistani coastal

waters. The issues mentioned in the previous bullet points hold good for the longer range missiles too.

- The exception to this will be the endurance of the Agosta (Khalid) class submarines which may permit crossover to India's east coast and bring more Indian cities within strike range. This will involve a long transit time as well as long task durations, requiring major skills and resources in avoiding Indian surveillance and defence strategies.
- The Pakistani ambiguity as to whether the submarines are carrying conventional weapons or strategic weapons will prompt the Indian Navy to prey on any submarine lurking in the conflict zones
- Besides the sub-criticality in the weapon assignment against many platforms mentioned in the previous section, it must be kept in mind that both Pakistan and India have carried out only a few nuclear tests. In the case of Pakistan, a further constraint is the absence of the test of any plutonium-based weapon. The safety and reliability requirements for weapon systems to be deployed on submarines are very demanding and serious compromises may have to be struck for fielding untested nuclear weapons on the Pakistani submarines.
- There could be a reduction in the compromises if technical help from China was available, but then, it is open to question why China would be interested in providing such technical assistance of a critical nature.
- For communication with submarines, Very Low Frequency (VLF) and Extremely Low Frequency (ELF) systems are used. VLF allows communication to the submarine in shallow waters to a depth of 10 m, while ELF allows greater depth penetration but at lower data rates. Pakistan is known to possess a VLF station at its naval base, PNS *Hameed,* in Sind province. The VLF array, quite visible from the air and space, will be an inviting target, to be neutralised at an early stage of hostility.
- Command and control issues come with their own challenges. The question of keeping the vehicle and warhead in a demated condition, which could be the practice with land-based weapons, is clearly impractical within the narrow confines of a submarine. It is understood

that Pakistan has underscored that nuclear weapons will remain under centralised control. However, in view of the communication challenges that are faced by most nations that adopt nuclear weapons as part of their triad, Pakistan may also be compelled to pre-delegate the authority for use of the nuclear weapon to the submarine commander, with some control enforced through the 'two-man rule'. There will be associated risks.

The points made above show that there are many vulnerabilities with the Babur-3 system and the weapon does not provide second strike capability of any significance to Pakistan. Nuclear weapons onboard submarines have associated challenges, and maintaining the safety and the readiness of the weapons at all time will be a demanding task. Pakistan faces major risks with the deployment of the Babur-3 on its communication and sub-surface assets from the Indian Navy. In the process, Pakistan has raised the risks for itself on a higher scale than the risks posed to India.

CONCLUSION

Pakistan has made a beginning with a sea-based deterrence using the torpedo tube launched cruise missile Babur-3. The missile does not meet the basic requirement of a second strike weapon, as its safety, stealth and survivability are no better than those of conventional submarines. More importantly, it has a limited targeting capability with the short range it possesses.

Pakistan can be expected to progress towards overcoming this shortcoming and work for a nuclear-powered submarine fielding long range ballistic missiles. The technology and financial needs towards this goal are challenging and involve long lead times.

APPENDIX 1

LIST OF SUBMARINE LAUNCHED CRUISE MISSILES IN THE WORLD

Name	Country	Propulsion	Weight (kg)	Warhead (kg)	Range (km)	Speed (km/hr)
Harpoon	USA	Turbojet	691	221	280	864
Exocet	France	Turbojet (Block3)	670	165	180	1,134
BGM-109B Tomahawk	USA	Turbofan	1,200	450	450	880
YJ-18B	China	Not available		140-300	220-540	Cruise: .8M, Terminal: 2.5-3 M
3M-54E1 Klub (SS-N-27 SIZZLER)	Russia	Turbojet	1,780	400	300	Cruise: 0.8M Terminal: 2.5/2.9M

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