MISSILE CAPABILITY OF PAKISTAN 2010–2020

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INTRODUCTION

In the past decade Pakistan's nuclear weapons and missile programme has expanded rapidly. The development and addition of new missiles in Pakistan's nuclear inventory during this time outnumbered the nuclear missiles developed in either of the previous two decades since Pakistan's first missile test in 1989.[1] These advances merit a study of the country's missile developments during this period.

Pakistan's research on rocketry began in the early 1960s at the Space Science Research Wing of the Pakistan Atomic Energy Commission (PAEC). Later, the research wing was established as a separate entity, Space and Upper Atmosphere Research Commission (SUPARCO). Pakistan's venture into ballistic missiles development began in SUPARCO and subsequently, the organisation emerged as the centre of its solid-fuel ballistic missile development programme.

National Engineering and Scientific Commission (NESCOM) is the primary military research organisation responsible for carrying out research

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1. Pakistan's nuclear inventory presently contains nine types of ballistic missiles and five types of cruise missiles. Among these, four types of ballistic missiles and three types of cruise missiles have been introduced and developed from 2010 to 2020. Out of fourteen missile types, seven new variants of missiles have been introduced in this time period.

Army Strategic Forces Command (ASFC) administers Pakistan Army's nuclear command and control mechanism. ASFC is responsible for training, deployment and activation of nuclear missiles.

for Pakistan's nuclear and ballistic missile development and production. NESCOM administers several defence development programmes, including National Defence Complex (NDC) and Air Weapon Complex (AWC). NDC is the single most important organisation for Pakistan's missile development programmes and credited with redesigning several ballistic missiles, originally developed by SUPARCO and PAEC. NDC also developed and conducted flight tests of Pakistan's first Ground Launched Cruise Missile Babur (Hatf-7).

Army Strategic Forces Command (ASFC) administers Pakistan Army's nuclear command and control mechanism. ASFC is responsible for training, deployment and activation of nuclear missiles. In February 2000, Pakistan instituted an elaborate command and control mechanism comprised of National Command Authority (NCA), Strategic Plan Division (SPD) and Strategic Forces Command. In 2006, the Pakistani government set up separate commands for all three services. The National Command Authority (NCA) is the highest decision-making body; the Strategic Plan Division (SPD) is in charge of developing and managing Pakistan's nuclear capability; and the Strategic Forces Command (SFC) is responsible for planning and control as well as operational directives for deployment of nuclear weapons.[2] Inter-Services Public Relations (ISPR) is the media wing of Pakistani military and operates as a unified public relations system for Pakistan Armed Forces.

In February 1989, Pakistan first tested two of its Hatf series of ballistic missiles—Hatf-I and Hatf-II (Abdali).[3] However, from the commencement of Pakistan's missile development programme, it is reported that foreign

2. Army Strategic Forces Command (ASFC), Globalsecurity.org, https://www.globalsecurity.org/wmd/world/pakistan/asfc.htm. Accessed on May 21, 2020.

3. "Pakistan Derives its First 'Hatf' Missiles from Foreign Space Rockets", *Wisconsin Project on Nuclear Arms Control*, October 1, 1995, https://www.wisconsinproject.org/pakistan-derives-its-first-hatf-missiles-from-foreign-space-rockets/. Accessed on May 20, 2020.

assistance primarily from China and North Korea has been forthcoming. This foreign assistance has mainly been in the form of transfers of missile technology, launchers and other related materials. Significant design similarities between various Chinese and Pakistani missiles have been observed by analysts studying missile proliferation.[4]

With four operational plutonium production reactors, uranium enrichment facilities and frequent tests of nuclear capable missiles, Pakistan's nuclear and missile programme is on its way to building Full Spectrum Deterrence capability and nuclear triad.

In the past decade, Pakistan's missile development programme has seen advances in building new missile technologies. The most significant technological developments include the deployment of Tactical Nuclear Weapon, development of the Multiple Independently Targetable Re-entry Vehicle (MIRV) technology, enhanced strategic standoff capability and development of Submarine Launched Cruise Missiles in order to complete the nuclear triad. While Pakistan is yet to completely develop and operationalise most of these technologies, the rapid pace of development has grown substantially in recent years through missile tests and suspected foreign assistance by China. With four operational plutonium production reactors, uranium enrichment facilities and frequent tests of nuclear capable missiles, Pakistan's nuclear and missile programme is on its way to building Full Spectrum Deterrence capability[5] and nuclear triad. According to a 2019 report on global nuclear warhead inventories by Stockholm International Peace Research Institute (SIPRI), presently the country has an estimated 150 to 160 warheads which include sophisticated miniaturised warheads. The

4. For more information on China-Pakistan nuclear proliferation network refer to Gordon Corera, *Shopping for Bombs: Nuclear Proliferation, Global Insecurity, and the Rise and Fall of the A.Q. Khan Network* (New York: Oxford University Press, 2009); Hassan Abbas, *Pakistan's Nuclear Bomb—A Story of Defiance, Deterrence, and Deviance* (Penguin-Allen Lane, 2018); Adrian Levy, *Deception: Pakistan, the United States, and the Secret Trade in Nuclear Weapons* (Walker Books, 2007).

5. ISPR press release no. PR-615/ 2017, December 21, 2017, https://www.ispr.gov.pk/press-release-detail.php?id=4459. Accessed on February 20, 2020.

number of warheads is more than India's estimated nuclear stockpile of 130-140 warheads, in the same year.[6]

SCOPE AND SOURCE

The scope of this paper is to highlight Pakistan's nuclear missile capabilities and the advancement of its nuclear missile programme from 2010 to 2020. During this period, several missile tests were carried out to reportedly improve guidance, propulsion and control features, along with enhanced range, accuracy and reduced circular error probabilities (CEP). Against this background, the paper also traces the development of new missile technologies, addition of new missiles in Pakistan's nuclear inventory, and also maps all the missile tests that have been conducted in those ten years.

The paper makes use of press releases issued by Pakistan's military media wing, the Inter-Services Public Relations (ISPR) Directorate to get the claimed technical parameters of Pakistan's missiles and improvements in their operational effectiveness. ISPR claims are then compared with additional information from transcripts of interviews of retired scientists from various sources and research reports of other think tanks. The assessment is based completely on information in the public domain. The paper begins by identifying the Ballistic and Cruise missiles as provided in Table 1.

BALLISTIC AND CRUISE MISSILES OF PAKISTAN

Presently, Pakistan has six types of nuclear capable ballistic missiles with three of them under development, i.e., Shaheen-III, Shaheen-1A and Ababeel. Based on a classification of their launch platforms, it has three types of cruise missiles—the Babur series of Ground/Submarine Launched Cruise Missiles (GLCM/SLCM) and the Air Launched Cruise missiles (ALCM) Ra'ad and Ra'ad-II. Of these the Babur-3 SLCM, Babur-2/1(B) GLCM and Ra'ad-2 ALCM are undergoing development. Apart from these, it is speculated that an ICBM—Taimur, with a range of 7,000 km—is under development by Pakistan.

6. Shannon N. Kile and Hans M. Kristensen, "Pakistani nuclear forces", World Nuclear Forces, *SIPRI Yearbook 2019*, accessed on December 4, 2019.

Table 1 summarises Pakistan's missiles with specific details. The missiles are listed on the basis of their range, from the longest to the shortest range.

Table 1: Pakistan's Ballistic and Cruise Missiles

Missile Name	Range	Type of the Missile	First Test	Remarks
Ballistic Missiles				
Shaheen-III	2,750 km	Surface to surface, two-stage, solid-fuel ballistic missile	March 9, 2015	Longest range missile in Pakistan's strategic arsenal. It is a road-mobile missile and reportedly mounted on a Chinese TEL. The missile is claimed to bring all parts of India under the range of Pakistan's missile.
Ababeel	2,200 km	Surface-to-surface, three-stage, solid-fuel ballistic missile	January 24, 2017	Reportedly capable of carrying MIRVs. Basic design shares resemblances with China's CSS–7/DF-11 missile.
Shaheen-II/ Hatf-6	1,500 km to 2,000 km	Road-mobile, solid-fuel, surface-to-surface ballistic missile	First displayed in March 2000 and first tested in March 2004	It is believed that the missile is based on PRC's M-18/DF 11. It is a two-stage version of Shaheen-I missile. The missile is in service since 2014.
Ghauri / Hatf-V	1,250-1,500 km	Road-mobile, liquid-fuelled, single-stage ballistic missile	First tested in 1998 In service since 2003	The only liquid-fuelled ballistic missile system of Pakistan. Launched from modified Russian 'Scud-B' Transporter-Erector-Launcher (TEL) vehicles. Nearly identical in appearance to North Korea's No Dong 1 missile.

Shaheen-1A (Hatf-IV)	900 km	Solid-fuel, road-mobile ballistic missile	April 25, 2012	Shaheen-1A is the extended-range version of Shaheen-1. It is presently under development. The missile's impact point was in the Arabian Sea. The missile is claimed to have advanced guidance system which makes it highly accurate.
Shaheen-1/ Hatf-IV	650 km	Solid-fuel, single-stage ballistic missile	April 1999	Flight tests may have begun as early as July 1997. Entered service with the Pakistani Army in 2003. It appears to be a scaled-up version of the Chinese DF-11 missile which Pakistan imported and possibly reverse engineered to develop Shaheen-1. In April 2013, the range of the missile was claimed to be 900 km.
Ghaznavi/ Hatf-III	290 km	Road-mobile, solid-fuel, single-stage ballistic missile	First tested in May 2002	The missile appears to be similar to a Chinese DF-11 variant. Entered service with the Pakistani Army in 2004. Flight tested six times in the last ten years.

Abdali/ Hatf-II	180 km	Road-mobile, single-stage, solid-fuel surface-to-surface ballistic missile	May 28, 2002 and entered service in 2005	ISPR claims that the missile system with its varied manoeuvrability options provides an "operational level capability" to Pakistan's Strategic Forces in additional to the strategic and tactical level capability, which Pakistan already possesses. Use of solid propellant decreases the preparation time and the TEL offers the advantage of effective mobility.
Hatf-IX/ Nasr	60-70 km	Surface-to-surface, solid-fuel, Tactical Nuclear Weapon (TNW)	April 19, 2011	The system is a quick reaction "shoot-and-scoot" missile. It appears that the missile is intended for battlefield use only. Tested eight times in the past decade. The missile is believed to be deployed in 2013.

Cruise Missiles (Three types of cruise missiles with land, air and sea launch capabilities)				
Missile Name	**Range**	**Type of the Missile**	**First test**	**Remarks**
Babur/ Hatf-VII	600-700 km	Turbojet powered, solid-fuel, terrain hugging, subsonic, Ground Launch Cruise Missile (GLCM)	August 12, 2005	It is designed to fly at low altitude to avoid radar detection. The storage facility of Babur at the Arabian Seaport of Ormara in Baluchistan province has recently been expanded massively. Both Babur and Ra'ad missiles are much slimmer than Pakistan's ballistic missiles, suggesting some success with warhead miniaturisation based on plutonium.
Babur-2/1(B)	700 km	Ground Launched Cruise Missile (GLCM)	December 14, 2016	An extended range version of Babur/Hatf-7. Babur Weapon System-2/1(B) is claimed to have incorporated advanced aerodynamics and avionics that can strike targets both at land and sea.

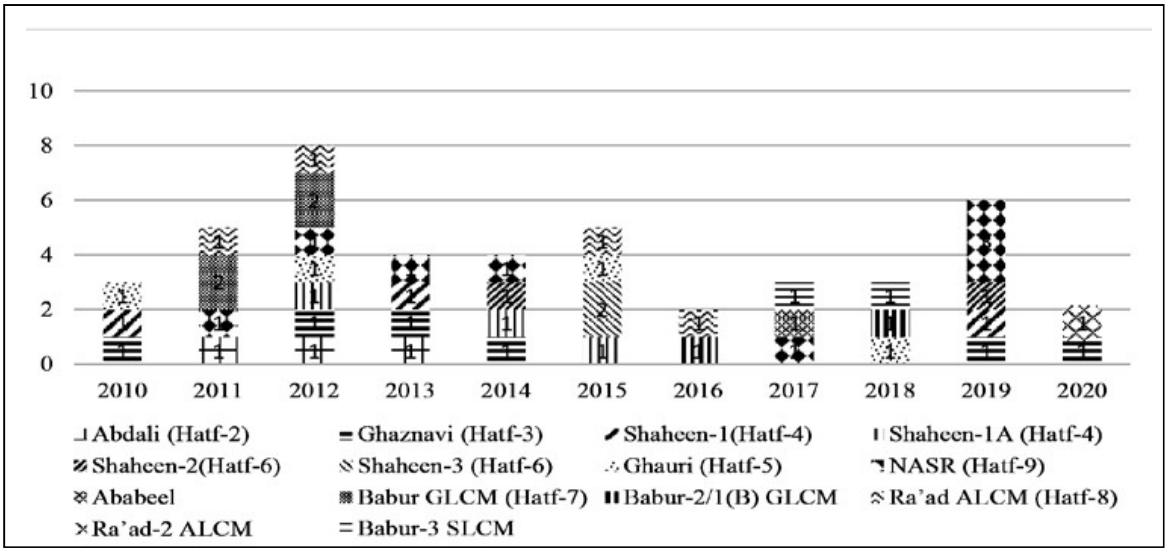
Babur-3	450 km	Submarine-Launched Cruise Missile (SLCM)	January 9, 2017	Babur-3 is a sea-based variant of Ground Launched Cruise Missile (GLCM) Babur-2. It has been test-launched twice from "an underwater, mobile platform" and "an underwater dynamic platform" from an undisclosed location in the Indian Ocean. The ISPR press statement says "the missile will provide Pakistan with a Credible Second-Strike Capability, augmenting deterrence." Once operational the Babur-3 will provide Pakistan with nuclear triad capability.
Ra'ad/ Hatf-8	350 km	Turbojet-powered, subsonic Air-Launched Cruise Missile (ALCM)	Test began in August 2007	Babur and Ra'ad are both much slimmer than Pakistan's ballistic missiles, suggesting some success with warhead miniaturisation based on plutonium instead of uranium.
Ra'ad-2	600 km	Nuclear capable Air-Launched Cruise Missile (ALCM)	February 18, 2020	Extended-range version of Ra'ad missile. The test is claimed to have enhanced the air delivered strategic standoff capability of the military on land and at sea.

TRENDS IN TESTING: 2010 TO 2020

Having documented the various kinds of ballistic and cruise missiles in the above section, the paper examines the trends evident through missile

tests. Fig. 1 presents a graphical representation of these tests over the years. The data is organised in chronological order, from 2010 to 2020. An examination of the figure reveals that in the last decade Pakistan has added seven new missile types to the already existing missile inventory. These additions include Nasr missile in 2011, Shaheen-1A in 2012, Shaheen-3 in 2015, Babur-2 cruise missile in 2016, Ababeel and Babur-3 missiles in 2017 and Ra'ad-2 missile in 2020. Missiles which were tested frequently are Nasr (eight times), Ghaznavi (six times), Abdali (three times), Shaheen-1A (three times), Ghauri (four times), Babur and Babur-2 (six times) and Ra'ad and Ra'ad-2 (four times).

Figure 1: Pakistan's Nuclear Missile Tests: 2010–2020



It can be observed that missiles of all ranges were tested multiple times, ranging from the relatively short-range missiles, i.e., Nasr (70 km), Abdali (180 km), Ghaznavi (290 km) along with the relatively long-range missiles, i.e., Ghauri (1,300 km), Shaheen-1A (900 km), Shaheen-III (2,750 km) and Ababeel (2,200 km). In the case of ballistic missiles, Pakistan has primarily emphasised the development of road-mobile, solid-fuel, relatively short-range missile systems. The number of tests for the short-range systems were more than the long-range systems. Similarly, with the

introduction of three new missile types, the last five years have marked significant progress in building cruise missile capability. The three cruise missile systems—the Babur, Ra'ad, and the naval variant of the Babur—are also suitable for short-range targeting. Overall, from 2010 to 2019, 43 missile tests have been conducted with almost five tests in a year on an average. Each of these tests was claimed to be successful by ISPR, whereas no official information on failed missile tests is available in the public domain.

These trends indicate two main objectives of Pakistan's nuclear development programme. Frequent testing of short-range missiles indicates a possible shift towards light-weight and more compact plutonium-based warheads to counter India's conventional superiority by use of low-yield nuclear weapons at the tactical level, thereby escalating the conflict to nuclear level. Second, the main objective towards developing relatively longer-range missiles with sophisticated technologies like multiple warhead technology is obviously to achieve Full Spectrum Deterrence capability.

Table 2: Pakistan's Nuclear Missile Tests: 2010–2020

Year	Missile Name	Range	Type of Missile	Remarks
May 8, 2010	Ghaznavi (Hatf-III)	290 km	Road-mobile, surface-to-surface, solid-fuel, single-stage ballistic missile	The test was conducted at the conclusion of the annual field training exercises of Army Strategic Forces Command, which were aimed at testing the operational readiness of Strategic Missile Groups.

May 8, 2010	Shaheen-I (Hatf-IV)	650 km	Solid-fuel, single-stage ballistic missile	The launch was conducted at the training exercise of Army Strategic Forces Command* to test the readiness of Strategic Missile Groups equipped with Ghaznavi and Shaheen missile systems.
December 21, 2010	Ghauri (Hatf-V)	1,300 km	Road-mobile, Liquid-fuelled, single-stage ballistic missile	The test was a training launch aimed at testing the operational readiness of the Army Strategic Force.
February 10, 2011	Babur (Haft VII)	600 km	Turbojet-powered, solid-fuel, terrain hugging, subsonic, Ground Launch Cruise Missile (GLCM)	The missile has stealth capabilities, is a low flying, terrain hugging missile with high manoeuvrability, radar avoidance capability and pinpoint accuracy. It also incorporates the TERCOM and DSMAC technologies. No mention of use of MLV.

March 11, 2011	Abdali (Hatf-II)	180 km	Road-mobile, single-stage solid propellant surface-to-surface ballistic missile	It was stated that the Abdali weapons system provides Pakistan with an operational level capability, additional to the strategic level capability, which Pakistan already possesses because of its medium-range and long-range ballistic missile systems.
April 19, 2011	Nasr (Hatf-IX)	70 km	Surface-to-surface, solid-fuel, Tactical Nuclear Weapon (TNW)	First flight test of the newly developed surface-to-surface ballistic Missile Hatf-IX (Nasr). The missile has been developed to add deterrence value to Pakistan's Strategic Weapons Development programme at shorter ranges. The Nasr Weapon System now provides Pakistan with short-range missile capability in addition to the already available medium and long-range ballistic missiles and cruise missiles in its inventory.

April 29, 2011	Ra'ad (Hatf-8)	350 km	Turbojet-powered, subsonic Air Launched Cruise Missile (ALCM)	The missile test was conducted as part of the continuous process of improving the technical parameters of the weapon system. Press release is same as 2012 test.
October 28, 2011	Babur (Hatf-VII)	700 km	Turbojet-powered, solid-fuel, terrain hugging, subsonic, Ground Launch Cruise Missile (GLCM)	The range has increased by 100 km from the last test in February 2011 (the declared range was 600 km). The test was conducted to validate design parameters of the weapon system and a new missile launch vehicle (MLV). The three-tube MLV enhances the targeting and deployment options in the conventional and nuclear modes. With its shoot-and-scoot capability, the MLV provides a major force multiplier effect for target employment and survivability.

March 5, 2012	Abdali (Hatf-II)	180 km	Road mobile, single-stage solid propellant surface-to-surface ballistic missile	It provides an operational level capability to Pakistan's Strategic Forces in addition to the strategic and tactical level capability, which Pakistan already possesses.
April 25, 2012	Shaheen-1A (Hatf-IV)	Not mentioned	Solid-fuel, road-mobile ballistic missile	First test of the missile. The missile is an improved version of Shaheen-1 with improvements in range and technical parameters. No mention of the range.
May 10, 2012	Ghaznavi (Hatf-III)	290 km	Road-mobile, surface-to-surface, solid-fuel, single-stage ballistic missile	The missile appears to be similar to a Chinese DF-11 variants. Entered service with the Pakistani Army in 2004.
May 29, 2012	Nasr (Hatf-IX)	70 km	Surface-to-surface, solid-fuel, Tactical Nuclear Missile (TNW)	The Director General Strategic Plans Division stated that it will consolidate Pakistan's deterrence capability at all levels of the threat spectrum.

May 31, 2012	Ra'ad (Hatf-8)	350 km	Turbojet-powered, subsonic Air Launched Cruise Missile (ALCM)	Enables Pakistan to achieve strategic standoff capability on land and at Sea. Ra'ad Cruise Missile with Stealth Capabilities is a Low Altitude, Terrain Hugging Missile with high manoeuvrability, can deliver nuclear and conventional warheads with pinpoint accuracy. According to the claim by ISPR, it employed fully automated Strategic Command and Control Support System (SCCSS) which enabled robust Command and Control capability of all strategic assets with round the clock situational awareness in a digitised network centric environment to decision makers at National Command Centre (NCC).

June 5, 2012	Babur (Hatf-VII)	700 km	Turbojet-powered, solid-fuel, terrain hugging, subsonic, Ground Launch Cruise Missile (GLCM)	It is a low flying, terrain hugging missile, which can strike targets both at Land and Sea with precision and high manoeuvrability. It carries stealth features. Equipped with modern cruise missile technology of Terrain Contour Matching (TERCOM) and Digital Scene Matching and Area Co-relation (DSMAC). The missile was launched from missile launch vehicle (MLV), which enhances the targeting and deployment options of Babur Weapon system.
September 17, 2012	Babur (Hatf-VII)	700 km	Turbojet-powered, solid-fuel, terrain hugging, subsonic, Ground Launch Cruise Missile (GLCM)	Missile specifications same as June 2012 test.

November 28, 2012	Ghauri (Hatf-V)	1,300 km	Road-mobile, Liquid-fuelled, single-stage ballistic missile	The test monitoring of the launch was conducted at the National Command Centre through the medium of National Command Authority's fully automated Strategic Command and Control Support System (SCCSS).
February 15, 2013	Abdali (Hatf-II)	180 km	Road-mobile, single-stage solid propellant surface-to-surface ballistic missile	The weapon system with its varied manoeuvrability options provides an operational level capability to Pakistan's Strategic Forces.
April 10, 2013	Shaheen I (Hatf-IV)	900 km	Solid-fuel, single-stage ballistic missile	The missile incorporates a series of improvements in range and technical parameters. The range was mentioned as 900 km.

November 5, 2013	Nasr (Hatf-IX)	70 km	Surface-to-surface, solid-fuel, Tactical Nuclear Missile (TNW)	The test fire was conducted with successive launches of 4 x Missiles from a Multi-Tube Launcher with Salvo Mode. Nasr has in-flight manoeuvre capability and is a quick response system, with shoot-and-scoot attributes. Nasr has been specially designed to defeat all known Anti-Tactical Missile Defence Systems. It contributes to the full spectrum deterrence against the prevailing threat spectrum.
April 22, 2014	Ghaznavi (Hatf-III)	290 km	Road-mobile, surface-to-surface, solid-fuel, single-stage ballistic missile	The successful launch concluded the Field Training Exercise of Strategic Missile Group of Army Strategic Forces Command.
May 8, 2014	Ghaznavi (Hatf-III)	290 km	Road-mobile, surface-to-surface, solid-fuel, single- stage ballistic missile	The test launch was the culminating point of the Field Training Exercise of Army Strategic Forces Command which was aimed at testing the operational readiness of a Strategic Missile Group besides up gradation of various capabilities of Weapon Systems.

September 26, 2014	Nasr (Hatf-IX)	70 km	Surface-to-surface, solid-fuel, Tactical Nuclear Missile (TNW)	The official statement was same as November 5, 2013 test. No significant developments.
November 13, 2014	Shaheen II (Hatf -VI)	1,500 km	Road-mobile, solid-fuel, surface-to-surface ballistic missile	Aimed at achieving Full Spectrum Credible Minimum Deterrence. Under development; expected to become operational soon.
November 17, 2014	Shaheen-1A	900 km	Solid-fuel, road-mobile ballistic missile	Aimed towards achieving Pakistan's Full Spectrum Credible Minimum Deterrence Capability.
February 2, 2015	Ra'ad	350 km	Turbojet-powered, subsonic Air Launched Cruise Missile (ALCM)	No details about the test are available on ISPR website. According to a media report, the Pakistani Army described the missile as a low altitude, terrain hugging missile with Strategic standoff capability.[1]
March 9, 2015	Shaheen-III	2,750 km	Surface-to-surface, two-stage, solid-fuel ballistic missile.	The test launch was aimed at validating various design and technical parameters of the weapon system at maximum range. The missile is under development by National Defence Complex.[2]

April 15, 2015	Ghauri (Hatf-V)	1,300 km	Road-mobile, Liquid-fuelled, single-stage ballistic missile	Unlike solid-fuel missiles, liquid-fuelled ballistic missiles cannot store the fuel for long periods and have to be refuelled prior to launch, which takes several hours, thus making them vulnerable to first strikes. Given the relative lack of Pakistan's strategic depth, such systems are not the first choice for nuclear warhead delivery—a possible reason that Ghauri remains the only liquid-fuelled system in Pakistan's missile inventory and no other liquid-fuelled missile was developed after Ghauri. It is believed to be a variant of North Korea's Nodong-1/Rodong-1 missile.
December 11, 2015	Shaheen-III	2,750 km	Surface-to-surface, two-stage, solid-fuel ballistic missile.	The flight test was conducted with its impact point in the Arabian Sea.

December 15, 2015	Shaheen-1A	900 km	Solid-fuel, road-mobile ballistic missile.	Shaheen-1A is claimed to have a sophisticated and advanced guidance system which makes it a highly accurate missile system. The flight test was aimed at revalidating several design and technical parameters of the weapon system.
January 19, 2016	Ra'ad (Hatf-8)	350 km	Turbojet-powered, subsonic Air Launched Cruise Missile (ALCM)	The missile enables Pakistan to achieve air delivered strategic standoff capability on land and at sea. Terrain hugging capability of the missile enables it to avoid detection and engagement by contemporary defence systems.
December 14, 2016	Babur-2/1(B)	700 km	Ground Launched Cruise Missile (GLCM)	Pakistan conducted successful test of an enhanced version of the indigenously developed Babur (Hatf-7) Cruise Missile. Babur Weapon System version 2 incorporates advanced aerodynamics and avionics that can strike targets both at land and sea with high accuracy.

January 9, 2017	Babur-3	450 km	Submarine-Launched Cruise Missile (SLCM)	First successful test fire of the Submarine Launched Cruise Missile (SLCM). Babur-3 is a sea-based variant of Ground Launched Cruise Missile (GLCM) Babur-2. The missile will provide Pakistan with a Credible Second-Strike Capability. Once operational the Babur-3 will provide Pakistan with a nuclear triad.
January 24, 2017	Ababeel	2,200 km	Surface-to-surface, three-stage, solid-fuel ballistic missile	First successful flight test. The missile has MIRV technology. Aim is to ensure survivability of Pakistan's ballistic missiles in the growing regional Ballistic Missile Defence (BMD) environment. Ababeel Missile System has ushered in a new era in technological sophistication of Pakistan's strategic capabilities.

July 5, 2017	Nasr (Hatf-IX)	70 km	Surface-to-surface, road-mobile, solid-fuel, Tactical Nuclear Missile (TNW)	Nasr is a high-precision weapon system with the ability of quick deployments. Chief of Army Staff (COAS) said "Nasr has put cold water on Cold Start."
February 11, 2018	Nasr (Hatf-IX)	70 km	Surface-to-surface, road-mobile, solid-fuel, Tactical Nuclear Missile (TNW)	The system is a quick reaction "shoot-and-scoot" missile. Nasr has been specially designed to defeat all known Anti-Tactical Missile Defence Systems.
March 29, 2018	Babur-3	450 km	Submarine-Launched Cruise Missile (SLCM)	The missile was fired from an underwater dynamic platform. The missile is claimed to have technologies like underwater controlled propulsion, advanced guidance and navigation features. It was stated that once operational, SLCM Babur will provide Pakistan Credible Second-Strike Capability, augmenting the existing deterrence regime.

April 14, 2018	Babur-2/ 1(B)	700 km	Low flying, terrain hugging Ground Launched Cruise Missile, which also carries certain stealth features.	An enhanced range version of the indigenously developed Babur Cruise Missile. Equipped with TERCOM and DSMAC, thus making it an important force multiplier for Pakistan's strategic deterrence. Babur Weapon System-1 (B) incorporates advanced aerodynamics and avionics that can strike targets both at land and sea.
October 8, 2018	Ghauri (Hatf-V)	1,300 km	Road-mobile, Liquid-fuelled, single-stage ballistic missile	The launch consolidates Pakistan's nuclear capability through a credible deterrence regime.

January 24, 28 and 31, 2019	Nasr (Hatf-IX)	70 km	Surface-to-surface, solid-fuel, Tactical Nuclear Missile	January 24: This Weapon System has augmented Full Spectrum Deterrence posture remaining within the precincts of policy of Credible Minimum Deterrence. Tested quad salvo on January 24, and single shots on January 28 and 31, 2019. According to ISPR statement, the second phase of this exercise was aimed at testing the extreme in-flight manoeuvrability, including the end-flight manoeuvrability It was also claimed that the Nasr is capable of defeating, by assured penetration, any currently available BMD system.
May 23, 2019	Shaheen-II	1,500 km	Road-mobile, solid-fuel, surface-to-surface ballistic missile.	The training launch of the missile was conducted to ensure operational readiness of Army Strategic Forces Command.
August 29, 2019	Ghaznavi/ Hatf-3	290 km	Road-mobile, surface-to-surface, solid-fuel, single-stage ballistic missile	It was a night training launch. Ghaznavi, capable of delivering multiple types of warheads.

November 18, 2019	Shaheen-I	650 km	Surface-to-surface, solid-fuel, single-stage ballistic missile	Capable of delivering all kinds of warheads. As claimed by ISPR press statement, the test ensures Pakistan's Credible Minimum Deterrence.
January 23, 2020	Ghaznavi	290 km	Road-mobile, surface-to-surface, solid-fuel, single-stage ballistic missile.	The latest missile test by Pakistan Army comes days after India test-launched the submarine-launched K-4 ballistic missile. According ISPR the test was aimed at rehearsing operational readiness procedures during day and night.
February 18, 2020	Ra'ad-II	600 km	Nuclear capable Air Launched Cruise Missile (ALCM)	The test is claimed to have enhanced the air delivered strategic standoff capability of the military on land and at sea.

Notes: *Pakistan Army Strategic Forces Command operates Hatf-II (Abdali), Hatf-III (Ghaznavi), Hatf-IV (Shaheen-1), Hatf-V(Ghauri), Hatf-VI (Shaheen), Babur Cruise Missile and Ra'ad Missile.

1. "Pakistan successfully test fires new stealth cruise missile", First Post, February 2, 2015 https://www.firstpost.com/world/pakistan-successfully-test-fires-new-stealth-cruise-missile-2075503.html
2. National Defence Complex (NDC) or National Development Complex is the primary facility of Pakistan's nuclear weaponisation programmes including missile development programmes. NDC has designed and improved several models of Pakistan's missile including Hatf-2/Abdali, Hatf-3/Ghaznavi, Hatf-4/Shaheen-1, Hatf-6/Shaheen-2 missiles and Hatf-7/Babur, Pakistan's first land attack cruise missile.

CAPABILITY ASSESSMENT

Ballistic Missile Capability

Presently, Pakistan has six types of surface-to-surface nuclear capable ballistic missiles. Among these missiles, Ababeel, Shaheen-1A and Shaheen-III are under development. The ballistic missile inventory also contains six operational nuclear capable missiles, this includes relatively short-range Abdali, Ghaznavi, Shaheen-I and Nasr and the medium-range Ghauri and Shaheen-II. In this, Ghauri is the only liquid fuel missile system; all other ballistic missiles are solid propellant systems.

In the last ten years Pakistan has added four new land-based ballistic missile systems to its already existing missile systems. This includes, addition of Shaheen-III with a range of 2,750 km, Shaheen-1A with a range of 900 km, tactical nuclear missile Nasr with a range of 60 km which was upgraded to 70 km, and the relatively long-range ballistic missile Ababeel (range 2,200 km). With this Pakistan's ballistic missile inventory contains three relatively short-range ballistic missiles, i.e., Nasr, Ghaznavi and Abdali and six relatively longer-range missiles, i.e., Ghauri, Shaheen-I, Shaheen-1A, Shaheen-II, Shaheen-III and Ababeel.

The development of land-based ballistic missile force in the last decade also includes eight or nine missile garrisons, including four or five along the Indian border for short-range systems (Babur, Ghaznavi, Shaheen-I, Nasr) and three or four other garrisons further inland for medium-range systems (Shaheen-II and Ghauri).[7]

Several flight tests of each of these systems have been conducted over the past ten years to achieve improved performance, targeting and accuracy parameters. In order to understand these developments in the past one decade, the following detailed analysis presents some significant and newly developed missiles in Pakistan's missile inventory.

Nasr (Hatf IX): Among the new additions in Pakistan's ballistic missile inventory, one of the most significant developments is tactical nuclear weapon

7. Ibid.

(TNW) Nasr (Hatf-IX). Nasr missile was developed to counter India's "Cold Start" doctrine. As, Pakistan's nuclear weapons development accelerated, it decided to use nuclear weapons as a shield behind which it could support terrorist groups fighting India, both in Jammu and Kashmir and other parts of India. Pakistan's strategy behind this was using the threat of escalation to the nuclear level to keep India from considering a full-scale conventional response to Pakistan's support for terrorism.[8]

Pakistan developed TNWs in an attempt to lower the nuclear threshold by using low-yield battlefield nuclear weapon Nasr. Thus, according to Pakistani thinking, one of the methods of increasing conventional deterrence is through the introduction of low-yield nuclear weapons.

The Indian Army introduced the Cold Start doctrine in 2004 after the Kargil War and the 2001 terrorist attack on the Indian Parliament with the objective of launching a swift, conventional limited strike against Pakistan in response to Pakistan's proxy war in the form of terrorist attack on Indian soil.[9] Under the Cold Start doctrine, a massive Indian offensive in terms of six to eight Integrated battle groups (IBGs) launched over a wide front significantly increases the challenge for Pakistani intelligence's limited reconnaissance assets to monitor the status of all the IBGs, improving the chance of surprise.[10] In response to this, Pakistan developed TNWs in an attempt to lower the nuclear threshold by using low-yield battlefield nuclear weapon Nasr. Thus, according to Pakistani thinking, one of the methods of increasing

8. Rajesh Rajagopalan, "India's Doctrinal Options" in Gurmeet Kanwal and Monica Chansoria, eds., *Pakistan's Tactical Nuclear Weapons*, (New Delhi: KW Publishers, 2014) in association with Centre for Land Warfare Studies, New Delhi.

9. For more information on Cold Start Doctrine refer to Rajaram Nagappa, Arun Vishwanathan and Aditi Malhotra, "Hatf-IX/NASR—Pakistan's Tactical Nuclear Weapon: Implications for Indo-Pak Deterrence", Report no. R17-2013, July 2013, International Strategic and Security Studies Programme, National Institute of Advanced Studies, Bangalore, accessed on January 11, 2020.

10. Arun Sahgal, "Logic and Options for Use" in Gurmeet Kanwal and Monica Chansoria, eds., *Pakistan's Tactical Nuclear Weapons*, (New Delhi: KW Publishers, 2014) in association with Centre for Land Warfare Studies, New Delhi.

conventional deterrence is through the introduction of low-yield nuclear weapons. It is in this context that Pakistan's decision to develop TNW should be seen. Pakistan appears willing to pay the price to make nuclear deterrence more effective at the conventional level by taking tactical risk.[11]

The significance of this missile system in Pakistan's nuclear posture is evident from the fact that the missile has been tested the most (eight times) in the past one decade. The first successful test launch of the short-range, surface-to-surface, solid-fuel quick reactionary shoot-and-scoot tactical ballistic missile system Nasr (Hatf-IX) was conducted on April 19, 2011. The latest version of Nasr is capable of delivering a low-yield nuclear weapon to a range of up to 70 km, at initial stage the declared range was 60 km. The US intelligence community has listed Nasr as a deployed system since 2013.[12]

After the first test flight of the missile in April 2011, Pakistan's Inter-Services Public Relations (ISPR) stated that "The missile has been developed to add deterrence value to Pakistan's Strategic Weapons Development programme at shorter ranges."[13] But with a range of 60 km (at initial stage), the weapon system appears to be more suitable for theatre specific battlefield use rather than use against cities or strategic target and for the same reason, the Nasr seems to fall under the category of tactical or non-strategic weapon, rather than weapon intended for strategic deterrence. Also, some experts state that the missile launcher used during the test had similarities with Chinese DF-10 ground-launched cruise missile or A-100 multiple rocket launcher.[14]

In the later phase of development during the May 2012 test, Pakistan described the Nasr as a "weapon of peace… which will consolidate Pakistan's deterrence capability at all levels of the threat spectrum", a likely reference to Nasr's intended use in limited conventional warfare to seek parity with

11. Ibid.

12. National Air and Space Intelligence Centre (NASIC). 2013. "Ballistic and Cruise Missile Threat." https://fas.org/programs/ssp/nukes/nuclearweapons/NASIC2013_050813.pdf.

13. ISPR report No. PR-94/2011-ISPR, April 19, 2011, accessed on November 29, 2019.

14. Hans M. Kristensen, Robert S. Norris and Julia Diamond (2018), "Pakistani nuclear forces", 2018, *Bulletin of the Atomic Scientists*, 74:5, 348-58.

India's conventional force.[15] The test was followed by another one in May 2013 from a multi-tube launcher, where the weapon system was claimed to have "in-flight manoeuvre capability" and for the first time the missile system was also claimed to contribute towards full spectrum deterrence, a concept which was first anticipated during the first test of Nasr in 2011.[16] Pakistan explains its need for full spectrum deterrence capability to put forward a threat to deter India of varied ranges of missiles and at all levels of the threat spectrum. The doctrine elucidates Pakistan's evolving counterforce targeting options with the inclusion of tactical nuclear weapon to deter limited Indian conventional military operations at the lowest level of engagement (counterforce targeting).

Successive test launches of Nasr were conducted in September 2014, July 2017 and January 2019. In 2017 an enhanced range (70 km) version of the missile was tested and the ISPR statement noted that "the missile system will augment credible deterrence against [the] prevailing threat spectrums more effectively, including anti-missile defences."[17] The statement is a direct indication of Pakistan's rising concern about survivability of its missile systems, at a time when India has been developing and procuring a range of ballistic missile defence systems. Also, the test launch came after former Indian Army Chief General Bipin Rawat's public acknowledgment of the existence of Cold Start doctrine during an interview, as he stated that "The Cold Start doctrine exists for conventional military operations."[18]

The latest three tests (till January 2020) of the Nasr were conducted in January 2019. The ISPR press release noted that the "exercise was aimed at testing the extreme inflight manoeuvrability, including the end flight

15. ISPR report No PR-130/2012-ISPR, May 29, 2012, https://www.ispr.gov.pk/press-release-detail.php?id=2075.
16. ISPR report No PR-179/2013-ISPR, November 5, 2013, https://www.ispr.gov.pk/press-release-detail.php?id=2409.
17. ISPR report No PR-344/2017-ISPR, July 5, 2017, https://www.ispr.gov.pk/press-release-detail.php?id=4097.
18. Sandeep Unnithan, "We will cross again" an interview with India's newly appointed Army Chief General Bipin Rawat, *India Today*, January 7, 2017, https://www.indiatoday.in/magazine/interview/story/20170116-lt-general-bipin-rawat-surgical-strikes-indian-army-985527-2017-01-04.

Claim by Pakistan of using Nasr against India's ballistic missile defence (BMD) system is ambiguous considering the fact that India's BMD system is intended to be installed primarily near New Delhi and in a later phase near Mumbai to provide necessary missile shield to these important cities.

manoeuvrability."[19] It also claimed that the missile system offers security against "adversary's ballistic missile defence system and other air defence systems". Here, it is important to note that the credibility of Nasr missile against missile defence systems was not mentioned before the September 2014 test. With the development and procurement of India's ballistic missile defence systems over the last decade, the Nasr missile is now being further considered to provide security against the missile defence systems. Also, the missile tests came days after the US released the 2019 Missile Defence Review, which noted that "There are now a number of states in South Asia that are developing an advanced and diverse range of ballistic and cruise missile capabilities. Within this context, the United States has discussed potential missile defense cooperation with India."[20]

Here, it is noteworthy that the claim by Pakistan of using Nasr against India's ballistic missile defence (BMD) system is ambiguous considering the fact that India's BMD system is intended to be installed primarily near New Delhi and in a later phase near Mumbai to provide necessary missile shield to these important cities. Whereas, the primary objective of Nasr missile system is to use it in battlefield for counterforce targeting. Moreover, the range of Nasr missile is too small to reach these cities where BMD systems will be installed.

Abdali (Hatf-II): Apart from Nasr, Pakistan has deployed another short-range, land-based, single-stage, dual-capable ballistic missile, the Abdali (Hatf-II) with declared range of 180 km. The Abdali programme began in

19. ISPR report No PR-37/2019-ISPR, January 31, 2019, https://www.ispr.gov.pk/press-release-detail.php?id=5179.

20. *Missile Defense Review*, Department of Defense, United States of America, https://media.defense.gov/2019/Jan/17/2002080666/-1/-1/1/2019-MISSILE-DEFENSE-REVIEW.PDF.

the 1980s but was terminated in 1994. In 1997, Pakistan restarted work on a new design for the missile with a reduced range and flight testing resumed in 2002.[21] After a long gap of several years, the SRBM was tested again in March 2011, March 2012 and February 2013. ISPR stated that, "The weapon system with its varied manoeuvrability options provides an operational level capability to Pakistan's Strategic Forces" in addition to the already existing "strategic and tactical level capability",[22] although its use as operational nuclear weapon to engage objects in the operational depth of the enemy deployment might be limited considering its relatively small warhead limits. But its high-precision ability could be used to target military targets and critical infrastructures. The system is also claimed to be highly accurate and capable of carrying nuclear and conventional warheads. After three successful tests the missile is believed to have been first deployed in 2015.[23] An article in *The Washington Quarterly* noted that with the development of Nasr and Abdali, Pakistan has opted for flexible response and these systems will help in escalation control by preventing use of countervalue nuclear weapons at the early stage of conflict.[24]

As displayed in a military parade in 2015 the missile was carried on a road-mobile Transporter Erector Launcher (TEL) vehicle.[25] As the missile is solid-fuel, this road-mobile launcher offers the advantage of effective mobility, thus increasing its evasiveness and range.

Along with Abdali, Pakistan also has other missile systems which have been developed pre-2010, i.e., solid-fuel ballistic missile Ghaznavi with a

21. Shannon N. Kile, Phillip Schell and Hans M. Kristensen, "Pakistani Nuclear Forces", *SIPRI Yearbook 2012: Armaments, Disarmament and International Security,* pp. 337-40.

22. ISPR report No PR-20/2013-ISPR, February 15, 2013, https://www.ispr.gov.pk/press-release-detail.php?id=2242.

23. "Pakistani nuclear forces", January 2018, *SIPRI Yearbook 2018: Armaments, Disarmament and International Security.* p. 274.

24. Sadia Tasleem and Toby Dalton, "Nuclear Emulation: Pakistan's Nuclear Trajectory", *The Washington Quarterly*, 41:4, 135-55, 2008, https://doi.org/10.1080/0163660X.2018.1558662, accessed on January 16, 2020.

25. Missile Defense Project, "'Hatf-2' 'Abdali', *Missile Threat*, Center for Strategic and International Studies, October 25, 2016, last modified June 15, 2018, https://missilethreat.csis.org/missile/hatf-2/.COPY.

Pakistan's National Defence Complex is developing the Ababeel ballistic missile that is claimed to have multiple independently targetable re-entry vehicle (MIRV) capabilities. The solid-fuel, three-stage missile with a reported range of 2,200 km was unveiled on January 24, 2017.

range of 290 km, the air launched cruise missile Ra'ad with a range of 350 km, Shaheen-1 with a range of 650 km and ground launched cruise missile Babur-2 with a range of 700 km. While potential counterforce deployment of these missiles is uncertain, the Abdali and Ghaznavi are particularly noteworthy because of their potential operational level capability. They allow Pakistan to launch on lofted trajectories, thereby avoiding operational risks like pre-emptive attack and degradation or loss of command and control, which are associated with forward deployments. These missiles can carry payloads greater than the Nasr, and thus can be armed with higher-yield warheads.[26]

Ababeel: Pakistan's National Defence Complex is developing the Ababeel ballistic missile that is claimed to have multiple independently targetable re-entry vehicle (MIRV) capabilities. The solid-fuel, three-stage missile with a reported range of 2,200 km was unveiled on January 24, 2017. The official statement noted that the "missile is capable of delivering multiple warheads, using MIRV technology… Development of Ababeel Weapon System is aimed at ensuring survivability of Pakistan's ballistic missiles in the growing regional Ballistic Missile Defence (BMD) environment."[27] Pakistan's claim of MIRV technology has not been verified and remains a point of debate. It is also not certain if the technology was used during the test launch. MIRV technology requires a broad degree of technical sophistication and Pakistan might have taken

26. Jaganath Sankaran, "The Enduring Power of Bad Ideas: 'Cold Start' and Battlefield Nuclear Weapons in South Asia." *Arms Control Today*, vol. 44, no. 9, 2014, pp. 16–21. JSTOR, www.jstor.org/stable/24336477. Accessed on February 2, 2020.

27. ISPR report No PR-34/2017-ISPR, January 24, 2017, https://www.ispr.gov.pk/press-release-detail.php?id=3705

external assistance to successfully develop it. Analysts note that Pakistan would have had to overcome a number of technical challenges before claiming to develop successful MIRV technology. Similarly, miniaturised warhead is a requirement for MIRV system but till date Pakistan has not demonstrated any such capability.[28] Since its introduction in 2017, no other tests of the Ababeel missiles are known to have taken place (till January 2020) which also indicates that the missile system is at a nascent stage of development and requires more testing before successful deployment. In this regard, in 2018 it was reported that China has sold Pakistan a powerful tracking system that could boost Pakistan's development of missiles that are capable of delivering multiple warheads.[29] The Chinese Academy of Science announced the deal and specified that, "An optical system is a critical component in missile testing. It usually comes with a pair of high-performance telescopes equipped with a laser ranger, high-speed camera, infrared detector and a centralised computer system that automatically captures and follows moving targets."[30] This report further strengthens the possibility of external assistance for the development of MIRV technology.

Shaheen-I: Shaheen-I is a single stage, solid-fuel ballistic missile with a range of 650 km that has been in service since 2003. Since 2010, the missile system has been test fired twice in 2013 and 2019. The missile is launched from road-mobile TELs.

Since 2012, Pakistan's National Defence Complex is developing additional variant of Shaheen missile. An extended range version of the Shaheen-I missile—Shaheen-1A is under development with an estimated range of 900 km. In 2013, a test launch of Shaheen-I missile was conducted

28. Rajaram Nagappa, "Does Pakistan's Ababeel Medium Range Ballistic Missile Really Have MIRV Capability?", *Delhi Defence Review* (blog), February 3, 2017, http://delhidefencereview.com/2017/02/03/does-pakistans-ababeel-medium-range-ballistic-missile-really-have-mirv-capability/

29. Stephen Chen, "China provides tracking system for Pakistan's missile programme", *The South China Morning Post,* March 22, 2018, https://www.scmp.com/news/china/society/article/2137643/china-provides-tracking-system-pakistans-missile-programme. Accessed on February 4, 2020.

30. Ibid.

Pakistan is also developing a road-mobile, solid-fuel, two-stage ballistic missile—Shaheen-III with a range of 2,750 km and conducted two test launches of the missile in 2015. The range of the missile will reportedly enable it to reach almost all of India and deep into west Asia, including Israel.

and the range was reported as 900 km. But in the subsequent test in November 2019, the reported range was brought back to 650 km. This indicates that the test launch in 2013 was most possibly conducted for Shaheen-1A missile and not the Shaheen-I. Shaheen-1A was most recently reported test launched in December 2015 after it was tested in April 2012 and November 2014. During the 2015 test the missile was claimed to have "sophisticated and advanced guidance system" that makes it a highly accurate missile system.[31] With this development Pakistan acquires another relatively long-range ballistic missile with already existing liquid-fuelled ballistic missile Ghauri (Hatf-V).

Besides this, the National development complex is also developing two other variants of Shaheen missile series—Shaheen-II and Shaheen-III. The solid-fuel, two-stage Shaheen-II has been under development for many years. The system was first tested on March 2004 and become operational in 2014. The missile is reportedly based on DF 11 (also known as CSS-7), a Chinese short-range ballistic missile. In the April 2008 test it was declared "longest range ballistic missile system with a range of 2000 km." whereas after the 2014 and 2019 tests ISPR reported the range as 1,500 km. ISPR described the November 2014 test as a milestone towards consolidating Full Spectrum Credible Minimum Deterrence.[32]

Pakistan is also developing a road-mobile, solid-fuel, two-stage ballistic missile—Shaheen-III with a range of 2,750 km and conducted two test launches of the missile in 2015. The range of the missile will reportedly enable

31. ISPR report No PR-382/2015-ISPR, December 15, 2015, https://www.ispr.gov.pk/press-release-detail.php?id=5507.
32. ISPR report No. PR-248/2014-ISPR, November 13, 2014, https://www.ispr.gov.pk/press-release-detail.php?id=2701.

it to reach almost all of India and deep into west Asia, including Israel. According to Pakistan's Gen. Kidwai, the missile is being developed to cover all parts of India including Andaman and Nicobar Islands that are "being developed as strategic bases."[33] The missile system is in development phase and requires more testing before it can become operational. It is also speculated by observers that the Shaheen solid-fuel ballistic missile series will replace liquid-fuelled ballistic missile system Ghauri, but the trend of flight tests of the Ghauri missile—four times in the past decade, indicates that the missile system might not be withdrawn from Pakistan's missile inventory in the near future.

The first cruise missile of Pakistan was a subsonic, ground launched cruise missile, the Babur. It was developed by Pakistan's National Engineering and Scientific Commission (NESCOM) and tested for the first time in 2005. Many analysts believe that Pakistan took external assistance as the design of the missile bears similarities with Chinese cruise missiles.

CRUISE MISSILE CAPABILITY

In recent years Pakistan is making significant progress in its cruise missile capabilities. Its cruise missile inventory consists primarily of land, air and submarine-based cruise missiles. It has Ground Launched Cruise Missile (GLCM)—Babur (Hatf-7), Air Launched Cruise Missiles (ALCM)—Ra'ad (Hatf-8) and Submarine Launched Cruise Missile (SLCM) (Babur-3). Recently, in April 2018, an enhanced range version of ground launch cruise missile Babur, Babur weapon system-2/1 (B), and in February 2020 extended range version of air launched cruise missile Ra'ad—Ra'ad II were tested. All of these, Babur-2/1 (B), Ra'ad II and SLCM Babur-3 are currently under development.

Babur (Hatf-7): The first cruise missile of Pakistan was a subsonic, ground launched cruise missile, the Babur. It was developed by Pakistan's National

33. Carnegie Endowment for International Peace. 2015. "A Conversation with Gen. Khalid Kidwai." Carnegie International Nuclear Policy Conference 2015. Transcript. March 23, p. 10, http://carnegieendowment. org/files/03-230315carnegieKIDWAI.pdf.

Engineering and Scientific Commission (NESCOM) and tested for the first time in 2005. Many analysts believe that Pakistan took external assistance as the design of the missile bears similarities with Chinese cruise missiles and the US Tomahawk missile. According to ISPR press release Babur missile "incorporates the most modern cruise missile technology of Terrain Contour Matching (TERCOM) and Digital Scene Matching and Area Co-relation (DSMAC)."[34] Terrain-contour-matching (TERCOM) is a missile guidance system in which a map stored in the missile's computer is continuously compared with the actual terrain to locate the missile's position relative to the target.

The missile has been tested four times in the past ten years, twice in 2011 and twice in 2012. The range of the missile has been enhanced over the period of its development. During the inaugural test in August 2005 the range of the missile was declared as 500 km, whereas in October 2011 the missile was claimed to have an operational range of 700 km,[35] although many analysts believe that the range is not more than 350 km.[36] Similarly, since October 2011, the missile was launched from a multi-tube missile launch vehicle that "enhances targeting and deployment options in the conventional and nuclear mode."[37]

The ISPR press report stated both the Babur and Ra'ad missile systems are "low altitude terrain hugging missile(s) with high manoeuvrability" with "pin point accuracy" and "stealth capability".[38] An enhanced range version of Babur missile known as Babur-2/1(B) is under development.[39] It was test launched

34. ISPR report No. PR-256/2011-ISPR, October 28, 2011, https://www.ispr.gov.pk/press-release-detail.php?id=1889. Accessed on February 24, 2020.
35. ISPR report No. PR-143/2012-ISPR, June 5, 2012, https://www.ispr.gov.pk/press-release-detail.php?id=2088
36. Hans M. Kristensen, Robert S. Norris and Julia Diamond (2018), "Pakistani nuclear forces", 2018, *Bulletin of the Atomic Scientists*, 74:5, 348-58, DOI: 10.1080/00963402.2018.1507796.
37. ISPR report No. PR-256/2011-ISPR, October 28, 2011, https://www.ispr.gov.pk/press-release-detail.php?id=1889.
38. ISPR report No. PR-135/2012-ISPR, May 31, 2012, https://www.ispr.gov.pk/press-release-detail.php?id=2080.
39. ISPR report No. PR-482/2016-ISPR, December 14, 2016, https://www.ispr.gov.pk/press-release-detail.php?id=3632.

twice in December 2016 and April 2018. A recent test launch of the missile in March 2020 suffered a setback. As the range of both Babur and "enhanced range version" Babur-1(B) are reported as 700 km, it can be estimated that the range of the initial system might be shorter than the stated range (700 km).

As per official statement, the Babur-2/1(B) weapon system has advanced aerodynamics and avionics that can strike targets both at land and sea. The Babur-2/1(B) system with almost the same features and advanced capability might replace the relatively older version, the Hatf-7. Although, considering the current state of development, it is likely to take significant time before it gets fully operationalised.

A recent report speculated that Pakistan's nuclear storage facility at the Arabian Sea port, Ormara has undergone massive expansion; it is believed that the facility is used to store the Babur missile system.[40] According to the report a recent satellite image has shown that the facility has expanded from an initial size of 425 acres in 2018 to almost 1,000 acres area post 2018, which shows the rapid pace of cruise missile capability enhancement by Pakistan.

Ra'ad (Hatf-8): Pakistan has been developing the Air Launched Cruise Missile (ALCM) Ra'ad (Hatf-8) since 2007. The missile with a range of 350 km has been flight tested four times since 2011 and test launches have been conducted from Mirage III combat aircraft, although some reports indicate that the missile might have been integrated with JF-17 aircraft.[41] Ra'ad is claimed to have low altitude terrain hugging capability with high manoeuvrability which enables it to avoid detection and engagement by missile defence systems. While, during the latest test of the missile in January 2016, it was mentioned by ISPR that the missile system is equipped with advanced navigation and guidance system, no particular information regarding the type of the guidance system has been stated yet. According

40. Col. Vinayak Bhat (Retd.), "Pakistan Navy's nuke storage facility at Arabian Sea port of Ormara sees massive expansion", *The Print,* December 3, 2019, https://theprint.in/defence/pakistan-navys-nuke-storage-facility-at-arabian-sea-port-of-ormara-sees-massive-expansion/329370/.

41. *SIPRI Yearbook 2018*, "Armaments, Disarmament and International Security", p. 277, https://www.sipri.org/sites/default/files/SIPRIYB18c06.pdf.

to the official statement the missile system enables Pakistan to achieve air delivered strategic standoff capability on land and at sea.

In the 2017 military parade, Pakistan displayed ALCM Ra'ad-II with a range of 550 km.[42] The missile system was tested for the first time in February 2020 with a stated range of 600 km which "significantly enhances air delivered strategic standoff capability on land and at sea."[43] The increase in range would allow the missile to hit targets at a greater distance. Pakistan's need to develop a longer range cruise missile with terrain hugging capability and high accuracy to avoid detection might be driven by India's modernisation of its air defence system by procuring systems such as S-400. The same is quite evident from the fact that the test was conducted days after the US Department of State approved possible sale of an Integrated Air Defence Weapon System (IADWS) to India.

After the February 2020 test of Ra'ad-II, some reports suggest that the rear of the missile might have undergone significant design changes with new intake and control surfaces to make it fit to launch from diverse range of combat aircraft, including Chinese supplied JF-17 fighter aircraft. This will help in replacing the aging Mirage as the Pakistani forces primary strike platform. Similarly, in 2017 the Pakistan Aeronautical Complex, which manufactures JF-17 combat aircraft, mentioned about integration of standoff weapon with JF-17. This makes the possibility of using JF-17 to launch Ra'ad missile even stronger. Apart from this, both missile systems (Babur and Ra'ad) are structurally much smaller and slimmer than Pakistan's ballistic missile systems, which might be an indicator of Pakistan's capability of warhead miniaturisation based on plutonium instead of uranium.[44]

Babur-3: In order to achieve a secure second-strike capability and complete nuclear triad, Pakistan is developing a sea-based variant of GLCM

42. Bilal Khan, "Pakistan Officially Unveils Extended Range Ra'ad 2 Air-Launched Cruise Missile." Quwa Defence News & Analysis Group. March 23, 2017, https://quwa.org/ 2017/03/23/ pakistan-officially-unveils-extended-rangeraad-2-air-launched-cruise-missile/.

43. ISPR report No. PR-27/2020-ISPR, February 18, 2020, https://www.ispr.gov.pk/press-release-detail.php?id=5625.

44. Hans M. Kristensen, Robert S. Norris and Julia Diamond, "Pakistani nuclear forces", 2018, *Bulletin of the Atomic Scientists*, 74 (5), pp. 348-58.

Babur-2, the SLCM Babur-3 with a range of 450 km.[45] The missile is under development and was flight tested twice in January 2017 and March 2018. The first test of the missile was conducted in January 2017 from an undisclosed location in the Indian Ocean. During the March 2018 test the missile was launched from "an underwater dynamic platform".[46] Some studies predict that the missile was most likely launched from the diesel-electric Agosta-90B (Khalid class) submarine in service with the Pakistan Navy.[47]

The future submarine-based nuclear capability is managed by Headquarters Naval Strategic Forces Command (NSFC), which the government said in 2012 would be the "custodian of the nation's 2nd strike capability" to "strengthen Pakistan's policy of Credible Minimum Deterrence and ensure regional stability".[48] Successful development of SLCM Babur-3 will provide Pakistan with complete nuclear triad and therefore it will have land, air and sea-based nuclear strike platforms. Given the fact that Pakistan does not have a nuclear-powered submarine, potential deployment of the SLCM and its ability to work in full capacity might get affected as the operational superiority of nuclear-powered submarine over diesel power submarine makes it a more effective launch platform for submarine launched missiles. However, in 2016, Pakistan signed a deal with China to buy eight Yuan class diesel-electric attack submarines. It was also reported that these submarines will have the air-independent propulsion system.[49] The submarines are expected to be completed between 2023 and 2028. These submarines might be a significant addition in Pakistan's submarine fleet, considering the fact

45. ISPR report No. PR-10/2017-ISPR, January 9, 2017, https://www.ispr.gov.pk/press-release-detail.php?id=3672.

46. ISPR report No. PR-125/2018-ISPR, March 29, 2018, https://www.ispr.gov.pk/press-release-detail.php?id=4660. Accessed on January 21, 2020.

47. Rajaram Nagappa, et al., "Babur-3—Pakistan's SLCM: Capability and Limitations", *Air Power Journal,* vol. 13 no. 3, Monsoon 2018 (July-September). Accessed on January 5, 2020.

48. Hans M. Kristensen, Robert S. Norris and Julia Diamond, "Pakistani nuclear forces", *Bulletin of the Atomic Scientists*, 2018, 74:5, 348-58, DOI: 10.1080/00963402.2018.1507796.

49. Zia Mian, M. V. Ramana and A. H. Nayyar, "Nuclear Submarines in South Asia: New Risks and Dangers", *Journal for Peace and Nuclear Disarmament*, 2019, 2:1, 184-202, DOI: 10.1080/25751654.2019.1621425.

From the current trend it can be observed that in the last decade, Pakistan has mainly focused on developing ballistic missile systems ranging from 70 km to 290 km and 900 km to 2,750 km.

that many modern attack submarines can launch cruise missiles while remaining underwater and its air independent propulsion system could significantly contribute to effective stealth capability. Apart from this, Pakistan may be also seeking to build a nuclear-powered submarine, although it is unclear if any work on this front has taken place yet.[50]

FUTURE TRAJECTORIES AND CONCLUSION

With the development of nuclear missile inventory, Pakistan's nuclear posture has undergone a steady transformation in the last decade. As Pakistan's posture evolves to greater numbers and variants of missile systems, it also incorporates terms like secure second strike capability, nuclear triad and full spectrum deterrence capability to define its nuclear posture. These advances in terms of nuclear posture and inclusion of new technologies have many implications for India and the South Asian region per se.

Pakistan's nuclear and missile developments are India-centric and essentially seek to deter India's air and missile defence system and conventional force superiority. With incessant development of dual-capable missiles of varied range and warheads in recent years, specifically particular emphasis on development of relatively short-range dual capable systems like Nasr, Abdali and Ghaznavi is a matter of concern as use of these systems in a limited conventional war could potentially lower the threshold of the nuclear conflict. Also, further development and operationalisation of these systems will invariably result in strategic instability.

Pakistan's use of the terms like "quick reactionary, shoot-and-scoot missile" to describe its TNW Nasr, likely indicates a quick response or ease of use of this missile. Which is also a possible projection that in wake of a

50. Ibid.

conflict situation Islamabad will not hesitate to use these weapon systems in the first place to gain strategic advantage.

From the current trend it can be observed that in the last decade, Pakistan has mainly focused on developing ballistic missile systems ranging from 70 km to 290 km and 900 km to 2,750 km. Pakistan's newly added MIRV capable missile and cruise missile systems with improved guidance and terrain hugging stealth technology significantly raise India's threat perception, especially when Pakistan operationalises and deploys these systems effectively with the obvious foreign assistance of China.

Although, Pakistan may require several test launches before effectively operationalising many of its missile systems, the rapid pace of development with supposed external assistance, majorly from China, indicates that it might not take much time before it fully develops these capabilities.

If Pakistan successfully develops MIRV capability with China's assistance, mutual threat perception is likely to grow further. MIRV capability provides the attacking state with disarming counterforce strike capability and with greater accuracy. MIRV systems indicate essentially first strike capability rather than retaliatory capability. With increased tendency for crisis, all of these developments could have a negative impact on regional deterrence stability.

The above analysis clearly indicates that in the last decade, Pakistan has taken significant strides in its nuclear and missile development programme. Diversity of these systems suggest that its nuclear missile development programme to build a nuclear triad and to achieve full spectrum deterrence will continue to grow in coming years. Although, Pakistan may require several test launches before effectively operationalising many of its missile systems, the rapid pace of development with supposed external assistance, majorly from China, indicates that it might not take much time before it fully develops these capabilities.

Similarly, in view of the present advances and diversity of these systems it is likely that its nuclear missile development programme to

build a nuclear triad and to achieve full spectrum deterrence capability will continue to expand in the near future. In the coming years, Pakistan will increasingly focus on developing and strengthening missile systems like Nasr, Ababeel, Shaheen, Air Launched Cruise Missile Ra'ad-2 and sea-based deterrents.