VI. Indian nuclear forces

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As of January 2020, India was estimated to have a growing arsenal of approximately 150 nuclear weapons (see table 10.7). This figure is based on calculations of India's inventory of weapon-grade plutonium and the number of operational nuclear-capable delivery systems. India is expanding the size of its nuclear weapon stockpile as well as its infrastructure for producing nuclear warheads.

Indian nuclear doctrine

During 2019, there was renewed speculation that India was considering modifying or scrapping the no-first-use nuclear doctrine that it adopted in 1998.[1] On 16 August, Indian defence minister Rajnath Singh posted on Twitter that 'India has strictly adhered to this doctrine. What happens in future depends on the circumstances'.[2] Singh's statement added to a growing number of similar statements by Indian defence officials issued over the past decade.[3] It cast further doubt on India's commitment to no-first-use and revived discussions both inside and outside India about the scope and limits of the doctrine and whether India would continue to maintain it.[4] Singh's statement was particularly noteworthy because it followed on the heels of a debate about whether India's modernization of its nuclear weapons was gradually moving the country closer to a more aggressive nuclear policy similar to the counterforce strategy (the capability for pre-emptive or retaliatory strikes on targets of military value) of many other nuclear-armed states.[5]

[1] Although India publicly stated in 2003 that the no-first-use doctrine would not prevent it from responding with nuclear weapons to chemical and biological attacks, it remained fairly clear that the doctrine covered nuclear scenarios. For further detail see e.g. Boyd, K., 'India established formal nuclear command structure', *Arms Control Today*, Jan. 2003.

[2] Rajnath Singh (@rajnathsingh), 'Pokhran is the area which witnessed Atal Ji's firm resolve to make India a nuclear power and yet remain firmly committed to the doctrine of "No First Use". India has strictly adhered to this doctrine. What happens in future depends on the circumstances', Twitter, 16 Aug. 2019.

[3] For examples of earlier statements by Indian defence officials see e.g. Chaudhury, D. R., 'Why bind ourselves to "no first use policy", says Manahar Parrika on India's nuke doctrine', *Economic Times*, 11 Nov. 2016.

[4] See e.g. *The Hindu*, 'Unclear doctrine: On "no first use" nuclear policy', 19 Aug. 2019; and Panda, A., 'If India rethinks nuclear no first use, it won't surprise Pakistan or China', The Diplomat, 26 Aug. 2019.

[5] Clary, C. and Narang, V., 'India's counterforce temptations: Strategic dilemmas, doctrine, and capabilities', *International Security*, vol. 43, no. 3 (winter 2018), pp. 7–52; and Sundaram, K. and Ramana, M. V., 'India and the nuclear policy of no first use of nuclear weapons', *Journal for Peace and Nuclear Disarmament*, vol. 1, no. 1 (2018), pp. 152–68.

Military fissile material production

India's nuclear weapons are believed to be single-stage plutonium-based implosion designs. The plutonium was produced at the Bhabha Atomic Research Centre (BARC) in Trombay, Mumbai, by the 40-megawatt-thermal (MW(t)) heavy water CIRUS reactor, which was shut down at the end of 2010, and the 100-MW(t) Dhruva heavy water reactor. India reportedly has plans to build a new 100 MW(t) reactor near Visakhapatnam, Andhra Pradesh.[6] To extract the plutonium, India operates a plutonium reprocessing plant for military purposes at the BARC as well as three dual-use plants elsewhere.[7]

The Indian Department of Atomic Energy has proposed plans to build six fast breeder reactors—at three sites with twin reactor units—by 2039.[8] This would significantly increase India's capacity to produce plutonium that could be used for building weapons.[9] The unsafeguarded 500-megawatt-electric (MW(e)) prototype fast breeder reactor (PFBR) at the Indira Gandhi Centre for Atomic Research complex at Kalpakkam, Tamil Nadu, was expected to achieve criticality in 2019 following a series of technical delays, but by the end of that year it remained unclear whether this had happened.[10] A new reprocessing plant is also under construction at Kalpakkam to reprocess spent fuel from the PFBR and future fast breeder reactors. The plant is scheduled to be commissioned by 2022.[11]

India is also increasing its uranium enrichment capabilities and continues to produce enriched uranium at the expanded gas centrifuge facility at the Rattehalli Rare Materials Plant near Mysore, Karnataka, for highly enriched uranium (HEU) for use as naval reactor fuel.[12] India is building a new industrial-scale centrifuge enrichment plant, the Special Material Enrichment Facility, near Challakere, Karnataka. This will be a dual-use facility that produces HEU for both military and civilian purposes.[13] India's expanding centrifuge enrichment capacity is motivated by plans to build new

[6] International Panel on Fissile Materials, 'Countries: India', 12 Feb. 2018.

[7] International Panel on Fissile Materials (note 6).

[8] Indian Government, Department of Atomic Energy, 'Statement referred to in reply to Lok Sabha starred question no. 2 due for answer on 18.07.2018 by Shri Rahul Shewale regarding nuclear power plants', [n.d.], p. 2.

[9] Sharma, R., 'India to have six fast breeder reactors by 2039; first to become operational in 2018', Nuclear Asia, 8 Nov. 2017; and Ramana, M. V., 'A fast reactor at any cost: The perverse pursuit of breeder reactors in India', *Bulletin of the Atomic Scientists*, 3 Nov. 2016.

[10] Press Trust of India (PTI), 'Kalpakkam fast breeder reactor may achieve criticality in 2019', *Times of India*, 20 Sep. 2018.

[11] *The Hindu*, 'HCC to construct fuel processing facility at Kalpakkam', 7 Aug. 2017; and World Nuclear News, 'India awards contract for fast reactor fuel cycle facility', 8 Aug. 2017.

[12] International Panel on Fissile Materials (note 6); and Naval Technology, 'India builds reactors to power nuclear submarines', 8 Sep. 2010.

[13] Albright, D. and Kelleher-Vergantini, S., *India's Stocks of Civil and Military Plutonium and Highly Enriched Uranium, End 2014* (Institute for Science and International Security: Washington, DC, 2 Nov. 2015).

Table 10.7. Indian nuclear forces, January 2020

Type (US/Indian designation)	Launchers deployed	Year first deployed	Range (km)[a]	Warheads x yield[b]	No. of warheads[c]
Aircraft[d]	*48*				*48*
Mirage 2000H	32	1985	1 850	1 x bomb	32
Jaguar IS	16	1981	1 600	1 x bomb	16
Land-based ballistic missiles	*70*				*70*
Prithvi-II	30	2003	250[e]	1 x 12 kt	30
Agni-I	20	2007	>700	1 x 10–40 kt	20
Agni-II	12	2011	>2 000	1 x 10–40 kt	12
Agni-III	8	[2014]	>3 200	1 x 10–40 kt	8
Agni-IV	0	[2020]	>3 500	1 x 10–40 kt	0
Agni-V	0	[2025]	>5 000	1 x 10–40 kt	0
Sea-based ballistic missiles	*14*				*16*
Dhanush	2	2013	400	1 x 12 kt	4[f]
K-15 (B05)[g]	1/12[h]	2018	700	1 x 12 kt	12
K-4	..[i]	..	3 000	1 x 10–40 kt	..
Cruise missiles[j]	..	..	..	..	..
Other stored warheads[k]					*16*
Total					**150**[k]

.. = not available or not applicable; [ ] = uncertain figure; kt = kiloton.

[a] Aircraft range is for illustrative purposes only; actual mission range will vary according to flight profile and weapon loading. Missile payloads may have to be reduced in order to achieve maximum range.

[b] The yields of India's nuclear warheads are not known. The 1998 nuclear tests demonstrated yields of up to 12 kt. Since then, it is possible that boosted warheads have been introduced with a higher yield, perhaps up to 40 kt. There is no open-source evidence that India has developed two-stage thermonuclear warheads.

[c] Aircraft and several missile types are dual capable. This estimate counts an average of 1 warhead per launcher. Warheads are not deployed on launchers but kept in separate storage facilities. All estimates are approximate.

[d] Other aircraft that could potentially have a secondary nuclear role include the Su-30MKI.

[e] The Prithvi-II's range is often reported as 350 km. However, the US Air Force, National Air and Space Intelligence Center (NASIC) sets the range at 250 km.

[f] Each Dhanush-equipped ship is thought to have possibly 1 reload.

[g] Some sources have referred to the K-15 missile as Sagarika, which was the name of the missile development project.

[h] The first figure is the number of operational nuclear-powered ballistic missile submarines (SSBNs); the second is the number of missiles they can carry. Only 1 of India's 2 SSBNs—*INS Arihant*—is believed to be operational and probably has only limited capability. The other SSBN—*INS Arighat*—is fitting out. The SSBNs have 4 missile tubes, each of which can carry 3 K-15 submarine-launched ballistic missiles (SLBMs), for a total of 12 missiles per SSBN.

[i] Each missile tube will be able to carry 1 K-4 SLBM once it becomes operational.

[j] There have been reports suggesting that the Nirbhay cruise missile might be nuclear capable but no official sources have confirmed this.

[k] In addition to the *c.* 134 warheads estimated to be assigned to operational forces, an additional *c.* 16 warheads are thought to have been produced (or be in production) to arm additional Agni and K-15 missiles, for a total estimated stockpile of *c.* 150 warheads. India's inventory is expected to continue to increase.

Sources: Indian Ministry of Defence, annual reports and press releases; International Institute for Strategic Studies, *The Military Balance 2019* (Routledge: London, 2019); US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, July 2017); Indian news media reports; *Bulletin of the Atomic Scientists*, 'Nuclear notebook', various issues; and authors' estimates.

naval propulsion reactors. However, the HEU produced at the plants could also hypothetically be used to manufacture thermonuclear or boosted-fission nuclear weapons.[14]

Aircraft

Aircraft are the most mature component of India's nuclear strike capabilities. It is estimated here that there are approximately 48 nuclear bombs assigned to aircraft.

The Indian Air Force (IAF) has reportedly certified its Mirage 2000H fighter-bombers for delivery of nuclear gravity bombs.[15] It is widely speculated that the IAF's Jaguar IS fighter-bombers may also have a nuclear delivery role.[16]

India is acquiring a planned total of 36 Rafale aircraft from France. The majority of the aircraft are scheduled for delivery in 2021–22.[17] The French Air Force uses the Rafale in a nuclear strike role. The Rafale aircraft could therefore potentially replace India's Jaguar IS fighter-bomber in that role. However, as of January 2020, there had been no official confirmation of this. According to the Indian Ministry of Defence, the 'Rafale will provide IAF the strategic deterrence and requisite capability cum technological edge'.[18]

Land-based missiles

Other than occasional parade displays and announcements about missile flight tests, the Indian Government does not provide much public information about the status of its nuclear-capable, land-based ballistic missiles. The Indian Army's Strategic Forces Command operates four types of mobile nuclear-capable ballistic missile: the short-range Prithvi-II (250 kilometres) and Agni-I (700 km); the medium-range Agni-II (2000+ km); and the

[14] Levy, A., 'India is building a top-secret nuclear city to produce thermonuclear weapons, experts say', *Foreign Policy*, 16 Dec. 2015.

[15] Kampani, G., 'New Delhi's long nuclear journey: How secrecy and institutional roadblocks delayed India's weaponization', *International Security*, vol. 38, no. 4 (spring 2014), pp. 94, 97–98.

[16] Cohen, S. and Dasgupta, S., *Arming Without Aiming: India's Military Modernization* (Brookings Institution Press: Washington, DC, 2010), pp. 77–78; and India Defence Update, 'SEPECAT Jaguar is India's only tactical nuclear carrying and ground attack aircraft', 13 Dec. 2016.

[17] Rajnath Singh (@rajnathsingh), Video footage, Twitter, 8 Oct. 2019; and Indian Ministry of Defence, Press Information Bureau, 'Rafale Jet', 20 Nov. 2019. For further detail see chapter 9, section II, in this volume.

[18] Indian Ministry of Defence (MOD), *Annual Report 2018–19* (MOD: New Delhi, 2019), p. 43.

intermediate-range Agni-III (3200+ km).[19] It is estimated here that India has approximately 70 nuclear warheads for its land-based ballistic missiles.

Two new and longer-range land-based ballistic missiles are in development: the Agni-IV (3500+ km) and the Agni-V (5000+ km). A variant with an even longer range, the Agni-VI (6000 km), is in the design stage of development.[20] Unlike the other Agni missiles, the Agni-V is designed to be stored in and launched from a new mobile canister system—an arrangement that, among other things, increases operational readiness by reducing the time required to place the missiles on alert in a crisis.[21]

India reportedly carried out at least six test launches of ballistic missiles in 2019. The known launches included flight tests of four Prithvi-II missiles, one Agni-II, and one Agni-III, which failed.[22]

India is pursuing a technology development programme for multiple independently targetable re-entry vehicles (MIRVs). However, there have been conflicting views among defence planners and officials about how to proceed with the programme, in particular, about whether MIRVs should be initially deployed on the Agni-V or on the longer-range Agni-VI, which will have a heavier payload capacity.[23]

Sea-based missiles

With the aim of creating an assured second-strike capability, India continues to develop the naval component of its triad of nuclear forces and is building a fleet of four to six nuclear-powered ballistic missile submarines (SSBNs).[24] The first of the four SSBNs, the *INS Arihant*, was launched in 2009 and formally commissioned in 2016.[25] It is estimated here that 12 nuclear warheads have been delivered for potential deployment by the *Arihant* and more are in production.

[19] The Prithvi-II's range is often reported as 350 km. However, the US Air Force, National Air and Space Intelligence Center (NASIC) sets the range at 250 km. NASIC, *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, July 2017), p. 17.

[20] Vikas, S., 'Why India may not test Agni 6 even if DRDO is ready with technology', OneIndia, 10 July 2019.

[21] Aroor, S., 'New chief of India's military research complex reveals brave new mandate', *India Today*, 13 July 2013.

[22] Press Trust of India (PTI), 'Nuclear-capable Prithvi II successfully test-fired', *Times of India*, 27 June 2019; PTI, 'DRDO successfully conducts Agni II missile's night trial for first time', *The Hindu*, 16 Nov. 2019; Asian News International (ANI), 'India successfully carries out night-time tests of Prithvi ballistic missile off Odisha coast', *Economic Times*, 20 Nov. 2019; Rout, H. K., 'Nuclear capable Agni-III missile fails in maiden night trial', *New Indian Express*, 1 Dec. 2019; and PTI, 'India conducts another night trial of Prithvi-II missile', *India Today*, 4 Dec. 2019.

[23] Basrur, R. and Sankaran, J., 'India's slow and unstoppable move to MIRV', eds M. Krepon, T. Wheeler and S. Mason, *The Lure and Pitfalls of MIRVs: From the First to the Second Nuclear Age* (Stimson Center: Washington, DC, May 2016), pp. 149–76.

[24] Davenport, K., 'Indian submarine completes first patrol', *Arms Control Today*, Dec. 2018.

[25] Dinakar, P., 'Now, India has a nuclear triad', *The Hindu*, 18 Oct. 2016.

In November 2018 the Indian Government announced that the *Arihant* had completed its first 'deterrence patrol'.[26] However, it is doubtful that the submarine's missiles carried nuclear warheads during the patrol.[27] The *Arihant* is assessed here to have only a limited operational capability.

A second SSBN, the *INS Arighat*, was launched in November 2017 and is fitting out at the naval base near Visakhapatnam.[28] Construction work has reportedly begun on a third and fourth submarine, with expected launch dates in 2020 and 2022, respectively.[29]

India seems to be developing a new SSBN class that would be able to carry more missiles than the *Arihant* and *Arighat*, which are each equipped with a four-tube vertical launch system and can carry up to 12 two-stage, 700-km range K-15 (also known as B05) submarine-launched ballistic missiles (SLBMs). After a visit to the Defence Research and Development Organization's (DRDO) Naval Science and Technological Laboratory, the Indian Vice President, Muppavarapu Venkaiah Naidu, posted a photograph on his Twitter account that appeared to show part of a model of a new SSBN.[30] The missile compartment looked wider and taller than on the *Arihant*, leading to speculation that the compartment might be able to carry eight or more SLBMs.[31]

The DRDO is developing a two-stage, 3500-km range SLBM, known as the K-4, which will eventually replace the K-15.[32] It has also started to develop extended-range versions: the K-5 SLBM, which reportedly will have a range in excess of 5000 km, and the K-6, which will have an even longer range.[33]

India's first naval nuclear weapon was the Dhanush missile, a version of the Prithvi-II that can be launched from a surface ship. Two Sukanya class coastal patrol ships based at the Karwar naval base on India's east coast have been converted to launch the Dhanush. The missile reportedly can carry a 500-kg warhead to a maximum range of 400 km and is designed to be able

[26] Indian Government, Prime Minister's Office, Press Information Bureau, 'Prime Minister felicitates crew of INS Arihant on completion of Nuclear Triad', 5 Nov. 2018; and Davenport (note 24).

[27] Joshi, Y., 'Angels and dangles: Arihant and the dilemma of India's undersea nuclear weapons', War on the Rocks, 14 Jan. 2019.

[28] Unnithan, S., 'A peek into India's top secret and costliest defence project, nuclear submarines', *India Today*, 10 Dec. 2017. The submarine was originally assumed to be named *INS Aridhaman*, but when launched it was named *INS Arighat*.

[29] Unnithan (note 28).

[30] Vice President of India (@VPSecretariat), 'Went around an exhibition displaying Naval Weapons and Systems at Naval Science & Technological Laboratory (NSTL), DRDO at Vizag, Andhra Pradesh today. I am here to participate in the Golden Jubilee Celebrations of NSTL', Twitter, 28 Aug. 2019.

[31] Sutton, H. I., 'Tweet may have inadvertently revealed India's next-Gen nuclear weapons platform with global reach', *Forbes*, 8 Sep. 2019.

[32] Jha, S., 'India's undersea deterrent', The Diplomat, 30 Mar. 2016; and the US Air Force, National Air and Space Intelligence Center (note 19), p. 25.

[33] Rout (note 22); and Unnithan (note 28).

to hit both sea- and shore-based targets.[34] The last known test launch was in November 2018.[35]

Cruise missiles

There have been unconfirmed reports that the Nirbhay long-range subsonic cruise missile is nuclear capable.[36] However, neither the Indian Government nor the United States' intelligence sources have stated that the Nirbhay is a nuclear-capable system.

[34] Indian Defence Research and Development Organization, 'Successful launch of Dhanush and Prithvi missiles', Press release, 11 Mar. 2011; and *New Indian Express*, 'Nuke-capable Dhanush and Prithvi-II launched', 12 Mar. 2011.

[35] Indian Ministry of Defence (note 18), p. 100.

[36] Pandit, R., 'India successfully tests its first nuclear-capable cruise missile', *Times of India*, 8 Nov. 2017; and Gady, F. S., 'India successfully test fires indigenous nuclear-capable cruise missile', The Diplomat, 8 Nov. 2017.