VI. Indian nuclear forces

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India is estimated to have a growing arsenal of 130–40 nuclear weapons (see table 6.7). 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.

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.[1] To extract the plutonium, India operates a plutonium reprocessing plant for military purposes at the BARC as well as three dual-use plants elsewhere.[2]

The Indian Department of Atomic Energy has proposed plans to build six fast breeder reactors—at three sites with twin reactor units—by 2039.[3] This would significantly increase India's capacity to produce plutonium that could be used for building weapons.[4] An unsafeguarded 500-megawatt-electric (MW(e)) prototype fast breeder reactor (PFBR) has been built at the Indira Gandhi Centre for Atomic Research (IGCAR) complex at Kalpakkam, Tamil Nadu. The PFBR is expected to achieve criticality in 2019 following a series of technical delays.[5] The IGCAR has announced that a fast reactor fuel cycle facility will be built at Kalpakkam to reprocess spent fuel from the PFBR and future fast breeder reactors. The plant is scheduled to be commissioned by 2022.[6]

India is also increasing its uranium enrichment capabilities. It continues to enrich uranium at the expanded gas centrifuge facility at the Rattehalli

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

[2] International Panel on Fissile Materials (note 1).

[3] 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.

[4] 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.

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

[6] *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.

Table 6.7. Indian nuclear forces, January 2019

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	*60*				*60*
Prithvi-II	24	2003	250	1 x 12 kt	24
Agni-I	20	2007	>700	1 x 10–40 kt	20
Agni-II	8	2011	>2 000	1 x 10–40 kt	8
Agni-III	8	(2014)	>3 200	1 x 10–40 kt	8
Agni-IV	0	(2018)	>3 500	1 x 10–40 kt	0
Agni-V	0	(2020)	>5 200	1 x 10–40 kt	0
Sea-based ballistic missiles	*14*				*16*
Dhanush	2	(2013)	350	1 x 12 kt	4[e]
K-15 (B05)[f]	12[g]	2018	700	1 x 12 kt	12
K-4	(4)[h]	..	3 000	1 x 10–40 kt	0
Cruise missiles	..	..	..	..	..
Nirbhay ALCM[i]	..	..	(>700)	..	..
Total					**130–140**[j]

.. = not available or not applicable; ( ) = uncertain figure; ALCM = air-launched cruise missile; 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. Cruise missile launchers carry more than 1 missile. 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 fighter-bombers that could potentially have a secondary nuclear role include the Su-30MKI.

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

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

[g] India's 2 nuclear-powered ballistic missile submarines (SSBNs)—*INS Arihant* and *INS Arighat*—each 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. The *Arihant* might have a limited operational capability; the *Arighat* is fitting out.

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

[i] There are unconfirmed reports that the Nirbhay might be nuclear-capable.

[j] In addition to the warheads assigned to operational forces, India is thought to have a number of warheads in production to give a total estimated stockpile of 130–140 warheads.

Sources: Indian Ministry of Defence, annual reports and press releases; International Institute for Strategic Studies, *The Military Balance 2018* (Routledge: London, 2018); 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; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

Rare Materials Plant (RMP) near Mysore, Karnataka, to produce highly enriched uranium (HEU) for use as naval reactor fuel.[7] India is building a new industrial-scale centrifuge enrichment plant, the Special Material Enrichment Facility (SMEF), near Challakere, Karnataka. This will be a dual-use facility that produces HEU for both military and civilian purposes.[8] India's expanding centrifuge enrichment capacity is motivated by plans to build new naval propulsion reactors. However, the HEU produced at the plants could also hypothetically be used to manufacture thermonuclear or boosted-fission nuclear weapons.[9]

Aircraft

Aircraft constitute the most mature component of India's nuclear strike capabilities. The Indian Air Force has reportedly certified the Mirage 2000H multi-role combat aircraft for delivery of nuclear gravity bombs.[10] It is widely speculated that the Indian Air Force's Jaguar IS fighter-bomber may also have a nuclear delivery role.[11]

Land-based missiles

Under its Integrated Guided Missile Development Programme, which began in 1983, India's Defence Research and Development Organization (DRDO) has developed two families of nuclear-capable, land-based ballistic missiles: the Prithvi family (although only the Prithvi-II is thought to be nuclear-capable), consisting of three types of road-mobile, short-range missiles; and the Agni family of longer-range, solid-fuelled ballistic missiles. The latter are designed to provide a quick-reaction nuclear capability and have taken over much of the Prithvi's nuclear delivery role.

The Agni-I is a single-stage, road-mobile missile that has a range of 700 kilometres. The nuclear-capable missile was inducted into service in 2004 with the Indian Army under the Strategic Forces Command (SFC), which is the body responsible for managing and exercising operational command and

[7] International Panel on Fissile Materials (note 1); and Naval Technology, 'India builds reactors to power nuclear submarines', 8 Sep. 2010.

[8] 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).

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

[10] 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.

[11] 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.

control over India's nuclear weapons. It was test-fired twice in 2018—on 6 February and 30 October—as part of user trials by the SFC.[12]

The Agni-II is a two-stage, solid-fuelled rail-mobile ballistic missile that can deliver a 1000-kilogram payload to a range exceeding 2000 km. The Agni-II appears to have been plagued by technical problems; according to an estimate from 2017 by the United States Air Force National Intelligence and Space Center (NASIC), fewer than 10 launchers have been deployed.[13] On 20 February 2018 an Agni-II was successfully test launched as part of a user trial by the SFC.[14] The previous test, in May 2017, had been aborted shortly after the launch of the missile.[15]

The Agni-III is a two-stage, rail-mobile missile with a range exceeding 3200 km. It was inducted into service with the SFC in 2011 and was most recently flight tested on 27 April 2017.[16]

India is developing two longer-range ballistic missiles, the Agni-IV and the Agni-V, which would give it the capability to strike targets throughout China for the first time. The two-stage, road- and rail-mobile Agni-IV missile has a range of over 3500 km. Agni-IV missiles were test launched as part of user trials by the SFC on 2 January 2018 and 23 December 2018; the test in December was the seventh test of the Agni-IV.[17]

The DRDO has prioritized the development of the three-stage, road-mobile Agni-V missile with a range in excess of 5000 km. 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.[18] During 2018, Agni-V missiles were successfully flight tested three times: on 18 January, 3 June and 10 December.[19] The missiles were launched from sealed canisters mounted on trucks located at the Integrated Test Range complex on Abdul Kalam Island (formerly Wheeler Island). The

[12] Taneja, R., 'India successfully test-fires nuclear capable ballistic Agni-1 missile: 10 facts', NDTV, 6 Feb. 2018; and Press Trust of India (PTI), 'Successful night trial of Agni-1 ballistic missile', *Times of India*, 30 Oct. 2018.

[13] US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, July 2017), p. 25.

[14] Press Trust of India (PTI), 'India test fires medium-range nuclear capable Agni-II missile', *The Hindu*, 20 Feb. 2018.

[15] Pandit, R., 'Trial of Agni-II ballistic missile fails: Sources', *Times of India*, 4 May 2017.

[16] *New Indian Express*, 'India successfully test fires nuclear capable Agni-III missile off Odisha coast', 27 Apr. 2017.

[17] Press Trust of India (PTI), 'Nuclear-capable Agni-IV missile successfully test-fired', *Economic Times*, 23 Dec. 2018.

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

[19] Gady, F. S., 'India test fires Agni-V nuclear-capable ICBM', The Diplomat, 10 Dec. 2018.

test launch in December marked the seventh consecutive successful trial of the Agni-V since 2012 and the final test before its induction into service.[20]

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.[21] The Agni-VI is currently under development.[22]

Sea-based missiles

India continues to develop the naval component of its triad of nuclear forces in pursuit of an assured second-strike capability. It is building a fleet of four to six nuclear-powered ballistic missile submarines (SSBNs) as part of its four-decade-old Advanced Technology Vessel project.[23]

India's first indigenously built SSBN, the *INS Arihant*, was launched in 2009 and formally commissioned in 2016.[24] The boat suffered significant flood damage in 2017 and was out of commission for most of the year and part of 2018.[25] 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] 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]

[20] Rout, H. K., 'Successful test of Agni-V leads way to induction in Indian Army', *New Indian Express*, 11 Dec. 2018.

[21] 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.

[22] Indian Defence Update, 'The Agni-6: The Indian ICBM', 18 June 2017.

[23] Davenport, K., 'Indian submarine completes first patrol', *Arms Control Today*, Dec. 2018; and Naval Technology, 'Arihant class submarine', [n.d.].

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

[25] Peri, D. and Joseph, J., 'INS Arihant left crippled after "accident" 10 months ago', *The Hindu*, 8 Jan. 2018.

[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 23).

[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).

The *Arihant* is 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). Some reports claimed that the *Arighat* would be equipped with twice as many tubes as the *Arihant*, but satellite imagery has shown that the two submarines are the same size.[30] On 11–12 August 2018 three K-15 missiles were test launched over two consecutive days from the submerged *Arihant* during a user trial off the Visakhapatnam coast.[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] On 17 December 2017 the test launch of a K-4 missile from an underwater pontoon in the Bay of Bengal was said to have failed. Indian officials did not release information on the cause of the failure.[33] The missile had previously been tested four times. The DRDO is currently developing a K-5 SLBM, which is expected to have a range in excess of 5000 km, and it has announced plans to develop a longer-range K-6 SLBM.[34]

The nuclear-capable Dhanush missile is a naval version of the Prithvi-II that is launched from a surface ship. It can reportedly carry a 500-kg warhead to a maximum range of 350 km and is designed to be able to hit both sea- and shore-based targets. On 23 February 2018 a Dhanush missile was successfully test-fired from a ship in the Bay of Bengal as part of a user trial by the SFC. The most recent test before that was in April 2015.[35] The Dhanush has been inducted into service with the Indian Navy and is deployed on two Sukanya class coastal patrol ships.[36]

Cruise missiles

The DRDO has been developing a long-range subsonic cruise missile since 2004. Known as the Nirbhay, it has a range exceeding 1000 km and is believed to have air-, ground- and sea-launched versions. Development of the missile has been delayed by technical problems with its flight control software and

[30] Gady, F. S., 'India launches second ballistic missile sub', The Diplomat, 13 Dec. 2017; and Kristensen, H. K., 'India's second SSBN only has four missile tubes', FAS Strategic Security Blog, Federation of American Scientists, 22 Feb. 2019.

[31] Rout, H. K., 'Nuke-capable submarine-launched missile operationalised, India in select triad club', *New Indian Express*, 19 Aug. 2018.

[32] Jha, S., 'India's undersea deterrent', The Diplomat, 30 Mar. 2016; and US Air Force, National Air and Space Intelligence Center (note 13), p. 33.

[33] Pubby, M., 'Setback for Indian missile programme: Two failures in a week, submarine version stuck', *The Print*, 24 Dec. 2017.

[34] Rout (note 31); and Unnithan (note 28).

[35] Press Trust of India (PTI), '"Dhanush" ballistic missile successfully test-fired', *Times of India*, 23 Feb. 2018.

[36] Naval Technology, 'Sukanya Class Offshore Patrol Vessels', [n.d.]; and Pandit, R., 'Navy, IAF induct Prithvi', *Times of India*, 22 Aug. 2006.

navigation system, which have caused several consecutive test failures since 2013.[37] On 7 November 2017 the Indian Ministry of Defence announced that the DRDO had conducted a successful test flight of a Nirbhay cruise missile at the Integrated Test Range on Abdul Kalam Island that 'had achieved all the mission objectives'.[38] The Indian Government has not confirmed media reports that the Nirbhay is a nuclear-capable system.[39]

[37] Sv, V., 'What ails ingenuously developed cruise missile Nirbhay', OneIndia, 28 Oct. 2018; and Subramanian, T. S., 'Nirbhay missile test "an utter failure"', *The Hindu*, 21 Dec. 2016.

[38] Indian Ministry of Defence, Press Information Bureau, 'DRDO conducts successful flight trial of "Nirbhay" sub-sonic cruise missile', 7 Nov. 2017.

[39] 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.