VI. Indian nuclear forces

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India is estimated to have a growing arsenal of 110–120 nuclear weapons. This figure is based on calculations of India's inventory of weapon-grade plutonium and the number of operational nuclear-capable delivery systems. It represents an increase in the Indian nuclear stockpile size from the 90–110 warheads estimated in *SIPRI Yearbook 2015*.

Military fissile material production

India's nuclear weapons are believed to be plutonium-based. As of 2015 India's weapon-grade plutonium stockpile was estimated to be between 0.57 and 0.61 tonnes (see section X). The plutonium was produced at the Bhabha Atomic Research Centre (BARC) 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.[1]

India has plans to build six fast breeder reactors by 2030, which will significantly increase its capacity to produce plutonium for weapons.[2] A 500 megawatt-electric (MW(e)) prototype fast breeder reactor (PFBR) is being built at the Indira Gandhi Centre for Atomic Research (IGCAR) complex at Kalpakkam, Tamil Nadu. The PFBR is capable of producing approximately 140 kilogrammes per year of weapon-grade plutonium in its blankets.[3] The reactor is expected to achieve first criticality in 2016.[4]

India currently has two reprocessing centres in operation—at Tarapur and Kalpakkam—dedicated to separating plutonium to produce MOX fuel for civilian reactors. The Kalpakkam Reprocessing Plant (KARP), which was commissioned in 1998, has also been used to separate plutonium for military purposes. In 2015 the director of IGCAR announced that the country's first fast reactor fuel reprocessing plant would be built at Kalpakkam to reprocess spent fuel from the PFBR and future fast breeder reactors. The plant is scheduled to be commissioned by the end of 2019.[5]

India is currently expanding its uranium enrichment capabilities. It continues to enrich uranium at the small centrifuge facility at the Rattehalli

[1] International Panel on Fissile Materials (IPFM), *Global Fissile Material Report 2015: Nuclear Weapon and Fissile Material Stockpiles and Production* (IPFM: Princeton, NJ, 2014), p. 26.

[2] A fast-breeder reactor is one that produces more material for a nuclear fission reaction than it consumes.

[3] IPFM (note 1), p. 27.

[4] 'India plans six more fast reactors', Nuclear Engineering International, Online news, 3 Dec. 2015.

[5] 'India to get first fast reactor fuel reprocessing plant in TN for Rs 9,600 crore', Economic Times (India), 27 Aug. 2015.

Table 16.7. Indian nuclear forces, January 2016

Type (US/Indian designation)	Launchers deployed	Year first deployed	Range (km)[a]	Warhead loading[b]	No. of warheads[c]
Aircraft[d]	*~36–48*				*~36–48*
Mirage 2000H	~32	1985	1 850	1 x bomb	~32
Jaguar IS	~16	1981	1 600	1 x bomb	~16
Land-based ballistic missiles	*~56*				*~56*
Prithvi II	~24	2003	250	1 x 12 kt	~24
Agni-I	~20	2007	>700	1 x 12 kt	~20
Agni-II	~8	2011	>2 000	1 x 12 kt	~8
Agni-III	~4	(2014)	>3 200	1 x 12 kt	~4
Agni-IV	0	(2016)	>3 500	1 x 12 kt	. .
Agni-V	0	(2017)	>5 200	1 x 12 kt	. .
Sea-based ballistic missiles	*~2*				*~14*
Dhanush	2	(2013)	350	1 x 12 kt	2
K-15 (B05)	(12)	(2017)	700	1 x 12 kt	(12)
K-4	0	. .	~3 000	1 x . .	. .
Cruise missiles	. .	. .	. .	. .	. .
Total					**~106 (118)**[e]

. . = 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. 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.

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

[e] The warheads for the K-15 SLBM may already have been produced.

Sources: Indian Ministry of Defence, annual reports and press releases; International Institute for Strategic Studies, *The Military Balance 2015* (Routledge: London, 2015); US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, May 2013); 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.[6] India appears to be building a second gas centrifuge uranium hexafluoride facility at the RMP, which could support an increasing number of centrifuges for uranium

[6] Kelley, R. and Cloughey, B., 'Nuclear option: India increases its uranium enrichment programme', *Jane's Intelligence Review*, vol. 26, no. 7 (July 2014), pp. 8–15.

enrichment.[7] India's expanding centrifuge enrichment capacity is motivated by plans to build new naval propulsion reactors, but the HEU produced at the plants could also be used to manufacture boosted-fission or thermonuclear weapons.[8]

India has begun construction of a new industrial-scale centrifuge enrichment plant, the Special Material Enrichment Facility (SMEF), at a site in Chitradurga district, Karnataka.[9] According to the chairman of the Indian Atomic Energy Commission, the plant will have both civilian and military roles and will not be under International Atomic Energy Agency (IAEA) safeguards.[10] BARC has confirmed that SMEF will be a 'large scale' dual-use facility, comparable to the Rare Materials Plant.[11]

Aircraft

Although India has prioritized the development of missiles for nuclear delivery roles, aircraft have so far constituted the most mature component of India's nuclear strike capabilities (see table 16.7). The Indian Air Force (IAF) has reportedly certified the Mirage 2000H multi-role combat aircraft for delivery of nuclear gravity bombs.[12] It is widely speculated that that some of the IAF's four squadrons of ageing Jaguar IS fighter-bombers may also have a nuclear delivery role.[13]

Land-based missiles

India continues to prioritize the development of its nuclear-capable land-based missile force. The road-mobile, single-stage Prithvi-II short-range ballistic missile, was the first Indian missile officially acknowledged to have a nuclear delivery role when it was inducted into service in 2003. The Indian Army conducted two successful test-flights of Prithvi-II missiles in 2015—on 19 February and 26 November—as part of its regular user-readiness trials.[14]

[7] Albright, D. and Kelleher-Vergantini, S., 'Construction finishing of likely new Indian centrifuge facility at rare materials plant', Institute for Science and International Security (ISIS) Imagery Brief, 4 Dec. 2013.

[8] Kelley and Cloughey (note 6); and Levy, A., 'India is building a top-secret nuclear city to produce thermonuclear weapons, experts say', *Foreign Policy*, 16 Dec. 2015.

[9] Albright, D. and Kelleher-Vergantini, S., 'India's new enrichment plant in Karnataka', Institute for Science and International Security (ISIS) Imagery Brief, 1 July 2014, p. 2.

[10] Jha, S., 'Enrichment capacity enough to fuel nuke subs', IBNLive, 26 Nov. 2011.

[11] 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).

[12] 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.

[13] The Sukhoi Su-30MKI combat aircraft has also been mentioned as having a possible nuclear role.

[14] PTI, 'India successfully test-fires N-capable Prithvi II missile', *Indian Express*, 26 Nov. 2015.

Indian defence sources indicate that the family of longer-range Agni ballistic missiles, which is also part of the Defence Research and Development Organization's (DRDO) Integrated Guided Missile Development Programme, has largely taken over the Prithvi's nuclear delivery role. The 700-kilometer range Agni-I (designated the A1 by the Indian Ministry of Defence, MOD) is a single-stage, solid-fuelled mobile missile that is in service with the Indian Army. During a regular training exercise on 27 November 2015, the Strategic Forces Command (SFC), which is the body responsible for exercising operational command and control over India's nuclear weapons, carried out a successful test-launch of an Agni-I missile at the Integrated Test Range complex on Wheeler Island, off the Odisha coast.[15] The Agni-II is a two-stage, solid-fuelled rail- and road-mobile ballistic missile that can deliver a 1000-kg payload to a range exceeding 2000 km. The missile has been deployed by the Indian army.[16]

The Agni-III is a two-stage, solid-fuelled mobile missile with a range exceeding 3000 km. On 16 April 2015 the SFC conducted a successful test-launch of an Agni-III from the Wheeler Island test complex as part of an army user-trial to establish the 'repeatability' of the missile's performance.[17] The Agni-III was inducted into service in 2011 but may not be fully operational.

The DRDO has been developing a longer-range version of the Agni-II, known previously as the Agni-II Prime but re-designated the Agni-IV. According to DRDO officials, the two-stage Agni-IV incorporates several technological advances, including composite rocket engines, improved stage separation and a state-of-the-art navigation system.[18] The missile, which has been inducted into service, was test-launched on 19 November 2015 as part of an army user-trial, although full operational capability has probably not yet been achieved.[19]

The DRDO has prioritized the development of the long-range, three-stage Agni-V missile. Indian analysts have emphasized that the near-intercontinental ballistic missile range of the Agni-V allows it to strike targets throughout China, thereby strengthening India's nuclear deterrence capabilities.[20] The missile incorporates a number of new indigenously developed propulsion and navigation system technologies. Unlike the other Agni missiles, the Agni-V is designed to be stored in and launched from a new mobile canister system, which reduces the time required to place the missiles on

[15] PTI, 'India successfully test-fires Agni-I missile', *The Hindu*, 27 Nov. 2015.

[16] PTI, 'Nuclear-capable Agni-II missile test fired', *Hindustan Times*, 9 Nov. 2014; and Indo-Asian News Service (IANS), 'India test-fires nuclear capable Agni-II missile', *Times of India*, 9 Nov. 2014.

[17] Mallikarjun, Y., 'Agni-III missile test-fired successfully by SFC', *The Hindu*, 16 Apr. 2015.

[18] Pandit, R., 'With China in mind, India tests new-generation Agni missile with high "kill efficiency"', *Times of India*, 16 Nov. 2011.

[19] Pandit, R., 'Ballistic missile Agni-IV test-fired as part of user trial', *Times of India*, 9 Nov. 2015.

[20] PTI, 'Agni-V, capable of reaching China, test-fired successfully', *Times of India*, 19 Apr. 2012.

alert in a crisis.[21] On 31 January 2015 an Agni-V missile was test-fired for the first time using the canister system.[22] It was the third successful test of an Agni-V.

Some Indian defence industry officials have indicated that India is pursuing a technology development programme for multiple independently targetable re-entry vehicles (MIRVs). However, it is not clear that the Indian government has authorized development of MIRVs for its longer-range missiles.[23]

Sea-based missiles

India continues to develop the naval leg of its triad of nuclear forces in pursuit of an assured second-strike capability. Its first indigenously built nuclear-powered submarine, INS *Arihant*, was launched after numerous delays in 2009, under the Advanced Technology Vessel project dating from the 1970s. The 6000-tonne submarine began sea trials in 2014 following 18 months of harbour tests.[24] A second Arihant class nuclear submarine is under construction, and work on a third submarine is believed to be at an early stage. Indian defence sources indicated in 2015 that the Indian Navy plans to induct the *Arihant* into service by early 2016.[25]

The DRDO has tested components of an underwater missile-launch system and is developing a two-stage medium-range missile that can be launched from a submerged Arihant class submarine. Indian MOD statements have designated the missile the K-15 or B05.[26] The 700-km range K-15 has been described as a 'hybrid missile' that combines aspects of both cruise and ballistic missiles. Unlike the latter, its flight trajectory can be controlled after launch. The *Arihant* is equipped with a four-tube vertical launch system and will reportedly carry a total of 12 K-15 missiles.[27] On 26 November 2015 the

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

[22] Bedi, R., 'India test-fires canister-launched Agni 5 missile', *Jane's Defence Weekly*, 1 Feb. 2015.

[23] Jha, S., 'The Indian move towards MIRVs', IBN Live, 1 Feb. 2014; and 'DRDO gears up for canister launch of Agni-V', *Indian Express*, 1 Feb. 2016.There has also been speculation that the K-15 submarine-launched ballistic missile (SLBM) might be given a MIRV capability, but the missile appears too small to carry multiple warheads. O'Donnell, F., 'Managing India's missile aspirations', Institute for Defence Studies and Analyses (IDSA), IDSA Comment, 10 Feb. 2013.

[24] Bedi, R., 'India's first SSBN embarks on sea trials', *Jane's Navy International*, 15 Dec. 2014.

[25] Indo-Asian News Service, 'Indian Navy keen on fielding indigenous nuclear-powered submarine at international fleet review', *Economic Times* (Mumbai), 18 Oct. 2015.

[26] Unnithan, S., 'The secret "K" missile family', *India Today*, 20 Nov. 2010; and Rai, R., 'The inside story of SLBM K-15', *Indian Defence Review*, 11 Feb. 2013.

[27] Bedi (note 24); and United States Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, May 2013), p. 25.

SFC and the DRDO jointly conducted the first of a series of underwater ejection test of a dummy missile from the submarine.[28]

The DRDO is developing a two-stage submarine-launched ballistic missile (SLBM), known as the K-4, which will have a range of up to 3500 km.[29] This would allow the missile to reach targets in Pakistan and most of China if it was launched from the northern Indian Ocean. The K-4 will eventually replace the K-15 missile in arming the Arihant class submarines. The DRDO is also reported to be developing a 5000-km range SLBM, designated the K-5.[30]

The 350-km range Dhanush missile is a naval version of the Prithvi-II that is launched from a stabilization platform mounted on a surface ship. The missile, which has been inducted into service, provides India with a rudimentary sea-based nuclear strike capability. As part of regular user trials, the SFC carried out two successful test-launches of Dhanush missiles in 2015—on 9 April and 24 November—from a warship deployed off the Odisha coast.[31]

Cruise missiles

India is developing the Nirbhay subsonic ground-launched cruise missile, with a range of 700–1000 km, that is widely rumoured to be nuclear-capable, but there is no evidence that the Indian government has decided to equip the missile with a nuclear warhead. The DRDO has encountered technical problems with the Nirbhay's guidance and flight control systems that have delayed the missile testing and evaluation programme. On 16 October 2015 a flight test had to be terminated by ground controllers after the missile's guidance system failed.[32] A Nirbhay flight test in 2013 had been similarly aborted, and a test in 2014 had been declared only a 'partial success'.[33]

India is developing a sea-launched version of the Nirbhay for the Arihant class submarine. There are unconfirmed reports that it is also developing an air-launched version for delivery by the Su-30MKI combat aircraft.[34]

[28] 'Confirmed: First Ejection Test of K-15 (B-05) SLBM from INS Arihant SSBN', Indian Defence News, 28 Nov. 2015.

[29] Rout, H. K., 'Longest range ballistic missile all set for undersea launch', *New Indian Express*, 10 Dec. 2013; and Unnithan (note 26).

[30] Isby, D., 'India's K-4 SLBM awaits first launch', *Jane's Missiles & Rockets*, vol. 17, no. 8 (Aug. 2013).

[31] Mallikarjun, Y., 'Dhanush missile successfully test-fired from ship', *The Hindu*, 9 Apr. 2015: and Indo Asian News Service, 'India test fires n-capable Dhanush missile', 24 Nov. 2015.

[32] Pandit, R., 'Nuclear-capable Nirbhay missile bites the dust for second time', *Times of India*, 16 Oct. 2015; and Bedi, R., 'India's Nirbhay cruise missile fails third test flight', *Jane's Missiles & Rockets*, vol. 19, no. 10 (Oct. 2015).

[33] Pandit (note 32).

[34] TASS, 'India begins development of the Nirbhay subsonic cruise missile for the Su-30MKI', Russia and India Report, 12 Feb. 2015.