

## VI. Indian nuclear forces

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India is estimated to have a growing arsenal of 120–130 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. India is widely believed to be gradually 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 plutonium-based. 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.

India plans to build six fast breeder reactors by 2030, which will significantly increase its capacity to produce plutonium that could be used for building weapons.<sup>1</sup> An unsafeguarded 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 expected to achieve first criticality in 2017 following several technical delays.<sup>2</sup> The IGCAR has announced that a Fast Reactor Fuel Cycle Facility (FRFCF) 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 the end of 2019.<sup>3</sup>

India is currently expanding its uranium enrichment capabilities. It continues to enrich uranium at the small gas centrifuge facility at the Rattehalli Rare Materials Plant (RMP) near Mysore, Karnataka, to produce highly enriched uranium (HEU) for use as naval reactor fuel, and it appears to be building a second enrichment facility at the site.<sup>4</sup> India has begun construction of a new industrial-scale centrifuge enrichment plant, the Special Material Enrichment Facility (SMEF), at a site in Karnataka. It will be a dual-use facility that produces HEU for both military and civilian purposes.<sup>5</sup>

<sup>1</sup> 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.

<sup>2</sup> Rohit, T. K., 'Prototype Fast Breeder Reactor likely to be delayed', *The Hindu*, 30 July 2016.

<sup>3</sup> Indo-Asian News Service (IANS), 'India to get first fast reactor fuel reprocessing plant in TN for Rs 9600 crore', *Economic Times* (India), 27 Aug. 2015.

<sup>4</sup> Kelley, R. and Cloughesy, B., 'Nuclear option: India increases its uranium enrichment programme', *Jane's Intelligence Review*, vol. 26, no. 7 (July 2014), pp. 8–15.

<sup>5</sup> 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,

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.<sup>6</sup>

## Aircraft

Aircraft constitute the most mature component of India's nuclear strike capabilities (see table 11.7). The Indian Air Force (IAF) has reportedly certified the Mirage 2000H multi-role combat aircraft for delivery of nuclear gravity bombs.<sup>7</sup> It is widely speculated that the IAF's Jaguar IS fighter-bomber may also have a nuclear delivery role.<sup>8</sup>

## 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, 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 largely taken over the Prithvi's nuclear delivery role.

The Agni-I is a single-stage, rail- and road-mobile missile that has a range of 700 kilometres carrying a maximum 2-tonne payload. During a user trial conducted by the Indian Army on 22 November 2016, an Agni I was successfully test launched at the Integrated Test Range complex located on Abdul Kalam Island (previously known as Wheeler Island), off the Odisha coast.<sup>9</sup>

The Agni-II is a two-stage, rail- and road-mobile ballistic missile that can deliver a 1000-kilogram payload to a maximum range of 2000 km. The missile is operational with the Indian army under the control of the Strategic Forces Command. The Agni-III is a two-stage, rail-mobile missile with a range exceeding 3000 km. It was inducted into service in 2011 and is thought to be operational.

India is developing two longer-range ballistic missiles, the Agni-IV and the Agni-V, that would give it the capability to strike targets throughout

<sup>2</sup> Nov 2015).

<sup>6</sup> Levy, A., 'India is building a top-secret nuclear city to produce thermonuclear weapons, experts say', *Foreign Policy*, 16 Dec. 2015.

<sup>7</sup> 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.

<sup>8</sup> Cohen, S. and Dasgupta, S., *Arming Without Aiming: India's Military Modernization* (Brookings Institution Press: Washington, DC, 2010), pp. 77–78; and 'SEPECAT Jaguar is India's only tactical nuclear carrying and ground attack aircraft', India Defence Update, 13 Dec. 2016.

<sup>9</sup> Press Trust of India, 'India test-fires Agni-I ballistic missile', *Times of India*, 22 Nov. 2016.

**Table 11.7.** Indian nuclear forces, January 2017

Type (US/Indian designation)	Launchers deployed	Year first deployed	Range (km) <sup>a</sup>	Warheads x yield <sup>b</sup>	No. of warheads <sup>c</sup>
<i>Aircraft<sup>d</sup></i>	48				48
Mirage 2000H	32	1985	1 850	1 x bomb	32
Jaguar IS	16	1981	1 600	1 x bomb	16
<i>Land-based ballistic missiles</i>	<b>68</b>				68
Prithvi II	24	2003	250	1 x 12 kt	24
Agni-I	20	2007	>700	1 x 12 kt	20
Agni-II	16	2011	>2 000	1 x 12 kt	16
Agni-III	8	(2014)	>3 200	1 x 12 kt	8
Agni-IV	0	(2018)	>3 500	1 x 12 kt	0
Agni-V	0	(2020)	>5 200	1 x 12 kt	0
<i>Sea-based ballistic missiles</i>	2				2
Dhanush	2	(2013)	350	1 x 12 kt	2
K-15 (B05) <sup>e</sup>	(4)	(2018)	700	1 x 12 kt	(12)
K-4	0	..	3 000	1 x ..	0
<i>Cruise missiles</i>	..	..	..	..	..
<b>Total</b>					<b>120–130<sup>f</sup></b>

.. = not available or not applicable; () = uncertain figure; kt = kiloton.

<sup>a</sup> 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.

<sup>b</sup> 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 2-stage thermonuclear warheads.

<sup>c</sup> 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.

<sup>d</sup> Other fighter-bombers that could potentially have a secondary nuclear role include the Su-30MKI.

<sup>e</sup> Some sources have referred to the K-15 missile as Sagarika, which was the name of the missile development project.

<sup>f</sup> The warheads for the K-15 submarine-launched ballistic missile (SLBM) may already have been produced.

Sources: Indian Ministry of Defence, annual reports and press releases; International Institute for Strategic Studies, *The Military Balance 2016* (Routledge: London, 2016); 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.

Pakistan and most of China. The two-stage, road-mobile Agni-IV missile is undergoing development and user trials and had been flight tested five times as of the end of December 2016. It is not yet operational.

The DRDO has prioritized the development of the road-mobile, three-stage Agni-V missile with a range exceeding 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.<sup>10</sup> On 26 December 2016 an Agni-V missile was test launched for the second time from a sealed canister mounted on a truck located at the Integrated Test Range complex. The missile flew on a programmed depressed trajectory for a reduced range of 2500 km.<sup>11</sup> It marked the fourth successful flight test of the Agni-V since 2012. The missile will have to undergo several additional test flights before it becomes operational.

India is pursuing a technology development programme for multiple independently targetable re-entry vehicles (MIRVs). However, there are conflicting statements from DRDO officials as to whether India will deploy MIRVs on the Agni-V or a future Agni-VI with an even longer range.<sup>12</sup> The Agni-VI is awaiting approval, but may begin testing as early as 2018.

### **Sea-based missiles**

India continues to develop the naval component 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, began sea trials at the end of 2014 and was formally commissioned in August 2016, although the boat will not become operational for some time.<sup>13</sup> A second, larger Arihant class submarine, INS *Aridaman*, is under construction, and work on a third submarine is believed to be at an early stage.<sup>14</sup>

The *Arihant* is equipped with a four-tube vertical launch system and will carry 12 two-stage, 700-km range K-15 (also known as the B05) submarine-launched ballistic missiles (SLBMs). In November 2015 the Strategic Forces Command and the DRDO reportedly jointly conducted the first in a series of underwater ejection tests of a dummy missile from the *Arihant*, but the maiden flight test of a K-15 from the submarine had not been conducted as of the end of 2016.<sup>15</sup>

The DRDO is developing a two-stage, 3500-km range SLBM, known as the K-4, that will eventually replace the K-15. On 7 March 2016 a K-4 missile was

<sup>10</sup> Aroor, S., ‘New chief of India’s military research complex reveals brave new mandate’, *India Today*, 13 July 2013.

<sup>11</sup> Bedi, R., ‘India’s first SSBN embarks on sea trials’, IHS Jane’s 360, 15 Dec. 2014; and Rout, H. K., ‘India successfully test-fires Agni-V missile for a reduced range’, *New Indian Express*, 26 Dec. 2016.

<sup>12</sup> See Basrur, R. and Sankaran, J., ‘India’s slow and unstoppable move to MIRV’, eds M. Krepon et al., *The Lure and Pitfalls of MIRVs: From the First to the Second Nuclear Age* (Stimson Center: Washington, DC, May 2016), pp. 149–76.

<sup>13</sup> Bedi (note 11); and ‘Now, India has a nuclear triad’, *The Hindu*, 18 Oct. 2016.

<sup>14</sup> Indian Defence Update, ‘India’s 2nd nuclear submarine “INS Aridhaman” to be deadlier than INS Arihant’, 27 Dec. 2016.

<sup>15</sup> Indian Defence News, ‘Confirmed: first ejection test of K-15 (B-05) SLBM from INS Arihant SSBN’, 28 Nov. 2015.

successfully launched from a submerged platform in the Bay of Bengal off the Visakhapatnam coast.<sup>16</sup> On 31 March a K-4 missile carrying a dummy payload was reportedly successfully launched from the *Arihant*.<sup>17</sup> The *Arihant* will only be able to carry four K-4 SLBMs, but the larger *Aridaman*, equipped with eight launch tubes, will be able to carry eight of the missiles.<sup>18</sup>

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. The missile is thought to be operational.

### Cruise missiles

India has been developing a nuclear-capable subsonic cruise missile since 2004. Known as the Nirbhay, it is thought to have ground-, sea- and air-launched versions. The missile, which has a range of 700–1000 km, is similar to Pakistan's Babur cruise missile and the US Tomahawk cruise missile. However, after four failed tests—one of which was described as a 'partial success'—sources within the DRDO indicated at the end of 2016 that the programme is likely to be terminated.<sup>19</sup>

<sup>16</sup> Rout, H. K., 'K-4 missile test a roaring success', *New Indian Express*, 16 Mar. 2016.

<sup>17</sup> Rout, H. K., 'Maiden test of undersea K-4 missile from Arihant submarine', *New Indian Express*, 9 Apr. 2016.

<sup>18</sup> Rout (note 17).

<sup>19</sup> Pandit, R., 'Nuclear-capable Nirbhay cruise missile's test fails for the fourth time', *Economic Times*, 21 Dec. 2016; Subramanian, T. S., 'Nirbhay missile test "an utter failure"', *The Hindu*, 21 Dec. 2016; and Rout, H. K., 'DRDO's cruise missile project Nirbhay on verge of closure', *New Indian Express*, 23 Dec. 2016.