

IX. North Korea's military nuclear capabilities

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The Democratic People's Republic of Korea (DPRK, or North Korea) maintains an active but highly opaque nuclear weapon programme. It is estimated that North Korea may have produced 10–20 nuclear weapons (see table 6.10). This is based on calculations of the amount of plutonium that North Korea may have separated from the spent fuel produced by its 5 megawatt-electric (MW(e)) graphite-moderated research reactor at the Yongbyon Nuclear Scientific Research Center (YNSRC) and assumptions about North Korean weapon design and fabrication skills. North Korea is believed to be increasing its limited holdings of weapon-usable plutonium (see section X), although assessments differ about the scale and pace of the increase.¹ In 2017 commercial satellite imagery and thermal imagery indicated that the Radiochemical Laboratory at the YNSRC might be continuing to operate intermittently to separate plutonium from the reactor's spent fuel rods.²

In 2016 North Korea publicly acknowledged that it was producing highly enriched uranium (HEU) for nuclear weapons.³ There has been considerable speculation that North Korea is seeking to build warheads using HEU as the fissile material in order to overcome the constraints imposed by its limited holding of separated plutonium. However, it is not known whether it has done so. Furthermore, little is known about North Korea's stock of HEU or its uranium enrichment capacity.⁴

On 3 September 2017 North Korea conducted its sixth nuclear test explosion at the Punggye-ri underground test site in the north-east of the country.⁵ Following the explosion, the North Korean Nuclear Weapons Institute announced that the event was a successful test of a hydrogen bomb that could be delivered by an intercontinental ballistic missile (ICBM).⁶ Many commentators assessed, based on indirect evidence, that North Korea's

¹ See e.g. Yonhap News Agency, 'North Korea has 50 kg of weapons-grade plutonium: Seoul's Defense White Paper', 11 Jan. 2017; and Albright, D. and Kelleher-Vergantini, S., 'Plutonium, tritium and highly enriched uranium production at the Yongbyon nuclear site', Institute for Science and International Security, Imagery Brief, 14 June 2016.

² Bermudez, J. et al., 'North Korea's Yongbyon facility: probable production of additional plutonium for nuclear weapons', 38 North, US–Korea Institute, 14 July 2017.

³ Kyodo News Agency, 'North Korea confirms restart of plutonium processing', *Japan Times*, 17 Aug. 2016.

⁴ Albright and Kelleher-Vergantini (note 1); and Hecker, S. et al., *North Korean Nuclear Facilities After the Agreed Framework*, Working Paper (Freeman Spogli Institute for International Studies, Stanford University: Stanford, CA, 2016).

⁵ For a technical assessment of the test and an overview of global nuclear weapon tests since 1945 see section XI of this chapter.

⁶ Korean Central News Agency, 'DPRK Nuclear Weapons Institute on successful test of H-bomb for ICBM', 3 Sep. 2017.

claim that the nuclear explosive device tested was a thermonuclear weapon was plausible.⁷ However, some experts noted that in the absence of the detection of leaked radioactive debris characteristic of a thermonuclear explosion, it was not possible to rule out that North Korea had tested another type of weapon design, such as a boosted composite device or even a large fission-only device.⁸

North Korea had previously conducted nuclear tests at the site in October 2006, May 2009, February 2013, and January and September 2016.⁹ The estimated yields (explosive energy) of the tests have progressively increased.

Ballistic missiles

North Korea is expanding and modernizing its ballistic missile force, which consists of 10 types of indigenously produced short-, medium- and intermediate-range systems that are either deployed or under development. It is developing a road-mobile ICBM as well as a submarine-launched ballistic missile (SLBM). In 2017 North Korea conducted 20 known missile tests, compared with 24 tests in 2016. Of the seven different types of missile tested in 2017, four had not been previously tested.¹⁰

In a speech on 1 January 2018, the North Korean leader, Kim Jong Un, said that the country would begin to mass-produce nuclear warheads and ballistic missiles.¹¹ There is no publicly available evidence to confirm North Korea's claim that it has built a nuclear warhead that is sufficiently compact to be delivered by a ballistic missile. In 2017 the Defense Intelligence Agency of the United States reportedly concluded that North Korea had successfully designed and produced an operational nuclear weapon that could be delivered by a ballistic missile.¹² In the 2016 edition of its biennial Defense White Paper, South Korea's Ministry of National Defense noted that North Korea had 'reached a significant level' of technical progress towards building a miniaturized warhead, but it did not state whether it believed that North Korea had succeeded in doing so.¹³ Other elements of the

⁷ See e.g. Lewis, J., 'Welcome to the thermonuclear club, North Korea!', *Foreign Policy*, 4 Sep. 2017.

⁸ Dominguez, G., 'North Korea conducts its sixth and largest nuclear test', *Jane's Defence Weekly*, 13 Sep. 2017, p. 6.

⁹ On the earlier tests see Fedchenko, V. and Ferm Hellgren, R., 'Nuclear explosions, 1945–2006', *SIPRI Yearbook 2007*; Fedchenko, V., 'Nuclear explosions, 1945–2009', *SIPRI Yearbook 2010*; Fedchenko, V., 'Nuclear explosions, 1945–2013', *SIPRI Yearbook 2014*; and Fedchenko, V., 'Nuclear explosions, 1945–2016', *SIPRI Yearbook 2017*.

¹⁰ James Martin Center for Nonproliferation Studies, North Korea Missile Test Database, 30 Nov. 2017. North Korea conducted an additional test in 2017 but the missile type is not known.

¹¹ Korean Central News Agency, 'Kim Jong-un makes new year address', 1 Jan. 2018.

¹² Warrick, J., Nakashima, E. and Fifield, A., 'North Korea now making missile-ready nuclear weapons, US analysts say', *Washington Post*, 8 Aug. 2017.

¹³ Park, B., '2016 Defense White Paper estimates North Korea has 50kg of plutonium', *Hankyoreh*, 12 Jan. 2017.

Table 6.10. North Korean forces with potential nuclear capability, January 2018

Type ^a	Range (km)	Payload (kg)	Status	No. of warheads
<i>Land-based ballistic missiles</i>				..
Hwasong-7 (Nodong)	>1 200	1 000	Single-stage, liquid-fuel missile. Fewer than 100 launchers; first deployed in 1990	
Hwasong-9 (Scud-ER)	1 000	500	Scud missile variant, lengthened to carry additional fuel	
Bukkeukseong-2 (KN-15)	1 000	..	2-stage, solid-fuel missile launched from canister launcher. Land-based version of Bukkeukseong-1 SLBM; test launched twice in 2017	
Hwasong-10 (BM-25, Musudan)	>3 000	(1 000)	Single-stage, liquid-fuel missile under development; several failed test launches in 2016	
Hwasong-12 (KN-17)	3 300–4 500	1 000	Single-stage, liquid-fuel missile under development; although half of 2017 test launches failed, North Korea declared it operational after Sep. 2017 test launch	
Hwasong-13 (KN-08) ^b	>5 500	..	3-stage, liquid-fuel missile with potential intercontinental range under development; no known test launches	
Hwasong-14 (KN-20)	6 700–10 400	500–1 000	2-stage, liquid-fuel missile under development; test launched twice in 2017	
Hwasong-15 (KN-22)	8 500–13 000	1 000–1 500	2-stage, liquid-fuel missile under development; test launched once in 2017	
Taepodong-2 ^c	12 000	..	Under development; 3-stage space launch vehicle variant placed satellites in orbit in 2012 and 2016	
<i>Submarine-launched ballistic missiles</i>				
Bukkeukseong-1 (KN-11)	2-stage, solid-fuel SLBM under development, replacing earlier liquid-fuel version	
Total				(10–20)^d

.. = not available or not applicable; () = uncertain figure; SLBM = submarine-launched ballistic missile.

^a The operational capability of North Korean warheads is uncertain. While there is speculation that some medium-range ballistic missiles might have operational nuclear capability, there is no authoritative open-source evidence that North Korea has developed and tested a functioning re-entry vehicle that is capable of carrying a nuclear warhead on a long-range ballistic missile and deployed warheads with operational forces. This table lists the ballistic missiles that could potentially have a nuclear delivery role, although that does not imply that each type is a mass-produced operational weapon system.

^b A longer-range variant, the KN-14, is under development but has yet to be test launched.

^c A 2-stage Taepodong-1 missile was unsuccessfully flight tested in 1998.

^d SIPRI's estimate is that North Korea may have fissile material for between 20 and 30 warheads. After 6 tests, 1 of which was more than 200 kilotons, North Korea might have a small number of deliverable nuclear warheads.

Sources: US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat*, various years; *IHS Jane's Strategic Weapon Systems*, various issues; International Institute for Strategic Studies, *The Military Balance 2018* (Routledge: London, 2018); 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

US intelligence community and military have expressed doubt about the operational capability of, in particular, the warheads on long-range missiles. The South Korean Vice Defense Minister, Suh Choo-suk, stated in August 2017 that 'Both the United States and South Korea do not believe North Korea has yet completely gained re-entry technology in material engineering terms'.¹⁴ Vice Chairman of the Joint Chiefs of Staff, US General Paul Selva, added in January 2018 that 'What [North Korea] has not demonstrated yet are the fusing and targeting technologies and survivable re-entry vehicle'.¹⁵

Medium- and intermediate-range ballistic missiles

Assuming that North Korea is able to produce a sufficiently compact warhead, some observers assess that the size, range and operational status of the Hwasong-7, also known as the Nodong, medium-range missile make it the system most likely to be given a nuclear delivery role.¹⁶ Based on a Soviet-era Scud missile design, the Nodong is a single-stage, liquid-fuelled ballistic missile with an estimated range exceeding 1200 kilometres. The North Korean Army's Strategic Rocket Force Command carried out five test launches of Nodong missiles in 2016.¹⁷ No tests were conducted in 2017.

North Korea has developed the single-stage, liquid-fuelled Hwasong-9, also known as the Scud-ER (extended-range) system. Based on the Hwasong-6 (Scud C variant) missile with a lengthened fuselage to carry additional fuel, the Scud-ER has an estimated range of 1000 km.¹⁸ On 6 March 2017 four Scud-ER missiles were test fired simultaneously from the Sohae Satellite Launch complex in north-western North Korea.¹⁹ According to some reports, a fifth Scud-ER may have failed to launch.²⁰ The missiles flew nearly 1000 km and landed in the Sea of Japan, approximately

¹⁴ 'N. Korea still needs time to perfect re-entry technology: S. Korea vice def min', Reuters, 13 Aug. 2017.

¹⁵ Ali, I., 'US general says North Korea not demonstrated all components of ICBM', Reuters, 30 Jan. 2018.

¹⁶ See e.g. Fitzpatrick, M., 'North Korea nuclear test on hold?', Shangri-La Voices, International Institute for Strategic Studies, 27 May 2014.

¹⁷ Three of the missile flight tests were apparently successful, but 2 of the missiles exploded (1 in July 2016 and 1 in Aug. 2016) shortly after launch. Kwon, K., Berlinger, J. and Hanna, J., 'North Korea fires 2 ballistic missiles, South Korea and US say', CNN, 3 Aug. 2016.

¹⁸ US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, July 2017), pp. 18, 25.

¹⁹ Bermudez, J. and Liu, J., 'North Korea's Sohae Satellite Launching Station: Scud-ER launch site visible; activity at vertical engine test stand', 38 North, US-Korea Institute, 17 Mar. 2017.

²⁰ Schmerler, D., 'Did North Korea test a fifth missile last week?', NK News, 16 Mar. 2017.

350 km from the Japanese island of Honshu.²¹ The test raised concerns in Japan that North Korea was developing an ability to launch salvos of missiles capable of overwhelming Japan's ballistic missile defence systems, including those that have yet to be deployed.²²

The Hwasong-10 missile, also designated the Musudan or BM-25, is a single-stage, liquid-fuelled missile with an estimated range exceeding 3000 km. The Musudan was first unveiled at a military parade in 2010. Flight testing began in 2016, with multiple failures.²³ No flight tests of the Musudan are known to have been conducted in 2017 and the status of the missile development programme is unclear.

The Hwasong-12 (also referred to by the US Department of Defense, DOD, designation KN-17) is a single-stage, intermediate-range missile that is believed to have a new liquid-propellant booster engine as well as design features that may serve as a technology test bed for a future ICBM.²⁴ Some analysts have speculated that the missile carries a small post-boost vehicle (PBV) that, in addition to increasing its maximum range, can be used to improve warhead accuracy.²⁵ The missile has an estimated range of 3300–4500 km, which would be sufficient to strike US military bases in the western Pacific Ocean, including on the island of Guam. A Hwasong-12 missile was successfully test launched for the first time on 14 May 2017.²⁶ Three tests conducted the previous month reportedly all failed.²⁷ On 28 August the North Korean Army's Strategic Rocket Force Command test launched a Hwasong-12 missile that travelled 2700 km, flying over Hokkaido in northern Japan before breaking up into three pieces during re-entry and falling into the Pacific Ocean.²⁸ The missile's flight path over Japan was strongly condemned by the Japanese Government.²⁹ A Hwasong-12 missile that was

²¹ Hancocks, P. and Westcott, B., 'North Korea fires four missiles into the Sea of Japan', CNN, 7 Mar. 2017.

²² Rich, M., 'North Korea launch could be test of new attack strategy, Japan analysts say', *New York Times*, 6 Mar. 2017.

²³ Savelsberg, R. and Kiessling, J., 'North Korea's Musudan missile: a performance assessment', 38 North, US–Korea Institute, 20 Dec. 2016. In 2016 North Korea conducted 8 flight tests of the Musudan system. Only 1 of the tests was judged to have been successful. In the other tests, the missiles exploded on launch or shortly thereafter.

²⁴ Yi, Y., 'Hwasong-12 a stepping stone in North Korea's ICBM development', *Hankyoreh*, 16 May 2017; and Savelsberg, R., 'A quick technical analysis of the Hwasong-12 missile', 38 North, US–Korea Institute, 19 May 2017.

²⁵ Elleman, M., 'North Korea's Hwasong-12 launch: a disturbing development', 38 North, US–Korea Institute, 30 Aug. 2017.

²⁶ Felstead, P. and Gibson, N., 'North Korea fires new missile to 2000 km altitude', *Jane's Defence Weekly*, 24 May 2017, p. 8.

²⁷ Panda, A., 'Exclusive: North Korea tested its new intermediate-range ballistic missile 3 times in April 2017', *The Diplomat*, 3 June 2017.

²⁸ Elleman (note 25); and Felstead, P. and Gibson, N., 'North Korean IRBM flies over Japan', *Jane's Defence Weekly*, 6 Sep. 2017, p. 5.

²⁹ Fifield, A., 'North Korean missile flies over Japan escalating tensions and prompting an angry response from Tokyo', *Washington Post*, 28 Aug. 2017; and McCurry, J., 'Trump and Abe vow to

test launched on 15 September also flew over Japan and travelled 3700 km—the longest distance by a North Korean missile to date—before landing in the Pacific Ocean.³⁰ Unlike previous tests, the missile was fired from a transporter-erector-launcher vehicle rather than from a concrete platform, which indicates a higher level of operational readiness.³¹

North Korea is developing the Bukkeukseong-2 missile ('Polaris-2', US DOD designation, KN-15), which is a land-based variant of the Bukkeukseong-1 SLBM. The two-stage, solid-fuelled missile has an estimated maximum range exceeding 1000 km.³² The missile was first flight tested on 12 February 2017, followed by a second test on 21 May 2017.³³ Some analysts noted that North Korea's development of the Bukkeukseong-2 was probably part of an effort to improve the survivability of its nuclear-capable ballistic missile systems. Solid-fuelled missiles can be fired more quickly than liquid-fuelled systems and require fewer support vehicles that might give away their position to overhead surveillance.³⁴

Intercontinental-range ballistic missiles

North Korea is widely believed to have prioritized building and deploying a long-range ballistic missile that can deliver a nuclear warhead to targets in the continental USA. In recent years it has pursued the serial development of several missile systems with progressively longer ranges and increasingly sophisticated delivery capabilities.

The Hwasong-13 (US DOD designation, KN-08) was first presented by North Korea as a road-mobile, three-stage missile with intercontinental range at a military parade in April 2012, although some non-governmental analysts have argued that the missiles displayed were only mock-ups.³⁵ Estimates of the range and payload capabilities of the missile are highly speculative. No test launch had been conducted as of the end of 2017.

North Korea has developed the Hwasong-14 (US DOD designation, KN-20), a prototype ICBM that first appeared in 2015 at a military parade in Pyongyang.³⁶ The two-stage missile appears to use the same high-energy

increase pressure after North Korea fires missile over Japan', *The Guardian*, 29 Aug. 2017.

³⁰ 'North Korea fires second missile over Japan', BBC News, 15 Sep. 2017.

³¹ Graham, C., Boyle, D. and Connor, N., 'North Korea fires second missile over Japan as US tells China and Russia to take "direct action"', *Daily Telegraph*, 15 Sep. 2017; and Panda, A., 'North Korea shows increased operational confidence in the Hwasong-12 IRBM', *The Diplomat*, 17 Sep. 2017.

³² US Air Force, National Air and Space Intelligence Center (note 18), p. 25.

³³ Felstead, P. and Gibson, N., 'North Korea tests Trump with ballistic missile launch', *Jane's Defence Weekly*, 22 Feb. 2017, p. 16; and BBC News, 'North Korea confirms "successful" new ballistic missile test', 21 May 2017.

³⁴ Panda, A., 'It wasn't an ICBM, but North Korea's first missile test of 2017 is a big deal', *The Diplomat*, 14 Feb. 2017.

³⁵ Schiller, M. and Kelley, R., 'Evolving threat: North Korea's quest for an ICBM', *Jane's Defence Weekly*, 18 Jan. 2017, p. 24.

³⁶ Schiller and Kelley (note 35).

liquid-propellant booster engine as the single-stage Hwasong-12.³⁷ The missile was test launched from mobile platforms twice in 2017, on 4 July and 28 July. In both tests the missiles were fired on elevated trajectories to avoid flying over Japan and reached maximum altitudes of 2800 km and 3700 km, respectively. The second test might not have been completely successful, as a lightweight re-entry vehicle carried by the missile apparently disintegrated before reaching the ground.³⁸ The Hwasong-14 is estimated to have a range of up to 10 400 km, depending on the payload and flight trajectory.³⁹

North Korea is developing a new two-stage ICBM, the Hwasong-15 (US DOD designation, KN-22) that has a significantly larger second stage and more powerful booster engines than the Hwasong-14. The first flight test was conducted on 28 November 2017, when a Hwasong-15 was launched on an elevated trajectory and flew higher and for a longer duration than any previous North Korean missile. One estimate put the theoretical maximum range of the Hwasong-15 on a normal trajectory at up to 13 000 km—sufficient to reach Washington, DC, and other targets on the east coast of the USA.⁴⁰ The missile was assessed to be carrying a light payload, however, and the range would be significantly reduced if it were carrying a heavier payload such as a nuclear warhead.⁴¹ According to a North Korean Government statement issued after the test, the Hwasong-15 is ‘an intercontinental ballistic rocket tipped with super-large heavy warhead which is capable of striking the whole mainland of the US’ that ‘meets the goal of the completion of the rocket weaponry system’.⁴²

Overall, in 2017 North Korea made progress towards building an operational ICBM across a range of technical challenges at a pace that surprised many experts.⁴³ Some analysts pointed out that North Korea had yet to validate the performance and reliability of an ICBM system, in particular that of the missile’s re-entry vehicle.⁴⁴ However, estimates of the time required for it to do so shortened during the year. According to a July 2017 media report, the US Defense Intelligence Agency had concluded that North Korea would be able to produce a ‘reliable, nuclear-capable ICBM’ some time in 2018. The

³⁷ According to 1 non-governmental analyst, North Korea probably acquired the engine through illicit channels operating in Russia or Ukraine. Elleman, M., ‘The secret to North Korea’s ICBM success’, IISS Voices blog, International Institute for Strategic Studies, 14 Aug. 2017.

³⁸ Schilling, J., ‘What’s next for North Korea’s ICBM?’, 38 North, US–Korea Institute, 1 Aug. 2017.

³⁹ Wright, D., ‘North Korean ICBM appears able to reach major US cities’, All Things Nuclear blog, Union of Concerned Scientists, 28 July 2017.

⁴⁰ Wright, D., ‘Re-entry of North Korea’s Hwasong-15 missile’, All Things Nuclear blog, Union of Concerned Scientists, 7 Dec. 2017.

⁴¹ Elleman, M., ‘North Korea’s third ICBM launch’, 38 North, US–Korea Institute, 29 Nov. 2017; and Wright (note 40).

⁴² Korean Central News Agency, ‘DPRK Gov’t statement on successful test-fire of new-type ICBM’, 29 Nov. 2017.

⁴³ Broad, W. and Sanger, D., ‘How US Intelligence agencies underestimated North Korea’, *New York Times*, 6 Jan. 2018.

⁴⁴ Wright (note 40); and Elleman (note 41).

US intelligence community had previously assessed that North Korea would not have a credible ICBM capability until 2020 at the earliest.⁴⁵ In his statement in August 2017, Choo-suk noted that North Korea would need ‘at least one or two more years’ to master the re-entry vehicle technology required for a long-range missile delivery system.⁴⁶

Submarine-launched ballistic missiles

North Korea is developing an SLBM called the Bukkeukseong-1 (‘Polaris-1’, US DOD designation, KN-11). The missile is now a two-stage, solid-fuelled design after initial test failures using a liquid-fuelled missile.⁴⁷ In August 2016, following a series of failed attempts, North Korea conducted the first successful underwater test launch of the Bukkeukseong-1 missile from an experimental submarine.⁴⁸ In 2017 North Korea conducted a series of successful underwater ejection tests—that is, tests designed to evaluate stabilization systems and the process of ejecting the missile from a submerged launch tube—but it did not conduct any flight tests of the missile.⁴⁹ Most observers assess that North Korea still has numerous technical challenges to overcome before it will be able to design, build and deploy an operational SLBM force. However, commercial satellite imagery of the shipyard in Sinpo from November 2017 revealed that North Korea appeared to be building a new, larger submarine capable of launching an SLBM.⁵⁰ As the year ended, concerns about North Korea’s technical progress towards achieving an SLBM capability spurred the USA, Japan and South Korea to conduct military drills for tracking submarine missile launches by North Korea.⁵¹

⁴⁵ Nakashima, E., Fifield, A. and Warrick J., ‘North Korea could cross ICBM threshold next year, US officials warn in new assessment’, *Washington Post*, 25 July 2017.

⁴⁶ ‘N. Korea still needs time to perfect re-entry technology: S. Korea vice def min’ (note 14).

⁴⁷ Schilling, J., ‘A new submarine-launched ballistic missile for North Korea’, 38 North, US–Korea Institute, 25 Apr. 2016.

⁴⁸ Park, J. M. and Kim, J., ‘North Korea fires submarine-launched ballistic missile towards Japan’, Reuters, 24 Aug. 2016.

⁴⁹ Ryall, J., ‘North Korea carries out “unprecedented” test of submarine missile system’, *Daily Telegraph*, 1 Aug. 2017.

⁵⁰ Bermudez, J., ‘North Korea’s submarine ballistic missile program moves ahead: indications of shipbuilding and missile ejection testing’, 38 North, US–Korea Institute, 16 Nov. 2017.

⁵¹ Mullany, G., ‘North Korean submarine missile threat prompts US-led military drills’, *New York Times*, 11 Dec. 2017.