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. As of January 2020, it is estimated that North Korea possessed approximately 30–40 nuclear weapons (see table 10.10). This is based on calculations of the amount of fissile material—plutonium and highly enriched uranium (HEU)—that North Korea is estimated to have produced for use in nuclear weapons (see section X) and on assumptions about its weapon design and fabrication skills.[1]

In 2019 North Korea continued to adhere to the moratoria on nuclear explosive tests and flight tests of long-range ballistic missiles that had been announced by North Korean leader Kim Jong Un in April 2018.[2] North Korea did, however, conduct multiple tests of guided artillery rocket systems and several new types of short-range ballistic missile (SRBM) in 2019. It also conducted the first flight test of a new submarine-launched ballistic missile (SLBM).

Fissile material production

North Korea's plutonium production and separation capabilities for manufacturing nuclear weapons are located at the Yongbyon Nuclear Scientific Research Centre (YNSRC).[3] In 2019 some of the nuclear facilities located there appeared not to be operating. In August the International Atomic Energy Agency (IAEA) reported that its analysis of satellite imagery and remote-sensor data showed no indications that the ageing 5 megawatt-electric (MW(e)) graphite-moderated research reactor located at the YNSCR had been in operation since the end of 2018.[4] In addition, the IAEA reported that there were no indications that reprocessing activities were under way at the adjacent Radiochemical Laboratory used to separate plutonium from

[1] For a discussion of US intelligence and other assessments of North Korea's nuclear warhead status see Kile, S. N. and Kristensen, H. M., 'North Korea's military nuclear capabilities', *SIPRI Yearbook 2019*, pp. 343–44.

[2] Korean Central News Agency, 'Third Plenary Meeting of Seventh CC, WPK held in presence of Kim Jong Un', 21 Apr. 2018. North Korea conducted underground nuclear test explosions in Oct. 2006, May 2009, Feb. 2013, Jan. and Sep. 2016, and Sep. 2017. The estimated explosive yields of the tests progressively increased.

[3] For an assessment of North Korea's nuclear weapon production facilities and infrastructure see Hecker, S. S., Carlin, R. L. and Serbin, E. A., 'A comprehensive history of North Korea's nuclear program: 2018 update', Center for International Security and Cooperation, Stanford University, 11 Feb. 2019, p. 3.

[4] International Atomic Energy Agency, 'Application of safeguards in the Democratic People's Republic of Korea', Report to the Board of Governors by the Acting Director General, GOV/2019/33-GC(63)/20, 19 Aug. 2019, p. 4; and Pabian, F. V., Liu, J. and Makowsky, P., 'North Korea's Yongbyon Nuclear Complex: No sign of operations', 38 North, 15 Mar. 2019.

the 5-MW(e) reactor's spent fuel rods.[5] In November 2019 commercial satellite imagery analysed by non-governmental experts indicated that the Experimental Light Water Reactor (ELWR) under construction at Yongbyon, which is also capable of producing plutonium for nuclear weapons, was undergoing system tests but had not yet commenced operation.[6]

There is considerable uncertainty about North Korea's uranium enrichment capabilities and its stock of HEU. It is widely believed that North Korea has focused on the production of HEU for use in nuclear warheads to overcome its limited capacity to produce weapon-grade plutonium. In 2019 satellite imagery analysis indicated that North Korea continued to operate the gas centrifuge enrichment plant located at the Yongbyon complex that it had declared in 2010.[7] Using commercial satellite imagery, several non-governmental researchers have identified a suspected covert uranium enrichment plant located at Kangsong, to the south-west of Pyongyang.[8] However, analysts cautioned that without access to the plant it was not possible to confirm the nature and purpose of the activities being conducted there.[9] A US intelligence assessment in 2018 reportedly concluded that North Korea probably had more than one covert uranium enrichment plant and that the country was seeking to conceal the types and numbers of production facilities in its nuclear weapon programme.[10]

Land-based ballistic missiles

North Korea is expanding and modernizing its ballistic missile force, which consists of indigenously produced short-, medium- and long-range missile systems that are either deployed or under development.[11] In recent years it has pursued the serial development of several missile systems with progressively longer ranges and increasingly sophisticated delivery capabilities.[12]

[5] International Atomic Energy Agency (note 4). The plutonium separated from the reactor's spent fuel can be used for the production of nuclear weapons.

[6] Serbin, E. and Puccioni, A., 'North Korea's Experimental Light Water Reactor: Possible testing of cooling system', 38 North, 6 Dec. 2019.

[7] Pabian, F. V. and Liu, J., 'North Korea's Yongbyon nuclear facilities: Well-maintained but showing limited operations', 38 North, 9 Jan. 2019; and Hecker, Carlin and Serbin (note 3), pp. 3–4.

[8] Panda, A., 'Exclusive: Revealing Kangson, North Korea's first covert uranium enrichment site', The Diplomat, 13 July 2018; and Albright, D., 'Kangsong: A suspect uranium enrichment plant', Imagery Brief, Institute for Science and International Security, 2 Oct. 2018.

[9] Hecker, Carlin and Serbin (note 3), p. 4; and Madden, M., 'Much ado about Kangson', 38 North, 3 Aug. 2018.

[10] Kube, C., Dilanian, K. and Lee, C. E, 'North Korea has increased nuclear production at secret sites, say US officials', NBC News, 1 July 2018; and Nakashima, E. and Warrick, J., 'North Korea working to conceal key aspects of its nuclear program, US officials say', *Washington Post*, 30 June 2018.

[11] Center for Strategic and International Studies Missile Defence Project, 'Missiles of North Korea', Missile Threat, accessed Jan. 2020.

[12] James Martin Center for Nonproliferation Studies (CNS), CNS North Korea Missile Test Database, accessed Jan. 2020. North Korea conducted 20 known tests of such missiles in 2017.

Table 10.10. North Korean forces with potential nuclear capability, January 2020

Type[a]	Range (km)	Payload (kg)	Status	No. of warheads
Land-based ballistic missiles				..
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	..	Single-stage, solid-fuel missile under development launched from canister TEL. Land-based version of Bukkeukseong-1 SLBM; test launched in 2017.	
Hwasong-10 (BM-25, Musudan)	>3 000	[1 000]	Single-stage, liquid-fuel missile under development; several failed tests in 2016.	
Hwasong-12 (KN-17)	>3 000	1 000	Single-stage, liquid-fuel missile under development.	
Hwasong-13 (KN-08)[b]	>5 500	..	Three-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	Two-stage, liquid-fuel missile under development; tested in 2017.	
Hwasong-15 (KN-22)	13 000	1 000–1 500	Two-stage, liquid-fuel missile under development; two tests in 2017.	
Taepodong-2[c]	12 000	..	Under development; three-stage space launch vehicle variant placed satellites in orbit in Dec. 2012 and Feb. 2016.	
Submarine-launched ballistic missiles				..
Bukkeukseong-3	[1 900]	..	Two-stage, solid-fuel SLBM under development, replacing earlier Bukkeukseong-1 version. First flight tested in Oct. 2019.	
Total				**[30–40]**[d]

.. = not available or not applicable; [ ] = uncertain figure; SLBM = submarine-launched ballistic missile; TEL = transporter-erector-launcher.

[a] This table lists the ballistic missiles that could potentially have a nuclear capability. There is no publicly available evidence that North Korea has produced an operational nuclear warhead for delivery by an intercontinental-range ballistic missile.

[b] A two-stage variant, the KN-14, is under development but has yet to be test launched.

[c] A two-stage Taepodong-1 missile was unsuccessfully flight tested in 1998.

[d] SIPRI's estimate is that North Korea may have enough fissile material to build between 30 and 40 nuclear warheads. It is unknown how many warheads may have been assembled.

Sources: US Department of Defense (DOD), Office of the Secretary of Defense, *Missile Defense Review 2019* (DOD: Arlington, VA, 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); *IHS Jane's Strategic Weapon Systems*, various issues; *Bulletin of the Atomic Scientists*, 'Nuclear notebook', various issues; and authors' estimates.

However, the flight tests were stopped in 2018, and the United States' Department of Defense (DOD) reported in January 2019 that none of the new longer-range ballistic missiles (Hwasong-10/12/13/14/15 or Bukkeokseong-1/2) had been deployed.[13]

In December 2019 North Korea conducted two sustained static firings of rocket engines at the Sohae Vertical Engine Test Stand.[14] Some analysts suggested that North Korea had ground tested a large, solid-fuel rocket motor designed for a new long-range ballistic missile.[15] However, others suggested that it was more likely that the test involved either a new, unknown liquid-fuel engine or an existing one.[16]

Short-range ballistic missiles

In 2019 North Korea conducted the initial launches of at least three new types of solid-fuelled SRBM.[17] One missile, designated by the US DOD as the KN-23, externally resembles the Russian Iskander-M SRBM.[18] The missile has an estimated maximum range exceeding 600 kilometres and was flight tested four times in 2019.[19] A second missile, designated by the US DOD as the KN-25, uses a large-calibre, multiple-launch rocket system and has a demonstrated range of 380 km.[20] A third missile, the KN-24, resembles an enlarged version of the US Army Tactical Missile System (ATACMS).[21] It was tested twice in 2019 and has an estimated range of 400 km.[22]

There is very little open-source information about the technical dimensions of the new SRBMs, including their ranges, accuracy and missile defence penetration capabilities. In 2019 some analysts speculated that the

[13] US Department of Defense (DOD), Office of the Secretary of Defense, *Missile Defense Review 2019* (DOD: Arlington, VA, 2019), p. 7.

[14] Warrick, J., 'North Korea never halted efforts to build powerful new weapons, experts say', *Washington Post*, 24 Dec. 2019.

[15] Ankit Panda (@nktpnd), 'Also, given the "very important" test that's set to improve their "strategic position"—and now Kim Yong Chol talking about surprises—we have more reason to expect the demonstration of a *qualitatively new* capability that we haven't seen before. Solid-fuel ICBM/IRBM looks likely', Twitter, 9 Dec. 2019.

[16] Elleman, M., 'North Korea's rocket engine test: What we know and don't know', 38 North, 10 Dec. 2019.

[17] Center for Strategic and International Studies Missile Defence Project, 'North Korean missile launches & nuclear tests: 1984-present', Missile Threat, 25 Mar. 2020.

[18] Lewis, J., 'Preliminary analysis: KN-23 SRBM', Middlebury Institute of International Studies at Monterey, James Martin Center for Nonproliferation Studies, 5 June 2019.

[19] Center for Strategic and International Studies Missile Defence Project, 'KN-23', Missile Threat, accessed Jan. 2020.

[20] Center for Strategic and International Studies Missile Defence Project, 'KN-25', Missile Threat, accessed Jan. 2020; and Byrne, L., 'North Korea tests "super-large" multiple rocket launch system: KCNA', NK News, 24 Aug. 2019.

[21] Elleman, M., 'North Korea's new short-range missiles: A technical evaluation', 38 North, 9 Oct. 2019; and Panda, A., 'North Korea tests new type of short-range ballistic missile', The Diplomat, 12 Aug. 2019.

[22] Center for Strategic and International Studies Missile Defence Project, 'KN-24', Missile Threat, accessed Jan. 2020.

KN-23 and perhaps the KN-24 missiles might be so-called dual-capable systems—that is, assigned delivery roles for both conventional and nuclear warheads.[23] They raised concerns that such a capability could create a 'new level of unpredictability' in military decision making because neither the USA nor South Korea would be able to ascertain whether an incoming missile of one of these types was nuclear armed and they might therefore respond disproportionately.[24] However, while older inaccurate SRBMs might have been developed with dual capability, there is no publicly available authoritative information confirming a nuclear delivery role for the more accurate KN-23 (or KN-24).[25]

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 or Nodong (also transliterated as Rodong) medium-range missile make it the system most likely to be given a nuclear delivery role.[26] Based on a Soviet-era Scud missile design, the Nodong is a single-stage, liquid-fuelled ballistic missile with an estimated range exceeding 1200 km. In addition, North Korea has developed the single-stage, liquid-fuelled Hwasong-9 or Scud-ER (extended-range), which may also be a nuclear-capable delivery 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.[27]

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.[28] No flight tests of the Musudan are known to have been conducted since 2016–17, and the status of the missile development programme is unclear.

The Hwasong-12 (also referred to by the US DOD designation KN-17) is a single-stage, intermediate-range missile that is believed to have a new

[23] Denyer, S., 'Fast, low and hard to stop: North Korea's missile tests crank up the threat level', *Washington Post*, 15 Aug. 2019; and Lewis (note 18).

[24] Kim, D. and Hanham, M., 'North Korean missiles: Size does not matter', *Bulletin of the Atomic Scientists*, 15 May 2019.

[25] For an unofficial technical assessment that did not assign nuclear capability to the KN-23 see Elleman (note 21).

[26] See e.g. Fitzpatrick, M., 'North Korea nuclear test on hold?', Shangri-La Voices, International Institute for Strategic Studies, 27 May 2014; and Albright, D., 'North Korean miniaturization', 38 North, 13 Feb. 2013.

[27] 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.

[28] Savelsberg, R. and Kiessling, J., 'North Korea's Musudan missile: A performance assessment', 38 North, 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.

liquid-propellant booster engine as well as design features that may serve as a technology test bed for a future intercontinental-range ballistic missile (ICBM).[29] Some analysts have speculated that the missile carries a small post-boost vehicle that, in addition to increasing its maximum range, can be used to improve warhead accuracy.[30] The missile, which has an estimated range of more than 3000 km, was last test launched in 2017 but has not been deployed.[31]

North Korea is developing the Bukkeukseong-2 missile (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 range of approximately 1000 km.[32] It was flight tested twice in 2017. Some analysts have 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.[33]

Intercontinental-range ballistic missiles

North Korea is widely believed to have prioritized building and deploying an ICBM that could potentially deliver a nuclear warhead to targets in the continental USA. However, there has remained considerable uncertainty in assessments of North Korea's current long-range missile capabilities.[34]

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. As of 2019, it had not been flight tested.

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

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

[30] Elleman, M., 'North Korea's Hwasong-12 launch: A disturbing development', 38 North, 30 Aug. 2017.

[31] Panda, A., 'North Korea shows increased operational confidence in the Hwasong-12 IRBM', The Diplomat, 17 Sep. 2017; and US Department of Defense (note 13).

[32] US Air Force, National Air and Space Intelligence Center (note 27), p. 25.

[33] 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.

[34] Albert, E., 'North Korea's military capabilities', Council on Foreign Relations, updated 20 Dec. 2019.

[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] Based on a flight test conducted in 2017, analysts have estimated that the missile's range was unlikely to exceed 8000 km when carrying a 500 kilogram payload, which is thought to be around the weight of a nuclear warhead. This meant that the missile could not reach targets in the USA beyond the West Coast when launched from North Korea.[38]

North Korea is developing a new two-stage ICBM, the Hwasong-15 (US DOD designation, KN-22), which has a significantly larger second stage and more powerful booster engines than the Hwasong-14. The first flight test was conducted in 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.[39] 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.[40]

While North Korea has made important progress towards building a nuclear-armed ICBM capable of credibly threatening the USA, it has yet to validate the performance and reliability of the missile systems under development.[41] In particular, defence analysts have pointed out that North Korea has not demonstrated a mastery of the technology for building a reliable atmospheric re-entry vehicle or for terminal-stage guidance and warhead activation.[42] The US DOD's 2019 *Missile Defense Review* indicated that North Korea had deployed one ICBM, the Taepodong-2.[43] However, other official US sources list the missile as a space-launch vehicle that would need reconfiguration to be used as an ICBM.[44]

Submarine-launched ballistic missiles

North Korea continues to pursue the development of an SLBM system as part of an effort to improve the survivability of its nuclear-capable ballistic missile

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

[38] Elleman, M., 'North Korea's Hwasong-14 ICBM: New data indicates shorter range than many thought', 38 North, 29 Nov. 2018.

[39] Wright, D., 'Re-entry of North Korea's Hwasong-15 missile', All Things Nuclear blog, Union of Concerned Scientists, 7 Dec. 2017.

[40] Elleman, M., 'North Korea's third ICBM launch', 38 North, 29 Nov. 2017.

[41] Acton, J., 'Assessing North Korea's progress in developing a nuclear-armed ICBM', Carnegie Endowment for International Peace, 4 May 2018.

[42] Wright (note 39); and Elleman (note 40). See also Ali, I., 'US general says North Korea not demonstrated all components of ICBM', Reuters, 30 Jan. 2018.

[43] US Department of Defense (note 13), p. 7.

[44] See e.g. US Defense Intelligence Agency (DIA), *Global Nuclear Landscape 2018* (DIA: Washington, DC, 2018), p. 22.

systems. In October 2019 North Korea announced that it had test launched 'a new type' of SLBM called the Bukkeukseong-3 (also transliterated as Pukguksong-3).[45] The test was conducted from a towed underwater platform in the waters off North Korea's east coast. The missile was a two-stage, solid-fuelled design, but it was unclear whether it used the same booster engine as the Bukkeukseong-1 SLBM that preceded it. With an estimated maximum range of 1900 km, the Bukkeukseong-3 would be the longest-range, solid-fuelled missile in the North Korean inventory.[46]

During 2019, North Korea demonstrated that it had made progress towards achieving its goal of designing, building and eventually deploying an operational ballistic missile submarine. Currently, North Korea has one Sinpo class experimental submarine in service, which can hold and launch one SLBM. A visit by North Korean leader Kim Jong Un to the Sinpo South Shipyard in July 2019 revealed circumstantial evidence that North Korea was building a new ballistic missile submarine.[47] The vessel appeared to be based on a modified Romeo class diesel-electric submarine and fitted with three missile-launch canisters.[48] According to the state-run Korean Central News Agency, the submarine's operational deployment was 'near at hand'.[49]

[45] Korean Central News Agency, 'DPRK succeeds in test-firing new-type submarine-launched ballistic missile', 2 Oct. 2019; Lee, J., 'North Korea says it successfully tested new submarine-launched ballistic missile', Reuters, 2 Oct. 2019; and Ji, D., 'Pukguksong-3 SLBM test-launch is "powerful blow" to hostile forces: Rodong Sinmun', NK News, 4 Oct. 2019.

[46] Panda, A., 'North Korea finally unveils the Pukguksong-3 SLBM: First takeaways', The Diplomat, 3 Oct. 2019; and Center for Strategic and International Studies Missile Defence Project (note 11).

[47] Bermudez, J. and Cha, V., 'Sinpo South Shipyard: Construction of a new ballistic missile submarine?', Beyond Parallel, Centre for Strategic and International Studies, 28 Aug. 2019.

[48] Liu, J. and Town, J., 'North Korea's Sinpo South shipyard: Recent activity', 38 North, 26 Sep. 2019; and Hotham, O., 'New North Korean submarine capable of carrying three SLBMs: South Korean MND', NK News, 31 July 2019.

[49] Yonhap News Agency, 'NK leader inspects new submarine to be deployed in East Sea: State media', 23 July 2019.