

VIII. North Korean nuclear forces

HANS M. KRISTENSEN AND MATT KORDA*

The Democratic People's Republic of Korea (DPRK, or North Korea) maintains an active but highly opaque nuclear weapon programme. SIPRI estimates that, as of January 2023, North Korea possessed around 30 nuclear weapons (see table 7.9, end of section), but that it probably possessed sufficient fissile material for an approximate total of 50–70 nuclear devices, depending on warhead design.

These estimates are based on calculations of the amount of fissile material—plutonium and highly enriched uranium (HEU)—that North Korea is believed to have produced for use in nuclear weapons (see section X), its nuclear weapon testing history and its observable missile forces. Analysing the numbers and types of North Korean warheads and delivery vehicles is fraught with uncertainty due to limited and untrustworthy public sources. Most of the data presented here is derived from sources outside North Korea, including satellite imagery, United States government reports and statements (which may also be biased), and expert analyses.¹

North Korea has conducted a total of six nuclear explosive tests: in 2006, 2009, 2013, twice in 2016, and most recently 2017.² In January 2020 the North Korean government announced that it would no longer observe the moratorium on conducting nuclear explosive tests or flight tests of intermediate-range and intercontinental ballistic missiles that it imposed upon itself in 2018.³ It actually ended the moratorium in 2022 by launching a Hwasong-12 (KN17) intermediate-range ballistic missile (IRBM).⁴ This publicly acknowledged long-range ballistic missile launch was part of an unprecedentedly busy year of missile testing for North Korea: it conducted more than 90 tests of short-range ballistic missiles (SRBMs), medium-range ballistic missiles (MRBMs), land-attack cruise missiles, hypersonic glide vehicles (HGVs), submarine-launched ballistic missiles (SLBMs), IRBMs and intercontinental ballistic missiles (ICBMs).

In addition, in January 2021 the North Korean leader, Kim Jong Un, announced that North Korea had been able to develop tactical (i.e.

¹ Kristensen, H. M. and Korda, M., 'Estimating world nuclear forces: An overview and assessment of sources', SIPRI Commentary, 14 June 2021.

² Fedchenko, V., 'Nuclear explosions, 1945–2017', *SIPRI Yearbook 2018*.

³ Nebhay, S., 'North Korea abandons nuclear freeze pledge, blames "brutal" US sanctions', Reuters, 21 Jan. 2020.

⁴ For the missiles and submarines discussed in this section, a designation in parentheses (e.g. KN17 in this case) following the North Korean designation (e.g. Hwasong-12) is the designation assigned by the US Department of Defense.

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non-strategic) nuclear weapons and ‘a super-large hydrogen bomb’.⁵ The latter claim might refer to a weaponized design of the nuclear device that was tested in 2017 and is suspected to have had a thermonuclear yield.⁶ Kim also emphasized the need to ‘make nuclear weapons smaller and lighter for more tactical uses’, possibly for deployment on some of the new shorter-range missiles that were test launched in 2021–22.⁷

This section continues by summarizing the role played by nuclear weapons in North Korea’s military doctrine. It then outlines the country’s capabilities for production of fissile material and nuclear warheads before describing its missiles and missile programmes.

The role of nuclear weapons in North Korean military doctrine

North Korea has repeatedly signalled through doctrinal commitments and the testing of new capabilities that it will continue to develop its long- and short-range nuclear capabilities to serve as both a deterrent and potentially a response to any perceived threat.

According to North Korea’s 2013 Law on Consolidating the Position of a Self-defence Nuclear Power, the country’s nuclear arsenal would only be used ‘to repel invasion or attack from a hostile nuclear weapons state and make retaliatory strikes’, and nuclear weapons would not be used against non-nuclear states ‘unless they join a hostile nuclear weapons state in its invasion and attack on the DPRK’.⁸ In a speech in October 2020, Kim Jong Un reiterated North Korea’s pledge not to use nuclear weapons ‘preemptively’.⁹ This does not constitute a no-first-use policy, however, since Kim made it clear that he could turn to nuclear weapons if ‘any forces infringe upon the security of our state’.¹⁰

The development of tactical weapons with lower yields could indicate plans to have the capability to respond on a more limited scale to threats that do not meet the threshold for a full-scale nuclear attack. In 2022 North Korea tested several short-range missiles that state media claimed were meant for deploying tactical nuclear weapons, and it even launched a barrage of missiles that simulated use of its tactical battlefield nuclear weapons to ‘hit and

⁵ Korean Central News Agency, ‘On report made by Supreme Leader Kim Jong Un at eighth Party Congress of WPK’, KCNA Watch, 9 Jan. 2021.

⁶ Fedchenko (note 2), p. 299.

⁷ Korean Central News Agency (note 5); and ‘Respected comrade Kim Jong Un guides military drills of KPA units for operation of tactical nukes’, *Rodong Sinmun*, 10 Oct. 2022.

⁸ [Law on Consolidating the Position of a Self-defence Nuclear Power], adopted by the Supreme People’s Assembly 1 Apr. 2013, articles 4 and 5 (in Korean). For an English translation see Korean Central News Agency, ‘Law on consolidating position of nuclear weapons state adopted’, Korea News Service, 1 Apr. 2013.

⁹ ‘Kim Jong Un’s October speech: More than missiles’, 38 North, 13 Oct. 2020.

¹⁰ ‘Kim Jong Un’s October speech’ (note 9). On North Korea’s nuclear doctrine and likely targets see also Kristensen, H. M. and Korda, M., ‘North Korean nuclear forces’, *SIPRI Yearbook 2022*, pp. 411–15.

wipe out the set objects'.¹¹ The eventual deployment of tactical weapons also raises questions about North Korea's nuclear command and control, particularly surrounding whether Kim has pre-delegated nuclear launch authority to his battlefield commanders.

Notably, on 8 September 2022 the North Korean Parliament, the Supreme People's Assembly, passed a law promulgating a new doctrine that specified updated principles and conditions for the use of nuclear weapons.¹² The law, which updated and repealed the 2013 law, requires that North Korea's nuclear forces are 'regularly ready for action'.¹³ It also clarifies that nuclear weapons could be used pre-emptively—contradicting the pledge from October 2020—in response to a perceived nuclear or non-nuclear attack on North Korea's leadership or the command structure of its nuclear forces, or other significant attack against a strategic target.¹⁴ It also suggests that North Korea could use nuclear weapons to 'seize the initiative' during wartime.¹⁵ In a speech to the assembly, Kim Jong Un declared that the law codified North Korea's 'irreversible' status as a nuclear-armed state and that it would 'never give up' its nuclear weapons.¹⁶

Further, in December 2022 the plenary meeting of the Central Committee of the Worker's Party of Korea (WPK) highlighted the importance of 'mass-producing of tactical nuclear weapons' for use against regional targets, in Japan and the Republic of Korea (South Korea).¹⁷ It also noted that the first mission of North Korea's nuclear force is to 'deter war and safeguard peace and stability', but that, if deterrence fails, it will 'carry out the second mission, which will not be for defense'. North Korea's strategy also includes the development of another ICBM system 'whose main mission is quick nuclear counterstrike'.¹⁸ This probably refers to North Korea's planned development of a solid-fuelled ICBM, which would allow launch crews to maintain a higher state of readiness and execute a quicker launch process than a liquid-fuelled ICBM.

¹¹ 'Respected comrade Kim Jong Un guides military drills' (note 7).

¹² [Law on the Nuclear Weapons Policy of the Democratic People's Republic of Korea], adopted by the Supreme People's Assembly 8 Sep. 2022 (in Korean). For an English translation see Korean Central News Agency, 'Law on DPRK's policy on nuclear forces promulgated', DPRK Today, 9 Sep. 2022.

¹³ [Law on the Nuclear Weapons Policy] (note 12), Article 7.

¹⁴ [Law on the Nuclear Weapons Policy] (note 12), Article 6.

¹⁵ [Law on the Nuclear Weapons Policy] (note 12), Article 6.

¹⁶ *Rodong Sinmun*, [State administration speech by dear comrade Kim Jong Un at the 7th session of the 14th Supreme People's Assembly of the Democratic People's Republic of Korea 8 September Juche 111 (2022)], KCNA Watch, 9 Sep. 2022 (in Korean, author translation).

¹⁷ 'Report on 6th enlarged plenary meeting of 8th WPK Central Committee', *Minju Choson*, 1 Jan. 2023.

¹⁸ 'Report on 6th enlarged plenary meeting' (note 17).

Fissile material and warhead production

Plutonium-production and -separation capabilities

North Korea's plutonium-production and -separation capabilities for manufacturing nuclear weapons are located at the Yongbyon Nuclear Scientific Research Centre in North Pyongan province.¹⁹ Since its inspectors were required to leave the country in 2009, the International Atomic Energy Agency (IAEA) has monitored North Korea's nuclear programme using open-source information and commercial satellite imagery.²⁰

The Yongbyon complex houses an ageing 5-megawatt-electric (MW(e)) graphite-moderated research reactor, from which plutonium can be extracted. Between December 2018 and July 2021 the IAEA found no signs that the reactor had been operational; however, in August 2021 the IAEA reported that there were indications that this had changed.²¹ These indications of the reactor's likely operational status were confirmed in September 2022 by the IAEA director general, Rafael Grossi.²² It remains unclear whether North Korea has resumed construction of the 50-MW(e) reactor at Yongbyon that began in the 1980s. However, various activities observable at the site suggest that construction may have restarted in early 2022.²³

In July 2022 commercial satellite imagery revealed smoke emitting from the thermal plant at the Yongbyon complex, which supplies steam to the radiochemistry laboratory used for plutonium reprocessing. This suggests that, although the plant may not be operating at full power, it could have been in early stages of preparation for a reprocessing campaign or treatment of radioactive waste.²⁴ New activity was also observed for the first time since 2016 at Building 500, a facility used to store radioactive and toxic waste produced at the radiochemistry laboratory.²⁵

Throughout 2021 and 2022, commercial satellite imagery indicated that North Korea continued construction of a new experimental light

¹⁹ 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', Stanford University, Center for International Security and Cooperation, 11 Feb. 2019.

²⁰ Dixit, A., 'IAEA ready to undertake verification and monitoring in North Korea', International Atomic Energy Agency (IAEA), 4 Mar. 2019.

²¹ International Atomic Energy Agency (IAEA), Board of Governors and General Conference, 'Application of safeguards in the Democratic People's Republic of Korea', Report by the director general, GOV/2021/40-GC(65)/22, 27 Aug. 2021, para. 12; and Pabian, F., Town, J. and Liu, J., 'North Korea's Yongbyon nuclear complex: More evidence the 5 MWe reactor appears to have restarted', 38 North, 30 Aug. 2021.

²² Grossi, R. M., Introductory statement to the Board of Governors, International Atomic Energy Agency (IAEA), 12 Sep. 2022.

²³ Lewis, J., Pollack, J. and Schmerler, D., 'North Korea resuming construction at the Yongbyon 50 MW(e) reactor', Arms Control Wonk, 10 May 2022.

²⁴ Makowsky, P. et al., 'North Korea's Yongbyon Nuclear Research Center: Plutonium production continues', 38 North, 28 July 2022.

²⁵ Makowsky et al. (note 24).

water reactor at Yongbyon, which will eventually be capable of producing plutonium for nuclear weapons.²⁶ Grossi stated in September 2022 that construction of these new buildings may have been completed.²⁷

In 2022 the South Korean Ministry of National Defense estimated that North Korea's plutonium stockpile had increased to approximately 70 kilograms, an increase of 20 kg in two years.²⁸ This is approximately 30 kg more than the estimate used for SIPRI's assessment of North Korea's nuclear weapon holdings (see section X). The latter estimate takes into account reductions to the plutonium stockpile as a result of North Korea's six nuclear tests. In April 2021 Siegfried Hecker—a former senior official in the US nuclear programme who was given unprecedented access to North Korean nuclear facilities over several years—estimated that North Korea's plutonium stocks could increase by up to 6 kg per year at full operation.²⁹

Uranium-enrichment capabilities

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. However, there is considerable uncertainty about North Korea's uranium-enrichment capabilities and its stock of HEU.

North Korea produces yellowcake—the raw material for reactor fuel rods—at its Pyongsan Uranium Concentrate Plant (Nam-chon Chemical Complex) in North Hwanghae province.³⁰ The IAEA director general reported in September 2022 that North Korea continued to operate its gas centrifuge enrichment facility after its floor space was expanded by approximately one-third of its original size.³¹ These activities were visible on satellite imagery throughout 2021 and 2022.³²

A classified intelligence assessment by the USA in 2018 reportedly concluded that North Korea probably had more than one covert uranium-enrichment

²⁶ IAEA, GOV/2021/40-GC(65)/22 (note 21), para. 12; and Bermudez, J. S., Cha, V. and Jun, J., 'Yongbyon update: New activity at Building 500 and rising waters', Beyond Parallel, Center for Strategic and International Studies, 11 July 2022.

²⁷ Grossi (note 22).

²⁸ South Korean Ministry of National Defense (MND), [2022 defence white paper] (MND: Seoul, 24 Feb. 2023) (in Korean).

²⁹ 'Estimating North Korea's nuclear stockpiles: An interview with Siegfried Hecker', 38 North, 30 Apr. 2021.

³⁰ Bermudez, J. S., Cha, V. and Jun, J., 'Current status of the Pyongsan Uranium Concentrate Plant (Nam-chon Chemical Complex) and January Industrial Mine', Beyond Parallel, Center for Strategic and International Studies, 8 Nov. 2021; and Bermudez, J. S., Cha, V. and Kim, D., 'Recent activity at the Pyongsan Uranium Concentrate Plant (Nam-chon Chemical Complex) and January Industrial Mine', Beyond Parallel, Center for Strategic and International Studies, 26 Mar. 2021.

³¹ Grossi (note 22).

³² United Nations, Security Council, Midterm report of the panel of experts submitted pursuant to Resolution 2627 (2022), S/2022/668, 7 Sep. 2022, para. 11; Lewis, J., Pollack, J. and Schmerler, D., 'North Korea expanding uranium enrichment plant at Yongbyon', Arms Control Wonk, 14 Sep. 2021; and Cohen, Z., 'Satellite images reveal North Korea expanding facility used to produce weapons-grade uranium', CNN, 16 Sep. 2021.

plant and that the country was seeking to conceal the types and numbers of production facilities in its nuclear weapon programme.³³ A more recent open-source assessment concludes that the increased production capacity at Pyongsan indicates that North Korea does not require another uranium milling facility of comparable size.³⁴

Several non-governmental researchers identified an additional suspected covert uranium-enrichment plant located at Kangson (or Kangsong), to the south-west of Pyongyang, in 2018.³⁵ A 2021 IAEA report noted that the plant shared ‘infrastructure characteristics with the reported centrifuge enrichment facility at Yongbyon’.³⁶ A report by a UN panel of experts cautioned that access to the plant was required to confirm the nature and purpose of the activities being conducted on-site.³⁷ Other experts have suggested that the site could be used for manufacturing centrifuge components rather than for enriching uranium.³⁸

Analysts agree that North Korea has HEU production capabilities, but there are many unknowns about how much HEU has been produced, especially given the uncertainties around activities at the Kangson site. Hecker estimated in early 2021 that North Korea had produced 600–950 kg of HEU by the end of 2020. The HEU stockpile estimate used for SIPRI’s assessment of North Korea’s nuclear weapon holdings suggests a wider range of 250–1350 kg as of the beginning of 2022 (see section X).³⁹

Nuclear warhead production

It is unclear how many nuclear weapons North Korea has produced with its fissile material, how many have been deployed on missiles and what the military characteristics of the weapons are. As noted above, North Korea has demonstrated a thermonuclear capability (or a nuclear explosive test with suspected thermonuclear yield) once, in 2017.⁴⁰ There is no open-source evidence or state intelligence confirming North Korea’s capability to deliver an operational nuclear warhead on an ICBM. Moreover, most of North

³³ 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*, 1 July 2018.

³⁴ Park, S. et al., ‘Assessing uranium ore processing activities using satellite imagery at Pyongsan in the Democratic People’s Republic of Korea’, *Science and Global Security*, vol. 29, no. 3 (2021).

³⁵ Panda, A., ‘Exclusive: Revealing Kangson, North Korea’s first covert uranium enrichment site’, *The Diplomat*, 13 July 2018; and Albright, D. and Burkhard, S., ‘Revisiting Kangsong: A suspect uranium enrichment plant’, Imagery brief, Institute for Science and International Security, 2 Oct. 2018.

³⁶ IAEA, GOV/2021/40-GC(65)/22 (note 21), para. 14.

³⁷ United Nations, Security Council, Midterm report of the panel of experts submitted pursuant to Resolution 2569 (2021), S/2021/777, 8 Sep. 2021, p. 7.

³⁸ ‘Estimating North Korea’s nuclear stockpiles’ (note 29).

³⁹ See also Kristensen, H. and Korda, M., ‘Nuclear notebook: How many nuclear weapons does North Korea have in 2022?’, *Bulletin of the Atomic Scientists*, 8 Sep. 2022.

⁴⁰ Fedchencko (note 2), p. 299.

Korea's nuclear tests demonstrated yields in the range of 5–15 kilotons.⁴¹ As a result, SIPRI estimates that North Korea has used only a small portion of its HEU for thermonuclear weapons and has probably used the majority for a larger number of fission-only single-stage weapons deliverable by an MRBM or possibly by an IRBM.⁴²

It is unclear whether North Korea is prioritizing the development and production of higher-yield thermonuclear weapons or lower-yield fission-only or boosted single-stage weapons.⁴³ More powerful warheads with the high yield demonstrated in the 2017 test would consume more fissile material if based on a composite warhead design, or would require special hydrogen fuel if based on a two-stage thermonuclear warhead design. Lower-yield single-stage fission weapon designs would require less fissile material. The choice of assumptions can thus result in very different estimates of the number of nuclear weapons.

For this reason, SIPRI estimates that North Korea could potentially produce 50–70 nuclear weapons with its inventory of fissile material as of January 2023; however, it is likely that the number of operational warheads is smaller, potentially 30.⁴⁴ Most of those warheads are likely to be single-stage fission weapons with possible yields of 10–20 kt, similar to those demonstrated in the 2013 and 2016 tests. The SIPRI estimate falls within the range of a July 2020 assessment by the US Army that North Korea had 20–60 bombs.⁴⁵ It also falls within the range of a 2018 South Korean intelligence assessment, which estimated that North Korea's nuclear arsenal contained 20–60 weapons.⁴⁶

Assumptions about fissile material production and warhead designs also affect projections of the future size of North Korea's nuclear arsenal. For example, a 2021 study assumed that North Korea might already have 67–116 nuclear weapons and projected that the inventory might reach 151–242 nuclear weapons by 2027.⁴⁷ It seems more plausible, however, that North Korea might be capable of adding sufficient fissile material for up to six nuclear warheads per year.⁴⁸ This would potentially be sufficient to produce a total of approximately 80–90 weapons by the end of the decade.⁴⁹

⁴¹ Fedchenko, V., 'Nuclear explosions, 1945–2016', *SIPRI Yearbook 2017*.

⁴² Ballistic missiles are typically divided into 4 range categories: short range (less than 1000 km), medium range (1000–3000 km), intermediate range (3000–5500 km) and intercontinental (>5500 km).

⁴³ Kristensen and Korda (note 39).

⁴⁴ For additional assessments see 'Estimating North Korea's nuclear stockpiles' (note 29).

⁴⁵ US Army, *North Korean Tactics*, Army Techniques Publication no. 7-100.2 (Headquarters, US Department of the Army: Washington, DC, July 2020), p. 1-11.

⁴⁶ Kim, H., 'Seoul: North Korea estimated to have 20–60 nuclear weapons', AP News, 2 Oct. 2018.

⁴⁷ Bennett, B. W. et al., *Countering the Risk of North Korean Nuclear Weapons* (RAND Corp.: Santa Monica, CA, Apr. 2021).

⁴⁸ This is in line with the production estimate suggested in US Army (note 45), p. 1-11.

⁴⁹ Kristensen and Korda (note 39).

Although North Korea demolished tunnels and facilities at the Punggye-ri nuclear test site in 2018, satellite images since 2021 show that the test tunnel and support buildings have been re-opened.⁵⁰ This construction indicates that the site had not been abandoned but kept in caretaker status, potentially allowing nuclear testing to resume in the future.⁵¹

Land-based missiles

North Korea is increasing both the size and capability of its ballistic missile force, which consists of indigenously produced missile systems with ranges from a few hundred kilometres to more than 12 000 km (see table 7.9).⁵² Since 2016, it has pursued development and production of several missile systems with progressively longer ranges and increasingly sophisticated delivery capabilities.⁵³ There is considerable uncertainty about the operational status of North Korea's IRBMs and ICBMs. According to independent analyses, North Korea may have deployed long-range missiles at several missile bases.⁵⁴

It is unclear which of North Korea's missiles can carry nuclear weapons. The available evidence suggests that some MRBMs and IRBMs are the most likely to have an operational nuclear capability. South Korea's 2022 Defence White Paper notes that, given that North Korea uses uniquely lofted launch angles for its ICBM tests, 'additional confirmation is needed to determine whether North Korea has acquired core ICBM technologies, including the ability to re-enter the atmosphere'.⁵⁵

It must be emphasized that inclusion of a specific North Korean missile in the following overview (and in table 7.9) does not necessarily indicate that it is confirmed as nuclear-capable or as having a nuclear role.

Short-range ballistic missiles

As of January 2023 North Korea had several types of SRBM, including older liquid-fuelled systems, possibly based on Soviet R-17 (Scud) missiles, and newer solid-fuelled missiles of indigenous design. These newer missiles, known by the designations given by the USA as the KN23, the KN24 and the

⁵⁰ United Nations, S/2022/668 (note 32), paras 4–5.

⁵¹ Lee, C., 'North Korea's saber-rattling rekindles nuclear test site questions', Voice of America, 26 Jan. 2022.

⁵² US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat 2020* (NASIC: Wright-Patterson Air Force Base, OH, July 2020).

⁵³ James Martin Center for Nonproliferation Studies (CNS), CNS North Korea Missile Test Database, Nuclear Threat Initiative, as of 24 Mar. 2022.

⁵⁴ Bermudez, J. S. and Cha, V., 'Undeclared North Korea: The Yusang-ni missile operating base', Beyond Parallel, Center for Strategic and International Studies, 9 May 2019; Frank, M., 'Continued construction at Yusang-ni missile base', Open Nuclear Network, 26 July 2021; and United Nations, Security Council, Final report of the panel of experts submitted pursuant to Resolution 2515 (2020), S/2021/211, 4 Mar. 2021, annexes 16–18.

⁵⁵ South Korean Ministry of National Defense (note 28), p. 30 (author translation).

KN25—and possibly all known by the common North Korean designation of Hwasong-11 (with different suffixes for each missile)—were tested or launched nearly 50 times, and possibly many more, between the beginning of 2019 and early 2023.⁵⁶ Notably, in September 2021 North Korea launched two KN23 SRBMs using a rail-mobile launcher for the first time and carried out two further test launches of the rail-mobile KN23 in January 2022.⁵⁷ Rail-mobile launchers would enable North Korea to move missiles around the country rapidly and significantly increase the survivability of its second-strike force. North Korea has also been modernizing its older SRBMs by equipping them with manoeuvrable re-entry vehicles (MaRVs) designed to evade the missile-defence systems of nearby states (particularly South Korea and Japan).⁵⁸

In April 2022 Kim Jong Un announced the launch of two SRBMs, which he called a ‘new-type tactical guided weapon’ developed to enhance ‘the efficiency in the operation of tactical nukes’, potentially implying that such warheads have already been deployed with earlier delivery systems.⁵⁹ Accompanying images pictured a new type of solid-fuelled SRBM mounted on a road-mobile launcher.⁶⁰ As an illustration of this new capability, North Korea test-launched eight SRBMs in June and seven in November 2022.⁶¹ The launches on 2 November were among at least 23 missiles fired that day, the highest number ever launched by North Korea in a single day. North Korean state media said that the missiles were a response to Vigilant Storm 23, a South Korean–US combined military exercise that took place between 31 October and 5 November.⁶²

Medium- and intermediate-range ballistic missiles

North Korea has four types of MRBM: the Hwasong-7 (Nodong/Rodong), -8 and -9 (KN04) and the Pukguksong-2 (KN15).⁶³ All except the Hwasong-8 were probably operational as of January 2023. Assuming that North Korea is able to produce a sufficiently compact warhead, these MRBMs are considered to be its most likely nuclear-delivery systems. All three operational missiles

⁵⁶ James Martin Center for Nonproliferation Studies (note 53); and Zwirko, C., ‘North Korea reveals internal names for several missile systems: Analysis’, NK News, 3 Apr. 2023.

⁵⁷ ‘Firing drill of railway-borne missile regiment held’, *Rodong Sinmun*, 15 Jan. 2022.

⁵⁸ Panda, A., ‘Introducing the KN21, North Korea’s new take on its oldest ballistic missile’, *The Diplomat*, 14 Sep. 2017.

⁵⁹ ‘Respected comrade Kim Jong Un observes test-fire of new-type tactical guided weapon’, *Rodong Sinmun*, 17 Apr. 2022.

⁶⁰ Van Diepen, V. H., ‘North Korea’s new short-range ballistic missile’, 38 North, 25 Apr. 2022.

⁶¹ Kristensen and Korda (note 39).

⁶² ‘Report of General Staff of KPA on its military operations corresponding to US–South Korea combined air drill’, Uriminzokkiri, 7 Nov. 2022; and US Air Force, ‘8th Operations Group surges for Vigilant Storm 23’, Kunsan Air Base, 7 Nov. 2022.

⁶³ On the Pukguksong-2 see Kristensen and Korda (note 10), p. 420.

have ranges of 1000–1200 km, meaning that they could reach targets anywhere in South Korea or Japan.⁶⁴

The Hwasong-10 (BM-25/Musudan) IRBM, with an estimated range exceeding 3000 km, has a poor test rate, with no flight tests since 2016–17. It is likely to have been superseded by more sophisticated missile programmes—in particular the Hwasong-12 (KN17).⁶⁵ The latter is a single-stage, liquid-fuelled IRBM carried on a road-mobile transporter-erector-launcher (TEL). In January 2022 North Korea launched a Hwasong-12 for the first time in nearly five years, demonstrating a similar trajectory to its previous launches.⁶⁶ It remains unknown if the Hwasong-12 has been deployed. North Korea launched a missile that resembled the Hwasong-12 in performance in October 2022, although the images and reports subsequently released by North Korean state media implied that it was a ‘new type’ of IRBM.⁶⁷

The Hwasong-8, which is another new missile, was first revealed in 2021. It appears to be composed of a modified Hwasong-12 booster and can carry multiple different payloads, including an HGV and a MaRV. The Hwasong-8 variant carrying a MaRV was tested twice in January 2022. During the second test, North Korea claimed that the missile conducted a ‘corkscrew’ manoeuvre.⁶⁸ This reportedly prompted the US civil aviation authority to temporarily pause commercial airline departures along the west coast of the USA for approximately 15 minutes.⁶⁹

Intercontinental ballistic missiles

North Korea has displayed four types of ICBM: the Hwasong-13 (KN08), -14 (KN20), -15 (KN22) and -17 (KN28). It has prioritized building and deploying an ICBM that could potentially deliver a nuclear warhead to targets in the USA. However, there remains considerable uncertainty in assessments of North Korea’s long-range missile capabilities. For example, neither the 2019 missile report issued by the US Department of Defense (DOD) nor the 2020 report from the US Air Force listed the Hwasong-13, -14 or -15 as being deployed.⁷⁰ The Hwasong-13 and, possibly, the Hwasong-14 are likely to have

⁶⁴ US Air Force (note 52), p. 25.

⁶⁵ James Martin Center for Nonproliferation Studies (note 53).

⁶⁶ Japanese Ministry of Defense, [North Korean missiles and other related formation], 30 Jan. 2022 (in Japanese).

⁶⁷ Xu, T., *Analysis of the DPRK’s Ballistic Missile Launch Campaign in September/October 2022* (Open Nuclear Network: Vienna, 14 Oct. 2022).

⁶⁸ *Chongnyon Chonwi*, ‘Distinguished feat of WPK in history of leading Juche-based defence industry success in another hypersonic missile test-fire respected comrade Kim Jong Un watches test-fire in field’, KCNA Watch, 12 Jan. 2022.

⁶⁹ Liebermann, O., Muntean, P. and Starr, B., ‘US grounded planes as a “precaution” after a North Korean missile launch’, CNN, 11 Jan. 2022.

⁷⁰ These publications present the USA’s most detailed current public assessments of North Korean long-range nuclear capabilities. The Hwasong-17 was first displayed in Oct. 2020. US Department of Defense (DOD), *2019 Missile Defense Review* (DOD: Washington, DC, 2019), p. 7; and US Air Force (note 52), p. 29.

been superseded by more sophisticated ICBM programmes and, as a result, the Hwasong-13 is excluded from SIPRI's estimate for January 2023.⁷¹

The Hwasong-15 has a significantly larger second stage and more powerful booster engines than the Hwasong-14.⁷² The Hwasong-17 would hypothetically be large enough to accommodate multiple warheads, but such capabilities have not yet been demonstrated.⁷³ On 24 March 2022 North Korea claimed to have test-launched the Hwasong-17 and said the missile reached an apogee of more than 6200 km and travelled nearly 1100 km over the course of 68 minutes.⁷⁴ This suggests a possible range of approximately 15 000 km if flown on a minimum-energy trajectory. However, some analysts believe that the ICBM may have been unsuccessfully tested on 16 March, and that the missile tested on 24 March may instead have been a Hwasong-15.⁷⁵ On 18 November North Korea again claimed to have successfully tested the Hwasong-17.⁷⁶

In December North Korea conducted a ground test of a solid-fuelled rocket motor, indicating progress towards capacity for building a solid-fuelled ICBM or SLBM.⁷⁷

Cruise missiles

North Korea has developed at least two land-attack cruise missiles (LACMs) that are explicitly designed to deliver nuclear weapons: the Hwasal-1 and the Hwasal-2. Combined, these two cruise missiles had been tested at least eight times as of the end of 2022. Although North Korea has described these LACMs as 'strategic weapons', it also clarified in October 2022 that the missiles were 'deployed at the units of the Korean People's Army for the operation of tactical nukes'.⁷⁸

⁷¹ NK News, 'North Korea military parade 2020: Livestream & analysis', YouTube, 10 Oct. 2020.

⁷² Kristensen, H. M. and Korda, M., 'North Korean nuclear forces', *SIPRI Yearbook 2021*, p. 402.

⁷³ Panda, A. (@nktpnd), Twitter, 13 Oct. 2021, <<https://twitter.com/nktpnd/status/1448073861363290124>>.

⁷⁴ *Pyongyang Times*, 'Striking demonstration of great military muscle of Juche Korea: Successful test-launch of new-type ICBM respected comrade Kim Jong Un guides test launch of ICBM Hwasongpho-17', KCNA Watch, 25 Mar. 2023.

⁷⁵ Zwirko, C., 'Imagery casts doubt over North Korea's Hwasong-17 ICBM claims', NK News, 25 Mar. 2022.

⁷⁶ 'Military miracles which demonstrated to whole world national prestige and honor of Juche Korea', *Rodong Sinmun*, 18 Nov. 2022.

⁷⁷ Van Diepen, V., 'The next big thing? North Korea ground tests ICBM-sized rocket motor', 38 North, 21 Dec. 2022.

⁷⁸ Shin, H. and Smith, J., 'N. Korea tests first "strategic" cruise missile with possible nuclear capability', Reuters, 13 Sep. 2021. See also Kristensen and Korda (note 10), pp. 421–22; and 'Respected comrade Kim Jong Un guides test-fire of long-range strategic cruise missiles', Korea Central News Agency, 13 Oct. 2022.

Sea-based missiles

North Korea has continued to develop its family of Pukguksong ('Polaris') solid-fuelled SLBMs as part of an effort to improve the survivability of its nuclear-capable ballistic missile systems.⁷⁹

In October 2021 North Korea unveiled a 'new type' of smaller SLBM with an unknown designation but with characteristics seemingly similar to its newer SRBM designs.⁸⁰ This SLBM was reportedly test launched one week later from the port of Sinpo to an approximate range of 590 km, landing in the Sea of Japan.⁸¹ The test's low apogee of 60 km indicated that this new SLBM is likely to have a shorter range than many of the Pukguksong SLBMs.⁸² The missile was launched using North Korea's only Goraе-class (Sinpo) experimental submarine, 8.24 *Yongung*.⁸³ The vessel appears to have been damaged during the launch.⁸⁴ This submarine can hold and launch only a single SLBM. The same type of missile may have also been tested on 7 May 2022.⁸⁵ It is unclear whether the test was successful. It is also possible that the same type of missile was tested on 25 September 2022 from an 'underwater launching ground' inside a reservoir; the North Korean media statement accompanying the launch explicitly stated that the missile was designed to carry a tactical nuclear warhead and implied that it was already operational.⁸⁶

At its April 2022 military parade, North Korea revealed a sixth probable member of the Pukguksong family that is longer and wider than all of North Korea's previously displayed SLBMs.⁸⁷ The missile's name has not yet been formally announced.

⁷⁹ On North Korea's earlier Pukguksong family of missiles see Kristensen and Korda (note 72), p. 403.

⁸⁰ Xu, T., *Brief on the Defence Development Exhibition of the Democratic People's Republic of Korea* (Open Nuclear Network: Vienna, 18 Oct. 2021); and Xu, T., 'Brief on the 19 October 2021 submarine-launched ballistic missile test of the Democratic People's Republic of Korea', Open Nuclear Network, 21 Oct. 2021.

⁸¹ Korean Central News Agency, 'Academy of Defence Science succeeds in test-launch of new-type SLBM', KCNA Watch, 20 Oct. 2021.

⁸² 'N. Korea fires what seems to be SLBM toward East Sea: S. Korea', Yonhap News Agency, 19 Oct. 2021.

⁸³ Korean Central News Agency (note 81); Makowsky, P. and Liu, J., 'Sinpho South shipyard: Evidence of the SINPO-class SSBA participation in recent SLBM test', 38 North, 21 Oct. 2021; and Bermudez, J. S. and Cha, V., 'Sinpo South shipyard update: SLBM test launch', Beyond Parallel, Center for Strategic and International Studies, 21 Oct. 2021.

⁸⁴ Bermudez, J. S., Cha, V. and Jun, J., 'Sinpo-class submarine damaged during October 19 test launch', Beyond Parallel, Center for Strategic and International Studies, 7 Jan. 2022.

⁸⁵ Japanese Ministry of Defense, '[North Korean missiles and other related formation]', 7 May 2022 (in Japanese).

⁸⁶ Chairman of Central Military Commission of WPK Kim Jong Un guides military exercises of tactical nuclear operation units of KPA, Voice of Korea, 9 Oct. 2022.

⁸⁷ Xu, T., *Emerging Capabilities? The Unflown SLBMs of the DPRK* (Open Nuclear Network: Vienna, 25 July 2022).

In November 2020 the South Korean National Intelligence Service announced that North Korea was building a new ballistic missile submarine.⁸⁸ The vessel, designated Sinpo-C by the US DOD, appears to be based on a modified Project-633 (Romeo) diesel-electric submarine and is expected to be fitted with three missile-launch canisters.⁸⁹ This Soviet-era submarine has a noisy design and limited underwater range, and thus could encounter operational challenges. According to a 2019 report by North Korean state media, the submarine's operational deployment was 'near at hand', although by the end of 2022 it did not yet appear to be operational.⁹⁰

⁸⁸ Bermudez, J. S. and Cha, V., 'Sinpo South shipyard: Construction of a new ballistic missile submarine?', *Beyond Parallel*, Center for Strategic and International Studies, 28 Aug. 2019; Cha, S., 'North Korea building two submarines, one capable of firing ballistic missiles: Lawmaker', *Reuters*, 3 Nov. 2020; and Dempsey, J. and Schmerler, D., 'Two halls enter: One sub leaves', *Arms Control Wonk*, 17 June 2021.

⁸⁹ Hotham, O., 'New North Korean submarine capable of carrying three SLBMs: South Korean MND', *NK News*, 31 July 2019; and Cha (note 88).

⁹⁰ 'NK leader inspects new submarine to be deployed in East Sea: State media', *Yonhap News Agency*, 23 July 2019.

Table 7.9. North Korean forces with potential nuclear capability, January 2023

All figures are approximate and some are based on assessments by the authors. The inclusion of a missile in this table does not necessarily indicate it is known to have a nuclear role. Systems that are unlikely to have a nuclear or operational role are excluded.

Type/ North Korean designation (US designation)	Year first displayed	Range (km)	Description and status
<i>Land-based missiles</i>			
Hwasong-5/-6 (Scud-B/-C)	1984/1990	300/500	Single-stage, liquid-fuelled SRBMs launched from 4-axle wheeled TEL. NASIC estimates fewer than 100 Hwasong-5 and -6 launchers. Operational.
.. (KN18/KN21)	2017	250/450	Hwasong-5 and -6 variants with separating manoeuvrable warhead. Flight-tested in May and Aug. 2017 from wheeled and tracked TELs. Deployment status unknown; may have been superseded by newer solid-fuelled SRBMs.
Hwasong-11 variants (KN23/KN24 ^a /KN25)	2018/2019	380–800	New generation of solid-fuelled SRBMs. Resemble Russia's Iskander-M, South Korea's Hyunmoo-2B and the USA's ATACMS SRBMs. Successfully flight-tested at least 50 times, and possibly many more, from wheeled, tracked and rail-based launchers since 2019, including nearly 20 known launches in 2022. Deployment status unknown; probably operational.
Hwasong-7 (Nodong/ Rodong)	1993	>1 200	Single-stage, liquid-fuelled MRBM launched from 5-axle wheeled TEL. NASIC estimates fewer than 100 Hwasong-7 launchers. Two launched on 18 Dec. 2022. Operational.
Hwasong-9 (KN04/ Scud-ER)	2016	1 000	Single-stage, liquid-fuelled Scud extended-range MRBM variant launched from 4-axle wheeled TEL. Flight-tested in 2016. Probably operational.
Pukguksong-2 (KN15)	2017	>1 000	Two-stage, solid-fuelled MRBM launched from tracked TEL. Land-based version of Pukguksong-1 SLBM. Flight-tested in 2017. Probably operational.

Type/ North Korean designation (US designation)	Year first displayed	Range (km)	Description and status
Hwasal-1	2021	1 500	Land-attack cruise missile flight-tested multiple times in 2021 and 2022 from wheeled TEL. Deployment status unknown; probably operational.
Hwasal-2	2021	2 000	Land-attack cruise missile flight-tested multiple times in 2022 from wheeled TEL. Deployment status unknown; probably operational.
Hwasong-8/Unnamed 'hypersonic missile'	2021	>1 000	Two versions of HGV carried by a shortened Hwasong-12 booster. Hwasong-8 flight-tested in Sep. 2021 with unknown result; unnamed missile successfully flight-tested twice in Jan. 2022. Both systems displayed at exhibition in Oct. 2021. Suspected flight test with MaRV on 5 and 11 Jan. 2022. Under development.
Hwasong-10 (BM-25/ Musudan)	2010	>3 000	Single-stage, liquid-fuelled IRBM launched from 6-axle wheeled TEL. NASIC estimates fewer than 50 Hwasong-10 launchers. Several failed flight tests in 2016. Deployment status unknown; may have been superseded.
Hwasong-12 (KN17)	2017	>4 500	Single-stage, liquid-fuelled IRBM launched from 8-axle wheeled TEL. Flight-tested several times in 2017 with mixed success. Tested again on 30 Jan. 2022. Deployment status unknown.
'New type' IRBM	2022	>4 500	Single-stage, liquid-fuelled IRBM launched on 4 Oct. 2022. Strongly resembles existing Hwasong-12 design, but with potential modifications to the nose cone and propulsion system. Deployment status unknown.
Hwasong-14 (KN20)	2017	>10 000	Two-stage, liquid-fuelled ICBM launched from 8-axle wheeled TEL. First ICBM. Successfully flight-tested twice in 2017. Deployment status unknown; may have been superseded.

Type/ North Korean designation (US designation)	Year first displayed	Range (km)	Description and status
Hwasong-15 (KN22)	2017	>13 000	Two-stage, liquid-fuelled ICBM launched from 9-axle wheeled TEL. Successfully flight-tested in Nov. 2017. Displayed at parade in Oct. 2020 and at exhibition in Oct. 2021. Possibly launched on 24 Mar. 2022. Deployment status unknown.
Hwasong-17 (KN28) ^b	2020	15 000	Two-stage, liquid-fuelled ICBM launched from 11-axle wheeled TEL. Largest ICBM to date, possibly capable of carrying MIRVs and penetration aids. Displayed at parade in Oct. 2020 and at exhibition in Oct. 2021. May have been unsuccessfully flight-tested on 16 Mar. 2022, and missile tested on 24 Mar. 2022 may have been a Hwasong-15 instead of a Hwasong-17 as claimed by North Korea. Successful test of Hwasong-17 on 18 Nov. 2022. Under development.
<i>Sea-based missiles</i>			
Pukguksong-1 (KN11)	2014	>1 000	Two-stage, solid-fuelled SLBM. Flight-tested several times in 2015 and 2016 with mixed success. Displayed at exhibition in Oct. 2021. Deployment status unknown; may have been superseded.
Pukguksong-3 (KN26)	2017	1 900– 2 500	Two-stage, solid-fuelled SLBM. Successfully flight-tested in Oct. 2019. Deployment status unknown.
Pukguksong-4	2020	3 500– 5 400	Two-stage, solid-fuelled SLBM. Appears wider than Pukguksong-1 and shorter than Pukguksong-3. No known flight tests. Displayed at parade in Oct. 2020. Deployment status unknown.
Pukguksong-5	2021	..	Two-stage, solid-fuelled SLBM. Roughly same length as Pukguksong-3 with elongated shroud; possibly capable of carrying MIRVs and penetration aids. No known flight tests. Displayed at parade in Jan. 2021 and at exhibition in Oct. 2021. Deployment status unknown.

Type/ North Korean designation (US designation)	Year first displayed	Range (km)	Description and status
Small 'new type' SLBM	2021	400–600	Appears to deviate from traditional Pukguksong SLBM design, instead bearing similarities to KN23 SRBM. Displayed at exhibition in Oct. 2021 and successfully flight-tested a week later. Deployment status unknown; possibly operational.
Unknown SLBM	2022	..	Revealed at military parade in Apr. 2022. Name not yet formally announced, but appears to be a member of the Pukguksong family of SLBMs.
Total warheads			30^c

.. = not available or not applicable; HGV = hypersonic glide vehicle; ICBM = intercontinental ballistic missile; IRBM = intermediate-range ballistic missile; MaRV = manoeuvrable re-entry vehicle; MIRV = multiple independently targetable re-entry vehicle; MRBM = medium-range ballistic missile; NASIC = US Air Force National Air and Space Intelligence Center; SLBM = submarine-launched ballistic missile; SRBM = short-range ballistic missile; TEL = transporter-erector-launcher.

Notes: Information about the status and capability of North Korea's missiles comes with significant uncertainty. This table includes missiles that could potentially have a nuclear capability, whether or not confirmed as being equipped with nuclear warheads or assigned nuclear missions. Several missiles may have been intended for development of technologies that will eventually become operational on newer missiles. There is no publicly available evidence that North Korea has produced an operational nuclear warhead for delivery by an ICBM.

^a North Korea refers to the KN24 as the Hwasong-11Na, which could be considered akin to 'Hwasong-11B', as Na (나) is the second letter in the Korean alphabet (Hangul). This indicates that the KN24 is an improvement on or replacement for the original Hwasong-11 (KN02 Toksa) SRBM. Many of North Korea's other new SRBMs also appear to use the official Hwasong-11 designation with different suffixes.

^b This missile was previously assumed to be designated the Hwasong-16; however, it was revealed at North Korea's Oct. 2021 Defence Development Exhibition that it is called the Hwasong-17.

^c SIPRI estimates that North Korea might have produced enough fissile material to build 50–70 nuclear warheads; however, it is likely that it has assembled fewer warheads, perhaps c. 30, of which only a few would be thermonuclear warheads and nearly all would be lower-yield single-stage fission warheads.

Sources: US Department of Defense (DOD), *2019 Missile Defense Review* (DOD: Washington, DC, 2019); US Air Force, National Air and Space Intelligence Center, *Ballistic and Cruise Missile Threat*, various years; *IHS Jane's Strategic Weapon Systems*, various editions; Hecker, S., Stanford University, Personal communication, 2020; *Bulletin of the Atomic Scientists*, 'Nuclear notebook', various issues; published expert analyses; and authors' estimates. For the estimated number of warheads see also Hecker, S., 'What do we know about North Korea's nuclear program?', Presentation, Dialogue on DPRK Denuclearization Roadmaps and Verification, Kyung Hee University, Global America Business Institute (GABI) and Natural Resources Defense Council (NRDC), 20 Oct. 2020; 'Estimating North Korea's nuclear stockpiles: An interview with Siegfried Hecker', 38 North, 30 Apr. 2021; and Fedchenko, V. and Kelley, R., 'New methodology offers estimates for North Korean thermonuclear stockpile', *Janes Intelligence Review*, Sep. 2020, pp. 44–49.