

## IX. 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 2022, North Korea possessed approximately 20 nuclear weapons, but that it probably possessed sufficient fissile material for approximately 45–55 nuclear devices (see table 10.10). 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), North Korea's 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 official public data and the fact that North Korean state media sources can be subject to manipulation, misinterpretation or exaggeration. Most of the data presented here is derived from sources outside North Korea, including satellite imagery, United States government reports and statements, and expert analyses.<sup>1</sup>

In 2021 North Korea did not conduct any nuclear explosive tests or flight tests of long-range ballistic missiles, despite the government's announcement in January 2020 that it would no longer observe its self-imposed moratorium from 2018 on conducting either type of test.<sup>2</sup> However, North Korea did conduct several tests of short-range ballistic missiles (SRBMs)—including tests from new types of launcher—as well as new land-attack cruise missiles, hypersonic glide vehicles (HGVs), and submarine-launched ballistic missiles (SLBMs).

Additionally, in January 2021 North Korean leader Kim Jong Un announced at the eighth congress of the ruling Workers' Party of Korea (WPK) that, since the previous congress in 2016, North Korea had 'already accumulated nuclear technology developed to such a high degree as to miniaturize, lighten and standardize nuclear weapons and to make them tactical ones and to complete the development of a super-large hydrogen bomb'. Kim also emphasized the need to 'develop the nuclear technology to a higher level and make nuclear weapons smaller and lighter for more tactical uses'.<sup>3</sup> The 'super-large hydrogen bomb' might refer to a weaponized design of the large-yield device with a suspected thermonuclear yield that was tested in 2017,

<sup>1</sup> Kristensen, H. M. and Korda, M., 'Estimating world nuclear forces: An overview and assessment of sources', SIPRI Topical Backgrounder, 14 June 2021.

<sup>2</sup> Nebehay, S., 'North Korea abandons nuclear freeze pledge, blames "brutal" US sanctions', Reuters, 21 Jan. 2020.

<sup>3</sup> Korean Central News Agency, 'On report made by Supreme Leader Kim Jong Un at eighth party congress of WPK', National Committee on North Korea, 9 Jan. 2021.

while the smaller and lighter weapons might be intended for deployment on one or several of the new shorter-range missiles test launched in 2021.<sup>4</sup>

### **The role of nuclear weapons in North Korean military doctrine**

The 2013 law on nuclearization—one of the most recent official documents pertaining to North Korean nuclear doctrine—states that North Korea’s nuclear arsenal would only be used ‘to repel invasion or attack from a hostile nuclear weapons state and make retaliatory strikes’, and that 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’.<sup>5</sup> In a speech marking the 75th anniversary of the ruling WPK in October 2020, Kim Jong Un reiterated North Korea’s pledge not to use nuclear weapons ‘preemptively’.<sup>6</sup> 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’.<sup>7</sup>

As with other nuclear-armed states, it seems unlikely that North Korea would use its nuclear weapons outside of extreme circumstances where the continued existence of the state and its leadership was in question. However, in the event of such a scenario, it is possible that North Korea would use its nuclear weapons in an attempt to forestall adversarial action. Occasionally, North Korea has signalled or explicitly mentioned which targets it intends to prioritize in the event of imminent invasion. North Korea has specifically indicated that it would first target the Blue House, the executive office and official residence of the head of state of the Republic of Korea (South Korea), most likely as a response to the public acknowledgement by South Korea of its preparations to conduct ‘decapitation’ strikes aimed at eliminating North Korea’s political and military leadership early in a conflict.<sup>8</sup> North Korea has stated that to forestall a conventional invasion, its second wave of targets would be US military bases in the Asia–Pacific region and continental USA.<sup>9</sup> Some nuclear weapons would probably be held in reserve to threaten targets

<sup>4</sup> For detail on North Korea’s nuclear test in late 2017 see Fedchencko, V., ‘Nuclear explosions, 1945–2017’, *SIPRI Yearbook 2018*.

<sup>5</sup> Law on Consolidating the Position of Nuclear Weapons State for Self-Defence, adopted 1 Apr. 2013, Articles 4 and 5. For a translation see Korean Central News Agency, ‘Law on consolidating position of nuclear weapons state adopted’, Korea News Service, 1 Apr. 2013, available via GlobalSecurity.org.

<sup>6</sup> ‘Kim Jong Un’s October speech: More than missiles’, 38 North, 13 Oct. 2020.

<sup>7</sup> ‘Kim Jong Un’s October speech’ (note 6).

<sup>8</sup> Korean Central News Agency, ‘Crucial statement of KPA Supreme Command’, Korea News Service, 23 Feb. 2016, available via GlobalSecurity.org; and Choe, S. H., ‘South Korea plans “decapitation unit” to try to scare North’s leaders’, *New York Times*, 12 Sep. 2017.

<sup>9</sup> Ko, Y. H., ‘North Korean missile proliferation’, Statement before the Subcommittee on International Security, Proliferation and Federation Services, US Senate Hearing no. 105-241, 21 Oct. 1997; Korean Central News Agency (note 8); and Allard, L., Duchâtel, M. and Godement, F., ‘Pre-empting defeat: In search of North Korea’s nuclear doctrine’, European Council on Foreign Relations, 22 Nov. 2017.

**Table 10.10.** North Korean forces with potential nuclear capability, January 2022

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. Some systems have been excluded because it is unlikely that they have a nuclear or operational role.

Type/ North Korean designation (US designation) <sup>a</sup>	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. Status unknown; may have been superseded by newer solid-fuelled SRBMs.
(KN23/KN24 <sup>b</sup> /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 several times from wheeled, tracked and rail-based launchers since 2019. 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. Operational.
Hwasong-9 (KN04/Scud-ER)	2016	1 000	Single-stage, liquid-fuelled Scud extended-range 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.
Land-attack cruise missile	2021	1 500	Flight tested multiple times in 2021 from wheeled TEL. Under development.
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. Under development.

Type/ North Korean designation (US designation) <sup>a</sup>	Year first displayed	Range (km)	Description and status
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. Status unknown; may have been superseded.
Hwasong-12 (KN17)	2017	>4 500	Single-stage, liquid-fuelled MRBM launched from 8-axle wheeled TEL. Flight tested several times in 2017 with mixed success. 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.
Hwasong-15 (KN22)	2017	>12 000	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. Deployment status unknown.
Hwasong-17 (KN28) <sup>c</sup>	2020	14 000	Two-stage, liquid-fuelled ICBM launched from 11-axle wheeled TEL. Largest ICBM to date, possibly capable of carrying MIRVs and penetration aids. No known flight tests. Displayed at parade in Oct. 2020 and at exhibition in Oct. 2021. 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) <sup>a</sup>	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; probably under development.
<b>Total warheads</b>			<b>20<sup>d</sup></b>

HGV = hypersonic glide vehicle; ICBM = intercontinental ballistic missile; IRBM = intermediate-range ballistic missile; MIRV = multiple independently targetable re-entry vehicle; MRBM = medium-range ballistic missile; NASIC = United States National Air and Space Intelligence Center; SLBM = submarine-launched ballistic missile; SRBM = short-range ballistic missile; TEL = transporter-erector-launcher.

<sup>a</sup> 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.

<sup>b</sup> 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 (Hangul) alphabet. This indicates that the KN24 is an improvement on or replacement for the original Hwasong-11 SRBM, which the US Department of Defense designates as the KN02 (Toksa).

<sup>c</sup> 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.

<sup>d</sup> SIPRI estimates that North Korea might have produced enough fissile material to build between 45 and 55 nuclear warheads; however, it is likely that it has assembled fewer warheads, perhaps around 20, 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: Arlington, VA, 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 the 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.

within the US mainland, in an attempt to 'decouple' the USA from its Asia-Pacific allies.

The North Korean announcement in 2021 to 'make nuclear weapons smaller and lighter for more tactical uses' could potentially 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.

## **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.<sup>10</sup> 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.<sup>11</sup> Between December 2018 and July 2021 the IAEA found no signs that North Korea's ageing 5-megawatt-electric (MW(e)) graphite-moderated research reactor had been operational; however, in August 2021 the IAEA reported that 'since early July 2021, there have been indications, including the discharge of cooling water, consistent with the operation of the reactor'.<sup>12</sup> Despite the intermittent discharge of cooling water throughout the latter half of 2021, there were no other indicators of reactor operations, such as steam emissions from the generator building.<sup>13</sup>

The Yongbyon complex's Thermal Plant—which supplies steam to the Radiochemical Laboratory used for plutonium reprocessing—operated between February 2021 and July 2021 after a multi-year hiatus.<sup>14</sup> The IAEA noted in August 2021 that 'this five-month timeframe is consistent with the time required to reprocess a complete core of irradiated fuel', which could indicate the possible completion of a new reprocessing campaign in 2021.<sup>15</sup>

<sup>10</sup> 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.

<sup>11</sup> Dixit, A., 'IAEA ready to undertake verification and monitoring in North Korea', International Atomic Energy Agency (IAEA), 4 Mar. 2019.

<sup>12</sup> 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.

<sup>13</sup> Pabian, Town and Liu (note 12); and Heinonen, O., Liu, J. and Pitz, S. J., 'North Korea's Yongbyon nuclear complex: 5 MWe reactor may still be operating', 38 North, 8 Oct. 2021.

<sup>14</sup> Makowsky, P., Pabian, F. and Liu, J., 'North Korea's Yongbyon nuclear center: Signs of activity at the radiochemical laboratory facilities', 38 North, 3 Mar. 2021; Pabian, F. et al., 'North Korea's Yongbyon nuclear center: Reprocessing status remains unclear', 38 North, 7 Apr. 2021; and Bermudez Jr, J. S. et al., 'Thermal imagery indicates activity at Yongbyon nuclear reprocessing facilities', Beyond Parallel, 15 Apr. 2021.

<sup>15</sup> 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.

Throughout 2021, commercial satellite imagery indicated that North Korea continued construction of a new experimental light water reactor (ELWR), which will eventually be capable of producing plutonium for nuclear weapons. The 2021 IAEA report noted that North Korea may have conducted infrastructure tests at the ELWR in March and April, but that ‘it is not possible to estimate when the reactor could become operational’.<sup>16</sup>

In April 2021 Siegfried Hecker—the former Los Alamos National Laboratory director who was given unprecedented access to North Korean nuclear facilities over several years—estimated that North Korea’s plutonium stocks were likely to be between 25 and 48 kilograms and could increase by up to 6 kg per year at full operation.<sup>17</sup>

### *Uranium enrichment capabilities*

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.<sup>18</sup> 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 September 2021 a report by the United Nations panel of experts assessed that North Korea continued to conduct activities at the gas centrifuge enrichment plant located at the Yongbyon complex, and noted the presence of what might have been a liquid nitrogen tank trailer at the site in April 2021—possibly indicating that the plant was operational.<sup>19</sup> Additionally, satellite imagery analysis indicates that North Korea is expanding this uranium enrichment plant, possibly by adding up to 1000 new centrifuges—thus potentially increasing the plant’s enrichment capacity by up to 25 per cent.<sup>20</sup>

Using commercial satellite imagery, several non-governmental researchers have identified an additional suspected covert uranium enrichment plant located at Kangson (or Kangsong), to the south-west of Pyongyang.<sup>21</sup> The

<sup>16</sup> IAEA, GOV/2021/40-GC(65)/22 (note 15), para. 12.

<sup>17</sup> ‘Estimating North Korea’s nuclear stockpiles: An interview with Siegfried Hecker’, 38 North, 30 Apr. 2021.

<sup>18</sup> Bermudez Jr, 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, 8 Nov. 2021; and Bermudez Jr, 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, 26 Mar. 2021.

<sup>19</sup> United Nations, Security Council, Midterm report of the Panel of Experts submitted pursuant to resolution 2569 (2021), S/2021/777, 8 Sep. 2021, pp. 6–7.

<sup>20</sup> 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.

<sup>21</sup> 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’, Institute for Science and International Security Imagery Brief, 2 Oct. 2018.

2021 IAEA report noted that ‘the Kangson complex shares infrastructure characteristics with the reported centrifuge enrichment facility at Yongbyon’, and that its construction matched the IAEA’s understanding of the construction sequence of North Korea’s uranium enrichment plant.<sup>22</sup> However, the 2021 UN panel of experts report cautioned that, without access to the plant, it was not possible to confirm the nature and purpose of the activities being conducted on-site.<sup>23</sup> A classified intelligence assessment by the USA 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, although a more recent open-source assessment concluded that the increased production capacity at Pyongsan indicates that North Korea does not require another uranium milling facility of comparable size.<sup>24</sup>

### *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. North Korea has demonstrated a thermonuclear capability (or a capability with suspected thermonuclear yield) once, in 2017.<sup>25</sup> There is no open-source evidence or state intelligence confirming North Korea’s capability to deliver an operational nuclear warhead on an intercontinental ballistic missile (ICBM). Moreover, most of North Korea’s nuclear tests demonstrated yields in the range of 5–15 kilotons. 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 a medium-range ballistic missile (MRBM) or possibly by an intermediate-range ballistic missile (IRBM).<sup>26</sup> For this reason, SIPRI estimates that North Korea could potentially produce 45–55 nuclear weapons with its inventory of fissile material as at January 2022; however, it is likely that the number of operational warheads is smaller, perhaps closer to 20.<sup>27</sup> This falls within the range offered by a July 2020 US Army study that stated: ‘Estimates for North Korean nuclear weapons range from 20–60 bombs, with the capability

<sup>22</sup> IAEA, GOV/2021/40-GC(65)/22 (note 15), para. 14.

<sup>23</sup> United Nations, S/2021/777 (note 19), p. 7.

<sup>24</sup> 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; Nakashima, E. and Warrick, J., ‘North Korea working to conceal key aspects of its nuclear program, US officials say’, *Washington Post*, 1 July 2018; and 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), pp. 111–44.

<sup>25</sup> Fedchenko (note 4).

<sup>26</sup> Ballistic missiles are typically divided into four range categories: short-range (less than 1000 km), medium-range (1000–3000 km), intermediate-range (3000–5500 km) and intercontinental (>5500 km).

<sup>27</sup> For additional assessments see ‘Estimating North Korea’s nuclear stockpiles’ (note 17).



to produce 6 new devices each year.<sup>28</sup> Although North Korea demolished tunnels and facilities at its nuclear test site in 2018, satellite images in 2021 and early 2022 indicated that the site had not been abandoned but kept in caretaker status, potentially allowing nuclear testing to resume.<sup>29</sup>

### 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.<sup>30</sup> Since 2016, it has pursued development and production of several missile systems with progressively longer ranges and increasingly sophisticated delivery capabilities.<sup>31</sup> 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.<sup>32</sup>

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, while the ICBMs being developed to fulfil the nuclear role specified in North Korea's military doctrine have not yet demonstrated a reliable atmospheric re-entry vehicle or a capability for terminal-stage guidance and warhead activation.<sup>33</sup> As such, it remains unclear whether North Korea's missiles would be able to deliver reliably a nuclear warhead to an intercontinental-range target without further development.<sup>34</sup>

It must be emphasized that inclusion of a specific North Korean missile in the following overview and in table 10.10 does not necessarily indicate that it is confirmed as nuclear-capable or as having a nuclear role.

#### *Short-range ballistic missiles*

As of January 2022, North Korea had several types of SRBM, including older liquid-fuelled systems, possibly based on Soviet R-17 Scud missiles, and newer

<sup>28</sup> United States Army, 'North Korean tactics', Army Techniques Publication no. 7-100.2, 24 July 2020, pp. 1–11.

<sup>29</sup> Lee, C., 'North Korea's saber-rattling rekindles nuclear test site questions', VOA, 26 Jan. 2022.

<sup>30</sup> United States Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat 2020* (NASIC: Wright-Patterson Air Force Base, OH, July 2020).

<sup>31</sup> James Martin Center for Nonproliferation Studies (CNS), *The CNS North Korea Missile Test Database*, Nuclear Threat Initiative, as of 24 Mar. 2022.

<sup>32</sup> Bermudez Jr, J. S. and Cha, V., 'Undeclared North Korea: The Yusang-ni missile operating base', *Beyond Parallel*, 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.

<sup>33</sup> Ali, I., 'US general says North Korea not demonstrated all components of ICBM', Reuters, 30 Jan. 2018; and Cohen, Z., Starr, B. and Crawford, J., 'Top general warns US may not see a North Korean attack coming', CNN, 27 Mar. 2019.

<sup>34</sup> Elleman, M., 'Does size matter? North Korea's newest ICBM', 38 North, 21 Oct. 2020.

solid-fuelled missiles of indigenous design. These newer missiles, known as the KN23, KN24 and KN25, have been tested more than 35 times since the beginning of 2019.<sup>35</sup> North Korea has also been modernizing its older SRBMs by equipping them with manoeuvrable re-entry vehicles designed to evade regional (e.g. South Korean) missile-defence systems.<sup>36</sup> Notably, in September 2021 North Korea launched two KN23 SRBMs using a rail-mobile launcher for the first time; following the successful test, North Korea announced its intention to expand the regiment into a brigade, which could eventually consist of nine launchers with 18 KN23s.<sup>37</sup> Rail-mobile launchers would enable North Korea to move missiles around the country rapidly and significantly increase the survivability of its second-strike force.

While the older, less accurate SRBMs might have been developed with dual capability, there is no publicly available, authoritative information confirming a nuclear delivery role for the newer, more accurate SRBMs—although as noted above, in a May 2021 speech, Kim Jong Un hinted that North Korea's shorter-range systems might have a 'tactical' (i.e. non-strategic) nuclear role.<sup>38</sup> Independent assessments have suggested that a nuclear device that North Korea displayed in 2017—if, indeed, it was a functional nuclear device—might be too large to fit into these newer SRBMs.<sup>39</sup> However, if North Korea has miniaturized its nuclear warheads as claimed, these types of missile could be used in a dual-capable role to target US military facilities south of Seoul.

### *Medium- and intermediate-range ballistic missiles*

Assuming that North Korea is able to produce a sufficiently compact warhead, the country's three types of MRBM—all of which were probably operational as of January 2022—are considered to be its most likely nuclear delivery systems. These three types include the single-stage, liquid-fuelled Hwasong-7 (Nodong/Rodong); the single-stage, liquid-fuelled Hwasong-9 (KN04/Scud-ER); and the two-stage, solid-fuelled Pukguksong-2 (KN15), a land-based variant of the Pukguksong-1 (KN11) SLBM.<sup>40</sup> All three missiles

<sup>35</sup> James Martin Center for Nonproliferation Studies (note 31).

<sup>36</sup> Panda, A., 'Introducing the KN21, North Korea's new take on its oldest ballistic missile', *The Diplomat*, 14 Sep. 2017.

<sup>37</sup> Korean Central News Agency, 'Secretary Pak Jong Chon guides launching drill of Railway Mobile Missile Regiment for inspection', *KCNA Watch*, 16 Sep. 2021; Xu, T., Shin, J. and Furukawa, K., 'The first DPRK missile launch from a rail-mobile launcher', *Open Nuclear Network*, 17 Sep. 2021; and Bermudez Jr, J. S., 'What is the significance of North Korea's rail-mobile ballistic missile launcher?', *Beyond Parallel*, 30 Sep. 2021.

<sup>38</sup> North Korean Ministry of Foreign Affairs, 'Great programme for struggle leading Korean-style socialist construction to fresh victory on report made by Supreme Leader Kim Jong Un at Eighth Congress of WPK', *Rodong Sinmun*, 9 Jan. 2021, available via *KCNA Watch*.

<sup>39</sup> Elleman, M., 'Preliminary assessment of the KN-24 missile launches', 38 North, 25 Mar. 2020.

<sup>40</sup> For the missiles and submarines discussed in this section, a designation in parentheses (e.g. Nodong/Rodong) following the North Korean designation (e.g. Hwasong-7) is that assigned by the US Department of Defense.

have ranges between 1000 and 1200 km, meaning that they could reach targets anywhere in South Korea or Japan.<sup>41</sup>

North Korea's development of the solid-fuelled Pukguksong-2 might be 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. In addition, the Pukguksong-2 is coupled with a tracked transporter-erector-launcher (TEL), allowing North Korea to launch it from hidden, off-road sites. Most other systems use wheeled launchers and thus require paved or relatively smooth roads—a rarity in North Korea's mountainous terrain. According to a 2021 UN panel of experts report, North Korea has also developed tracked launchers for some of its newer SRBM systems, including the KN23, KN24 and KN25.<sup>42</sup>

The Hwasong-10 (BM-25/Musudan) is a single-stage, liquid-fuelled missile with an estimated range exceeding 3000 km. The missile has a poor test rate and no flight tests of the Hwasong-10 are known to have been conducted since 2016–17; as such, SIPRI assesses that the Hwasong-10 programme might have been superseded by North Korea's more sophisticated missile programmes—in particular, the Hwasong-12 (KN17), a single-stage IRBM that is believed to have a new liquid-propellant booster engine that is also used for North Korea's ICBM programme.<sup>43</sup> The Hwasong-12 was test launched in 2017 but it is unclear whether it has been operationally deployed.<sup>44</sup>

In September 2021 North Korea tested a new missile called the Hwasong-8, which appeared to include an HGV carried by a modified Hwasong-12 booster. Notably, state media reported that the Hwasong-8 is the first North Korean missile to use a 'fuel ampoule', which involves placing pre-fuelled liquid-fuelled missiles in temperature-controlled canisters to facilitate faster launches.<sup>45</sup>

### *Intercontinental-range ballistic missiles*

As of January 2022, North Korea was widely believed to have prioritized building and deploying an ICBM that could potentially deliver a nuclear warhead to targets in continental USA. However, as mentioned above, considerable uncertainty remained in assessments of North Korea's long-range

<sup>41</sup> United States Air Force (note 30).

<sup>42</sup> United Nations, S/2021/211 (note 32), annex 12.

<sup>43</sup> James Martin Center for Nonproliferation Studies (note 31).

<sup>44</sup> Elleman, M., 'North Korea's Hwasong-12 launch: A disturbing development', 38 North, 30 Aug. 2017.

<sup>45</sup> Korean Central News Agency, 'Hypersonic missile newly developed by Academy of Defence Science test-fired', KCNA Watch, 30 Sep. 2021; and Xu, T., 'Brief on the Defence Development Exhibition of the Democratic People's Republic of Korea', Open Nuclear Network, 18 Oct. 2021.

missile capabilities, and the US Air Force's most recent report, from 2020, did not list any of North Korea's ICBMs as deployed.<sup>46</sup>

The Hwasong-13 (KN08) had not been flight tested as of January 2022 and SIPRI assesses that it is unlikely to become an operational military system. North Korea has twice tested the Hwasong-14 (KN20), a prototype ICBM that first appeared in 2015 at a military parade in Pyongyang, but it is unclear if it was operational in 2021.<sup>47</sup> However, the Hwasong-14 was absent from North Korea's most recent military parade featuring ICBMs, which took place in 2020. This suggests that it may have been superseded by more sophisticated ICBM programmes.<sup>48</sup>

North Korea has been developing a new two-stage ICBM, the Hwasong-15 (KN22), which has a significantly larger second stage and more powerful booster engines than the Hwasong-14, as well as a new liquid-fuelled type of ICBM, the Hwasong-17.<sup>49</sup> The Hwasong-17 (thought to have the US designation KN28) would hypothetically be large enough to accommodate multiple warheads; however, such capabilities have not yet been demonstrated.<sup>50</sup>

In 2019 the US Department of Defense (DOD) indicated that North Korea had deployed one ICBM, the Taepodong-2; however, other official US sources have listed the missile as a space-launch vehicle that would need reconfiguration to be used as an ICBM and therefore it is not included in SIPRI's assessment for January 2022 of North Korean forces with potential nuclear capability.<sup>51</sup>

### *Cruise missiles*

In September 2021 North Korea conducted test launches of a new land-attack cruise missile (LACM) at a claimed speed of roughly 200 metres per second to a range of 1500 km. Although North Korea has other cruise missiles in its arsenal, this is the first system that has been explicitly described as a 'strategic weapon', thus potentially implying a connection to North Korea's nuclear weapon programme.<sup>52</sup> The test launches followed Kim Jong Un's

<sup>46</sup> United States Air Force (note 30).

<sup>47</sup> United States Air Force (note 30), p. 27; Wright, D., 'North Korean ICBM appears able to reach major US cities', Union of Concerned Scientists, 28 July 2017; and Elleman, M., 'North Korea's Hwasong-14 ICBM: New data indicates shorter range than many thought', 38 North, 29 Nov. 2018.

<sup>48</sup> NK News, 'North Korea military parade 2020: livestream & analysis', YouTube, 10 Oct. 2020.

<sup>49</sup> For further detail see Kristensen, H. M. and Korda, M., 'North Korean nuclear forces', *SIPRI Yearbook 2021*, p. 402.

<sup>50</sup> Ankit Panda (@nktpond), 'Real good catch by @ColinZwirko: North Korea's very large road-mobile ICBM seen at the end of the October 2020 is the \*Hwasong-17\*, NOT Hwasong-16 (KN28 to USIC)', Twitter, 13 Oct. 2021.

<sup>51</sup> United States Department of Defense, *Missile Defense Review 2019* (Office of the Secretary of Defense: Arlington, VA, Jan. 2019); and United States Air Force (note 30), p. 29.

<sup>52</sup> Shin, H. and Smith, J., 'N.Korea tests first "strategic" cruise missile with possible nuclear capability', Reuters, 13 Sep. 2021.

January 2021 statement on pursuing ‘tactical’ missiles and nuclear weapons.<sup>53</sup> Imagery of the LACM released by North Korean state media indicates that it might include a terminal guidance system—which would improve the missile’s accuracy—and that it could be launched from a TEL that carries five missiles.<sup>54</sup> Notably, South Korean news sources subsequently reported that neither South Korea nor the USA were aware of the LACM launch until after the announcement in North Korean state media.<sup>55</sup> Given that this system is designed to circumvent radars and missile-defence systems by flying at lower altitudes on manoeuvrable trajectories, it could offer North Korea a new and unique capability to attack regional targets. Kim Jong Un’s statement in January 2021 that this system’s ‘conventional warheads are the most powerful in the world’ indicates that the LACM could either be dual-capable or exclusively conventional.<sup>56</sup>

### 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.<sup>57</sup> During North Korea’s October 2020 military parade, a new type of SLBM was unveiled—the Pukguksong-4, which the UN panel of experts estimates has a maximum range between 3500 and 5400 km for payloads of 1300 kg and 650 kg, respectively.<sup>58</sup> At a military parade in January 2021, North Korea unveiled its new Pukguksong-5. Both the Pukguksong-4 and Pukguksong-5 are two-stage, solid-fuelled missiles and are wider than North Korea’s previous Pukguksong SLBMs.<sup>59</sup>

In October 2021 North Korea unveiled a ‘new type’ of smaller SLBM with an unknown designation at its Defence Development Exhibition.<sup>60</sup> The missile appears to bear similar characteristics to North Korea’s newer SRBM designs.<sup>61</sup> The same SLBM, which North Korea described as having ‘flank mobility and gliding skip mobility’, was reportedly test launched one week

<sup>53</sup> Korean Central News Agency, ‘Newly-developed long-range cruise missiles test-fired’, KCNA Watch, 13 Sep. 2021; and Van Diepen, V. H., ‘Initial analysis of North Korea’s “new type long-range cruise missile”’, 38 North, 15 Sep. 2021.

<sup>54</sup> Xu (note 45).

<sup>55</sup> See e.g. Lee, C. J., [(Exclusive) ‘Both pre- and post-detection of North Korean missiles failed . . . Korea–US information disaster’], *JoongAng*, 13 Sep. 2021 (in Korean).

<sup>56</sup> North Korean Ministry of Foreign Affairs (note 38).

<sup>57</sup> For further detail on North Korea’s earlier Pukguksong family of missiles see Kristensen and Korda (note 49), p. 403.

<sup>58</sup> NK News (note 48); and United Nations, S/2021/211 (note 32), annex 11.

<sup>59</sup> United Nations, S/2021/777 (note 19), annex 18-2. The larger diameter of the missiles could potentially indicate that they are designed to carry penetration aids or even multiple warheads; however, such capabilities have not yet been demonstrated.

<sup>60</sup> Xu (note 45).

<sup>61</sup> 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.

later from the port of Sinpo to an approximate range of 590 km, landing in the Sea of Japan.<sup>62</sup> The test's short apogee of 60 km indicates that this new SLBM is likely to have a shorter range than many of the Pukguksong SLBMs.<sup>63</sup> The missile was launched using North Korea's single Gorae-class (Sinpo) experimental submarine, 8.24 *Yongung*.<sup>64</sup> This submarine can hold and launch only a single SLBM.

In November 2020 the South Korean National Intelligence Service announced that North Korea was building a new ballistic missile submarine.<sup>65</sup> The vessel, designated Sinpo-C by the US DOD, appears to be based on a modified Project-633 (Romeo) diesel–electric submarine and to be fitted with three missile launch canisters.<sup>66</sup> According to a 2019 report by North Korea's state-run Korean Central News Agency, the submarine's operational deployment was 'near at hand'.<sup>67</sup>

<sup>62</sup> Korean Central News Agency, 'Academy of Defence science succeeds in test-launch of new-type SLBM', KCNA Watch, 20 Oct. 2021.

<sup>63</sup> 'N. Korea fires what seems to be SLBM toward East Sea: S. Korea', Yonhap News Agency, 19 Oct. 2021.

<sup>64</sup> Korean Central News Agency (note 62); 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 Jr, J. S. and Cha, V., 'Sinpo South shipyard update: SLBM test launch', Beyond Parallel, 21 Oct. 2021.

<sup>65</sup> Bermudez Jr, J. S. and Cha, V., 'Sinpo South shipyard: Construction of a new ballistic missile submarine?', Beyond Parallel, 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.

<sup>66</sup> Hotham, O., 'New North Korean submarine capable of carrying three SLBMs: South Korean MND', NK News, 31 July 2019; and Cha (note 65).

<sup>67</sup> 'NK leader inspects new submarine to be deployed in East Sea: State media', Yonhap News Agency, 23 July 2019.