IX. North Korea's military nuclear capabilities

SHANNON N. KILE AND HANS M. KRISTENSEN

The Democratic People's Republic of Korea (DPRK, or North Korea) maintains an active but highly opaque nuclear weapon programme. Estimates of the size of North Korea's nuclear arsenal vary considerably. It is estimated here that North Korea may have built up to ten rudimentary nuclear warheads, although there is no open-source evidence that it has weaponized and deployed the warheads with operational forces. This is based primarily on calculations of the amount of plutonium that North Korea may have separated from the spent fuel produced by its 5-megawatt-electric (MW(e)) graphite-moderated research reactor at the Yongbyon Nuclear Scientific Research Centre, prior to its 'disablement' in 2007 as part of the Six Party Talks, and assumptions about North Korean weapon design and fabrication skills.[1] The estimate assumes that each weapon requires five kilogrammes of plutonium.

Military fissile material production

North Korea is believed to have a limited plutonium production capacity. When fully operational, the 5-MW(e) graphite-moderated reactor at Yongbyon is estimated to be capable of producing approximately 6 kg of plutonium per year, enough for one nuclear weapon.[2]

There have been contradictory reports about the operational status of the reactor. In 2013 the General Department of Atomic Energy announced that it had begun renovation and new construction activities intended to 'readjust and restart' the facilities at its main nuclear complex at Yongbyon.[3] The disabled reactor was reported to have resumed operation later in the year.[4] North Korea appeared to resume the production of fuel rods for the reactor at the same time.[5] In September 2015 North Korea declared that all of the nuclear facilities at Yongbyon, including the reactor, had 'started normal

[1] See Albright, D. and Waldron, C., *North Korea's Estimated Stocks of Plutonium and Weapon Grade Uranium* (Institute for Science and International Security: Washington, DC, 16 Aug. 2012).

[2] Hansen, N. and Lewis, J., 'North Korea restarting its 5 MW reactor', 38 North, US–Korea Institute, Johns Hopkins University, 11 Sep. 2013, <http://38north.org/2013/09/yongbyon091113/>. It would take 2–3 years before the reactor's irradiated fuel could be discharged and another 6–12 months before plutonium could be separated from the spent fuel.

[3] Korean Central News Agency (KCNA), 'DPRK to adjust uses of existing nuclear facilities', 2 Apr. 2013.

[4] International Atomic Energy Agency, Board of Governors and General Conference, 'Application of Safeguards in the Democratic People's Republic of Korea', Report by the Director General, GOV/2014/42-GC(58)/21, 3 Sep. 2014, p. 3.

[5] Hansen, N., 'Major development: reactor fuel fabrication facilities identified at Yongbyon nuclear complex', 38 North, US–Korea Institute, Johns Hopkins University 23 Dec. 2013.

Table 16.10. North Korean forces with potential nuclear capability, January 2016

Type	Range (km)	Payload (kg)	Status
Ballistic missiles[a]			
Nodong	1 250	1 000–1 250	Fewer than 50 launchers; first deployed in 1990; most recent test-launch on 26 Mar. 2014
Hwasong-10 (BM-25, Musudan)	>3 000	~1 000	Under development; no test-launch yet
Hwasong-13 (KN-08)	>5 500	. .	Under development; no test-launch yet
Taepodong-2[b]	>5 500	. .	Under development; failed test-launch in 2006; 3-stage space launch vehicle variant placed satellite in orbit in Dec. 2012 and Feb. 2016
Bukkeukseong-1 (KN-11)	. .	. .	3 underwater ejection tests apparently conducted in 2015 with mixed results; KN-11 may be a submarine-launched variant of the Musudan

. . = not available or not applicable.

[a] There is no open-source evidence that North Korea has developed and tested a re-entry vehicle that is intended to carry a nuclear warhead on a long-range ballistic missile, developed a warhead that is sufficiently compact for this purpose, or deployed warheads with operational forces. This table lists the ballistic missiles that could potentially have a nuclear delivery role.

[b] A 2-stage Taepodong-1 missile was unsuccessfully flight-tested in 1998.

Sources: US Air Force, National Air and Space Intelligence Center (NASIC), *Ballistic and Cruise Missile Threat* (NASIC: Wright-Patterson Air Force Base, OH, May 2013); *Jane's Strategic Weapon Systems*, various issues; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and authors' estimates.

operation'.[6] However, commercial satellite imagery in 2015 indicated that the reactor might be operating at low power or only intermittently.[7]

There has been considerable speculation that North Korea is seeking to build nuclear weapons using HEU as the fissile material in order overcome the constraints posed by its limited stock of weapon-grade plutonium. There has also been speculation that North Korea may attempt to build a fusion-boosted fission device or even a thermonuclear weapon.[8] However, it remains unclear whether North Korea has made HEU for use in a nuclear weapon and, if so, how much.

North Korea is known to have at least one uranium centrifuge enrichment plant, located in a former metal fuel rod fabrication building at Yongbyon.

[6] KCNA, 'Director of Atomic Energy Institute of the DPRK on its nuclear activities', 15 Sep. 2015.

[7] Albright, D. and Kelleher-Vergantini, S., 'Updates on North Korea's Yongbyon nuclear site', Institute for Science and International Security (ISIS), Imagery Brief, 15 Sep. 2015.

[8] Lewis, J, 'Setting expectations for a DPRK test', Arms Control Wonk, 29 Jan. 2013; and Makino, Y., 'N. Korea likely to test fusion-boosted fission bomb able to reach US', Asia and Japan Watch, *Asahi Shimbun*, 25 Jan. 2013.

The plant was shown to visiting scientists from the United States in 2010, who were told that it was equipped with 2000 centrifuges.[9] Subsequent satellite imagery revealed construction work at the site to expand the centrifuge facility, with a new roof covering roughly twice the area of the previous one, hypothetically allowing the installation of a significant number of new centrifuges.[10] According to reports in 2015, work on the expanded centrifuge hall appears to have proceeded rapidly, but it would not be possible to determine its internal configuration and operational status without on-site access.[11] Both the United States and South Korea have said that they believe that North Korea has at least one additional site linked to a uranium-enrichment programme.[12]

Ballistic missiles

A growing number of non-governmental analysts believe that North Korea is probably able to build a nuclear warhead that is sufficiently compact and robust for delivery by a ballistic missile.[13] US and South Korean government assessments state that North Korea has made significant technical progress towards building a sufficiently compact nuclear warhead for this purpose.[14] However, a South Korean Defence Ministry spokesperson cautioned in February 2015 that '[d]espite its significant technology level, we do not think the North is capable of making such nuclear weapons'.[15] A US National Security Council official made a similar statement in May 2015.[16]

North Korea's ballistic missile arsenal is known to include nine types of indigenously produced guided ballistic missile, which are believed to be derived from older Soviet missile designs and from technologies that were reverse engineered by North Korea.[17] These include four longer-range

[9] Hecker, S., 'A return trip to North Korea's Yongbyon nuclear complex', Center for International Security and Cooperation, Stanford University, 20 Nov. 2010.

[10] International Atomic Energy Agency, Application of Safeguards in the Democratic People's Republic of Korea, Report by the Director General, GOV/2015/49-GC(59)/22, 26 Aug. 2015, p. 4.

[11] Albright and Kelleher-Vergantini (note 7); International Atomic Energy Agency (note 10).

[12] Jeong, Y. and Ser, M., 'North operates new uranium plant', *Joongang Daily*, 5 Nov. 2014; and Clapper, J. R., US Director of National Intelligence, 'Worldwide threat assessment of the US Intelligence Community for the House Permanent Select Committee on Intelligence', Statement for the record, 10 Feb. 2011, p. 6.

[13] See e.g. Lewis, J., 'North Korea's nuclear weapons: the great miniaturization debate', 38 North, US–Korea Institute, Johns Hopkins University, 5 Feb. 2015.

[14] Sanger, D., 'US commander sees key nuclear step by North Korea', *New York Times*, 24 Oct. 2014; Oh, S., 'N. Korea has "significant" technology for miniaturized nukes: Seoul', Yonhap News Agency, 6 Jan. 2015; and Capaccio, T., 'North Korea can miniaturize a nuclear weapon, US says', Bloomberg News, 7 Apr. 2015.

[15] Yonhap News Agency, 'N. Korea yet to miniaturize nukes: Seoul', *Korea Herald*, 26 Feb. 2015.

[16] 'US rejects N. Korea claim to have miniaturized warheads', Agence France-Presse, 20 May 2015.

[17] For a detailed history of North Korea's missile programme see Pollack, J. D., *No Exit: North Korea, Nuclear Weapons and International Security* (Routledge: Abingdon, 2011); and Bermudez, J. S.,

missiles: the Nodong; Hwasong-10 (also designated Musudan BM-25); Hwasong-13 (also designated KN-08); and Taepodong-2 (see table 16.10). North Korea is frequently cited in the open-source literature as possessing a total of 800–1000 ballistic missiles of all types, but these estimates are highly uncertain.[18] There is also considerable uncertainty about the reliability and operational readiness of North Korea's ballistic missile force. Compared with the missile programmes of other countries, North Korea carries out only a small number of test and training launches of its indigenously produced missiles before declaring them to be operational.[19]

Assuming that North Korea is able to produce a compact nuclear warhead, some observers assess that the size, range and operational status of the Nodong make it the missile system most likely to be given the nuclear delivery role.[20] The Nodong is a road-mobile, single-stage, medium-range ballistic missile (MRBM) with an estimated maximum range of 1000–1250 kilometres.[21] North Korea flight-tested the missile first in 1993. In March 2014 the North Korean Army's Strategic Rocket Force Command launched two Nodong missiles from mobile launchers that travelled 650 km before falling into the Sea of Japan.[22]

The Hwasong-10 missile, also designated the Musudan or BM-25, is reportedly a road-mobile, single-stage, intermediate-range ballistic missile (IRBM). Most analyses in the open-source literature have concluded that its design is based on the Russian R-27 (SS-N-6) submarine-launched ballistic missile (SLBM). The Musudan was first unveiled during a military parade in 2010.[23] As of the end of 2015, the missile had never been tested and was not believed to be deployed.

The Hwasong-13, also referred to by the US designation KN-08, was first presented by North Korea as a road-mobile missile with intercontinental range during a military parade in 2012. There are contradictory reports about the deployment status of the missile, which has not been flight-tested to date. Some non-governmental analysts have argued that the missiles displayed during military parades in 2012 and 2013 were mock-ups that contained a number of design anomalies which called into question whether the

A History of Ballistic Missile Development in the DPRK, Occasional Paper no. 2 (Monterey Institute of International Studies, Center for Nonproliferation Studies: Monterey, CA, 1999).

[18] Schiller, M., *Characterizing the North Korean Nuclear Missile Threat* (Rand Corporation: Santa Monica, CA, 2012), p. xv.

[19] Schiller (note 18), pp. 11–13, 34–36.

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

[21] Fitzpatrick, M. (ed.), *North Korean Security Challenges: A Net Assessment* (International Institute for Strategic Studies: London, July 2011), pp. 134–35.

[22] Yonhap News Agency, 'N. Korea fires two ballistic missiles', 26 Mar. 2014.

[23] Lewis, J., 'Origins of the Musudan IRBM', Arms Control Wonk, 11 June 2012.

system really existed.[24] In October 2015 the North Korean military displayed a new version KN-08 that was significantly different to previous years, with two stages rather than three. The missile's overall size was somewhat reduced, and it appeared to have a more modern structural design.[25] Several leading non-governmental experts assessed that the new design reflected North Korea's gradual progress towards a road-mobile ICBM but that the new system was unlikely to achieve an initial operational capability before 2020.[26]

The Taepodong-2 is believed to be a three-stage ballistic missile that may have an intercontinental range, although estimates of its range vary considerably. The initial test-launch in 2006 failed, as did two subsequent attempts, using space launch vehicle variants, in 2009 (Unha-2) and April 2012 (Unha-3).[27] North Korea successfully used a Unha-3 rocket to place a satellite into orbit in December 2012.[28] Despite the successful application of three-stage separation technology for the satellite launch, analysts note that North Korea has not demonstrated the guidance and re-entry capabilities required for building an intercontinental-range ballistic missile.[29]

Sea-based ballistic missiles

In 2014 US and South Korean defence officials disclosed that North Korea appeared to be seeking to develop a capability to launch ballistic missiles from submarines.[30] Such a capability would be consistent with speculation by some Western analysts that North Korea is moving towards an assured-retaliation strategy based on more survivable nuclear forces.[31] According to US defence officials, North Korea carried out the first flight of a KN-11 missile from a sea-based platform on 23 January 2015.[32] The KN-11

[24] Richardson, D., 'North Korea developing mobile missile: US intelligence', *Jane's Missiles & Rockets*, vol. 18, no. 2 (Feb. 2014); and Schiller, M. and Schmucker, R., 'The assumed KN-08 technology', Arms Control Wonk, 31 May 2012.

[25] Fisher, R., 'North Korea unveils new version of KN-08 ICBM', *Jane's Defence Weekly*, 12 Oct. 2015.

[26] Schilling, J., Lewis, J. and Schmerler, D., 'A new ICBM for North Korea?', 38 North, US–Korea Institute, Johns Hopkins University, 22 Dec. 2015.

[27] Wright, D. and Postol, T., 'A post-launch examination of the Unha-2', *Bulletin of the Atomic Scientists*, Opinion, 29 June 2009.

[28] Richardson, D., 'Unha-3 was largely of North Korean manufacture', *Jane's Missiles & Rockets*, vol. 17, no. 3 (Mar. 2013), pp. 4–6.

[29] Elleman, M., 'Prelude to an ICBM? Putting North Korea's Unha-3 launch into context', *Arms Control Today*, vol. 43, no. 2 (Mar. 2013).

[30] Fisher, R., 'US, S Korean sources suggest North has SLBM ambitions', *Jane's Defence Weekly*, 22 Sep. 2014.

[31] See e.g. Jackson, V., 'Why North Korea wants Mutually Assured Destruction', The Diplomat, 4 June 2015.

[32] Gertz, B., 'North Korea flight tests new submarine-launched ballistic missile', *Washington Free Beacon*, 18 Feb. 2015.

may be a sea-launched variant of the Musudan IRBM.[33] On 9 May 2015 North Korean state-run media reported that ballistic missile, later identified as a Bukkeukseong-1 ('Polaris-1') missile, had been successfully test-fired from a submerged submarine at an undisclosed offshore location.[34] However, the accompanying photographs that purportedly showed the undersea missile launch were widely dismissed by outside experts as having been manipulated.[35] Some analysts speculated that North Korea may have carried out a so-called ejection test—that is, a test designed to evaluate stabilization systems and the process of ejecting a ballistic missile from a submarine launch tube—from a submerged barge using the KN-11 SLBM.[36]

Two subsequent sea-based missile test launches in 2015 were also apparently unsuccessful. On 28 November South Korean defence sources reported that North Korea conducted an underwater launch test of a KN-11 missile, this time from its sole Sinpo class experimental submarine. The missile reportedly failed to be ejected from the launch tube and the submarine may have been damaged.[37] On 21 December North Korea conducted a third ejection test of a submarine-launched missile, most likely from a submersible barge, that was subsequently determined by non-governmental analysts to have been unsuccessful.[38]

There is general agreement among outside observers that while North Korea is devoting significant resources and making technical progress towards a submarine-launched missile capability, it will probably need many years to design, build and deploy an operational SLBM force. Some experts note, however, that North Korea has demonstrated a willingness to deploy strategic systems, including ballistic missiles, without completing a flight-trial programme to validate their capabilities.[39]

[33] Oliemans, J. and Mitzerv, S., 'First North Korean SLBM presents wholly novel threat', NK News.org, 11 May 2015.

[34] KCNA, 'Kim Jong Un watches strategic submarine underwater balllistic missile test-fire', 9 May 2015; and 'North test-fires its first missile from a submarine', *Joongang Daily*, 11 May 2015.

[35] Pearson, J. 'North Korea modified submarine missile launch photos, says US official', Reuters, 20 May 2015.

[36] Elleman, M., 'From under the sea: North Korea's latest missile test', 38 North, US–Korea Institute, Johns Hopkins University, 3 June 2015; Bermudez, J. S., 'Underwater test-fire of Korean-style powerful strategic submarine ballistic missile', 38 North, US–Korea Institute, Johns Hopkins University, 13 May 2015; and Capaccio, T. and Kim, S. 'North Korea didn't launch submarine missile, US officials say' Bloomberg News, 12 May 2015.

[37] Choe, S.-H., 'North Korean missile test was unsuccessful, South says', *New York Times*, 30 Nov. 2015; and 'North Korea tested submarine-launched missile, but launch failed: report', Reuters, 28 Nov. 2015.

[38] Dill, C., 'Video analysis of DPRK SLBM footage', Arms Control Wonk, 12 Jan. 2016.

[39] Elleman (note 36).