

CHAPTER 1

Alternative North Korean Nuclear Futures

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On February 12, 2013, North Korea's state media announced that it had conducted a third nuclear test "of a smaller and light A-bomb unlike the previous ones, yet with great explosive power...demonstrating the good performance of the DPRK's nuclear deterrence that has become diversified."² Since then, there has been renewed debate and speculation over the nature and direction of North Korea's nuclear program. Can it develop weapons using both plutonium and uranium? How far away is it from having a deliverable warhead and how capable are its delivery systems? How many and what kind of weapons is it looking to build? What are the strategic goals that drive its nuclear related decision-making? These are not easy questions to answer. North Korea remains one of the most notoriously secret nations, and details about its nuclear program are undoubtedly some of its most valued secrets. Yet, the answers to these questions have far reaching implications for U.S. and regional security.

This paper takes stock of what we know about North Korea's nuclear motivations, capabilities, and ambitions to explore where it's

1. This paper represents the author's personal views and does not reflect the views of the National Defense University, the Department of Defense, or any part of the U.S. government.

2. "KCNA Report on Successful 3rd Underground Nuclear Test," *Korea Central New Agency* (KCNA), February 12, 2013, available from http://www.ncnk.org/resources/publications/KCNA_3rd_Nuke_Test.pdf.

been and where it might be headed over the next 20 years. Drawing on available evidence, it maps one path it may take and explores what that path might mean for the shape, size, and character of North Korea's future arsenal. Making long-term national security predictions is of course fraught with challenges and prone to failure.³ Making predictions about North Korea's nuclear future should be done with even more humility considering so many questions about the current state of its program remain unanswered. However, there is a growing amount of evidence to suggest that North Korea's leaders have high ambitions for its nuclear program and the investments in place to sooner or later realize at least some of those goals.

The first section maps out the different motivations that animate North Korea's nuclear program and related decisions. The next section assesses what is known about North Korea's current capabilities. The paper then sets out alternative nuclear paths and what the evidence suggests about the direction North Korea might be heading over the next generation. The paper concludes with a discussion about what that path could mean for the size, shape, and character of North Korea's future nuclear arsenal.

North Korea's Multiple Motivations

North Korea has built its nuclear weapons program over decades despite significant costs in terms of international sanctions, diplomatic isolation, and heightened military tensions with neighbors and the United States. Not to mention, it has likely spent billions of dollars on the program even while at times struggling to feed its own people. The decision to continue its nuclear program with such a high price tag suggests that its leaders place significant value in it. In fact, some argue that the Kim regime increasingly depends on the

3. For a discussion of the challenges of national security predictions and how to plan for the unexpected, see Richard Danzig, *Driving in the Dark: Ten Propositions about Prediction and National Security*, Washington, DC: Center for a New American Security, 2011.

nuclear program for survival.⁴

With roots dating back to the 1950s, North Korea's nuclear program is driven by a number of factors that tend to fall into three broad categories: Military, politics, and diplomacy.⁵ These motivations have evolved overtime to become so intertwined and entrenched that, as one expert puts it, "the nation itself and nuclear weapons have been combined in a condensed symbol of intention."⁶ It is worth discussing them separately, however, because they frame North Korea's nuclear decision-making and strategic goals.

Military

North Korean leaders have consistently justified developing nuclear weapons as a deterrent primarily against U.S. aggression.⁷ There

4. James Clapper, the U.S. Director of National Intelligence, told the Senate Armed Services Committee that Kim Jong Un appears to feel "more intensely than his father" that nuclear weapons are "key to their [the regime's] survival." Tony Capaccio and Sangwon Yoon, "Kim Won't Talk on N. Korea's Nuclear Arms, DIA Chief Says," *Bloomberg*, April 18, 2013, available from www.bloomberg.com/news/2013-04-18/north-korea-demands-u-s-remove-nuclear-arms-before-any-dialogue.html. For a study on how authoritarian regimes leverage nuclear programs for political survival as well as the impact of domestic and international factors on related decisions, see Etel Solingen, ed., *Sanctions, Statecraft, and Nuclear Proliferation*, New York: Cambridge University Press, 2012.

5. This is similar to Siegfried S. Hecker, "Lessons from North Korea's Nuclear Crises," *Daedalus* 139, no. 1, Winter 2010, pp. 44-56; and, it largely follows the framework of Scott D. Sagan, "Why do States Build Nuclear Weapons?: Three Models in Search of the Bomb," *International Security* 21, no. 3, Winter 1996-1997, pp. 54-86.

6. Peter Hayes, "The DPRK's Nuclear Constitution," *NAPSNet Policy Forum*, Nautilus Institute for Science and Sustainability, June 13, 2012, available from nautilus.org/napsnet/napsnet-policy-forum/the-dprks-nuclear-constitution/#axzz2jhUXzEj8.

7. "Rodong Sinmun on DPRK's legitimate right to self-defence," *KCNA*, De-

is evidence, however, that they have also considered them for more offensive purposes.⁸ North Korea's military strategy has long favored offense over defense to provide for a rapid, short-notice invasion and forceful reunification of the peninsula before the United States can flow reinforcements.⁹ Its leaders might simply be incorporating nuclear weapons into this strategy. If so, they may believe that they can launch an attack at some favorable time, perhaps for limited objectives, and present the United States with a *fait accompli* that is protected by the threat of nuclear retaliation or nuclear use to deny U.S. access to the peninsula.¹⁰ In the past, of course, North Korea often emphasized that it would "never use nuclear weapons first" but recent statements and preemptive nuclear threats raise

ember 20, 2002, available from <https://web.archive.org/web/20141012035046/www.kcna.co.jp/item/2002/200212/news12/21.htm>; "DPRK FM on Its Stand to Suspend Its Participation in Six-party Talks for Indefinite Period," *KCNA*, February 10, 2005, available from <https://web.archive.org/web/20141012071035/www.kcna.co.jp/item/2005/200502/news02/11.htm>; "DPRK Foreign Ministry Clarifies Stand on New Measure to Bolster War Deterrent," *KCNA*, October 3, 2006, available from <https://web.archive.org/web/20120424180417/www.kcna.co.jp/item/2006/200610/news10/04.htm>; "Meeting Marks Anniversary of KPA Supreme Commander," *KCNA*, December 23, 2010, available from <https://web.archive.org/web/20141012035158/%20www.kcna.co.jp/item/2010/201012/news21/20101221-14ee.html>. Some argue that the target of its nuclear doctrine has in fact shifted since 2009 from the United States to a multi-directional and flexible strategy that has South Korea as its main focus. Peter Hayes and Scott Bruce, "North Korean Nuclear Nationalism and the Threat of Nuclear War in Korea," *Pacific Focus* XXVI, no. 1, April 2011, pp. 65-89.

8. In interviews with North Korean officials before 2000, for instance, Joseph Bermudez found that for its leaders "detering the United States also creates the opportunity to reunify Korea by force and under their terms." Joseph S. Bermudez, Jr., "The Democratic People's Republic of Korea and Unconventional Weapons," in Peter R. Lavoy, Scott D. Sagan, and James J. Wirtz, eds., *Planning the Unthinkable: How New Powers will use Nuclear, Biological, and Chemical Weapons*, Ithaca: Cornell University Press, 2000, p. 183.

9. Mark Fitzpatrick, ed., *North Korean Security Challenges: A Net Assessment*, London: International Institute for Strategic Studies, 2011, p. 49.

10. Brad Roberts, *The Case for U.S. Nuclear Weapons in the 21st Century*, Stanford: Stanford University Press, 2016, pp. 51-80.

doubts about that pledge.¹¹

Politics

Juche and *Songun* are twin concepts that have shaped North Korean domestic politics, strategic culture, and arguably, its nuclear decisions.¹² *Juche* emphasizes national self-determination and unquestioned loyalty to the supreme leader. *Songun* is a “military first” policy that prioritizes military might in state and social affairs and is arguably aimed at achieving two goals.¹³ One is the professed North Korean desire to strengthen its military in the face of an increasingly precarious international environment. The other has been to consolidate domestic power through the military under the heirs to the regime after the death of Kim Il Sung. These may be ideological tools that provide political legitimacy but they are also organizing principles for the North Korean state and society.¹⁴

Nuclear weapons, in part, seem to be an outgrowth of these con-

11. “DPRK Foreign Ministry Spokesman Totally Refutes UNSC ‘Resolution’,” *KCNA*, October 17, 2006, available from <https://web.archive.org/web/20150330021549/www.kcna.co.jp/item/2006/200610/news10/18.htm> and “Second Korean War Is Unavoidable: DPRK FM Spokesman,” *KCNA*, March 7, 2013, available from <https://web.archive.org/web/20150609004941/www.kcna.co.jp/item/2013/201303/news07/20130307-17ee.html>.

12. Joseph S. Bermudez, Jr., “North Korea and the Political Uses of Strategic Culture,” in Jeannine L. Johnson, Kerry M. Kartchner, and Jeffrey A. Larsen, eds., *Strategic Culture and Weapons of Mass Destruction: Culturally Based Insights Into Comparative National Security Policymaking*, New York: Palgrave, 2009, pp. 189-200; Victor Cha, *The Impossible State: North Korea, Past and Future*, New York: HarperCollins, 2012; and Alexandre Y. Mansourov, “The Origins, Evolution, and Current Politics of the North Korean Nuclear Program,” *Nonproliferation Review* 2, no. 3, Spring-Summer 1995, pp. 25-38.

13. Suk Hi Kim, “North Korea: Yesterday, Today, and Tomorrow,” in Suk Hi Kim, Terrence Roehrig and Bernhard Seliger, eds., *The Survival of North Korea: Essays on Strategy, Economics, and International Relations*, Jefferson, NC: McFarland & Company, 2011, pp. 18-19.

14. *Ibid.*

cepts. They allow North Korea to present itself as the true protector of an independent Korean people while portraying the South as being under the yoke of U.S. colonialism.¹⁵ International crises over its nuclear program similarly feed Pyongyang's narrative of being the sole defender against U.S. imperialism, while simultaneously rallying domestic support around the leadership. Nuclear weapons also offer North Korea perhaps the last remaining area where it holds superiority over South Korea in order to divert attention away from other clear deficiencies in military, economic, and technological matters. Lastly, nuclear weapons traditionally serve narrow bureaucratic interests, such as a state's scientific and engineering communities and elements within the military. This should be no different in North Korea's case; the nuclear program could be manipulated to shape and reshape a ruling coalition in ways that maximize the regime's control over the state and minimize potential rivals for power.

Diplomacy

North Korea has long exploited its nuclear program for international influence, prestige, and revenue. Its leaders have never hidden their belief that nuclear weapons can provide North Korea with international privilege on par with major powers.¹⁶ Since the 1994 Agreed Framework, of course, they have also used their nuclear program as a bargaining chip to garner political and economic concessions from the international community. More recently, however, North Korean leaders have emphatically claimed that their nuclear program is not a bargaining chip. Rather, it is "the nation's life [and a national treasure] which can never be abandoned."¹⁷

15. Brian Reynolds Myers, *The Cleanest Race: How North Koreans See Themselves—and Why it Matters*, Brooklyn, NY: Melville House, 2010, pp. 151-162.

16. International Crisis Group, "North Korea's Nuclear and Missile Programs," *Asia Report*, no. 168, June 18, 2009, p. 3.

17. "Report on Plenary Meeting of WPK Central Committee," *KCNA*, March 31, 2013, available from www.kcna.co.jp/item/2013/201303/news31/20130331-

TABLE 1. North Korea's Multiple Nuclear Motivations

Military	Political	Diplomatic
Deter primarily U.S. and secondarily ROK aggression	Symbol of self-reliance (<i>Juche</i> and <i>Songun</i>)	Bargaining Chip
Part of offensive military strategy to unify Korea by force	Technological triumph over U.S.-dependent ROK	Prestige of nuclear weapons
Supplement declining conventional balance	Bureaucratic interests	Revenue

North Korean Nuclear Capabilities

North Korea's nuclear capabilities and investments ought to reflect its motivations and also tell us something about its ambitions. Of course, here too we need to be cautious about overstating the evidence. The available information is rarely straightforward and can lead reasonable people to different conclusions. Assessments of North Korea's nuclear capabilities can be broken down into three areas: Size, design, and delivery systems.

Size

Estimates about the size of North Korea's nuclear arsenal—past, present or future—turn on different calculations about the weapons

grade material that North Korea has or can produce. That calculation is then typically divided by the amount of material the IAEA says is a “Significant Quantity” (IAEA SQ) for atomic bombs (8kg for Pu and 25kg for HEU) but some estimates include different assumptions about the amount of material that is required for North Korea’s weapons.¹⁸ For instance, North Korea claimed that its 2006 test used only 2kg of plutonium. Some use 2kg of plutonium-per weapon to help bound the range of weapons North Korea could have in its stockpile, even though they may be skeptical about North Korean claims.¹⁹

By most assessments, Pyongyang now has two routes for attaining bomb-making material. It is thought to have enough separated plutonium for around half a dozen or so weapons and it has a long-suspected uranium enrichment program that it acknowledged in 2009. Indeed, the North Korean statement that opens this paper claiming to have a diversified arsenal suggests to some that it has now tested both plutonium and uranium devices.

Plutonium Production

North Korea is reported to have everything it needs to produce Pu-239.²⁰ However, there is a great deal of uncertainty over exactly how much plutonium it has produced and stockpiled to date. Estimates

18. Mary Beth Nikitin, *North Korea’s Nuclear Weapons: Technical Issues*, RL34256, Washington, DC: Congressional Research Service, April 3, 2013. For IAEA definitions, see, *IAEA Safeguards Glossary*, 2001 Edition, Vienna: IAEA, June 2002, p. 23, available from http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_prn.pdf.

19. David Albright and Christina Warlond, “North Korea’s Estimated Stocks of Plutonium and Weapons Grade Uranium,” *Institute for Science and International Security*, August 16, 2012, p. 9.

20. It has industrial-scale mining and plants for milling, refining, and converting uranium as well as a fuel fabrication plant, reactor, and reprocessing facility. Nikitin, p. 3.

range between 24 and 50kg depending on how one answers technical questions about early covert production, the efficiency of the separation and conversion processes, and the amounts required for North Korea's first two tests—it is uncertain whether the third test was a plutonium or uranium device.²¹ As a result, estimates of its current plutonium based arsenal range from 4-7 weapons at the low end and 12-23 weapons at the high end, again also depending on how much plutonium North Korea might need per-weapon.²²

From 2007-2012, North Korea froze and largely disabled its plutonium production program but it reportedly restarted its 5 MWe reactor in 2013 for the purpose of growing its weapons stockpile.²³ Siegfried Hecker projected at the time that it could operate the reactor for two years with 8,000 fuel rods and extract roughly 10 to 12 kg of plutonium within three years. Thereafter, it could produce enough plutonium for about one weapon per year.²⁴ Moreover, some believe that an experimental light water reactor (25-30 MWe) that was under construction in 2010 may be nearing completion. While its stated purpose is to produce electricity, some experts assess that it also be used to produce 10-15kg of weapons grade plutonium per year.²⁵ Even more troubling, Hecker argues, is the

21. For a catalog of the different estimates, see *North Korean Security Challenges*, p. 112.

22. Albright and Walrond, p. 2.

23. Nick Hansen, "More Evidence that North Korea has Restarted Its 5 MWe Reactor," *38 North*, October 2, 2013, available from 38north.org/2013/10/yongbyon100213/ and Joseph S. Bermudez, Jr., "North Korea's Yongbyon Nuclear Facility: Possible Resumption of Operations at the 5 MWe Plutonium Production Reactor," *38 North*, January 18, 2017, available from <http://38north.org/2017/01/yongbyon011817/>.

24. Siegfried S. Hecker, "North Korea reactor restart sets back denuclearization," *Bulletin of the Atomic Scientists*, October 17, 2013, available from thebulletin.org/north-korea-reactor-restart-sets-back-denuclearization.

25. "North Korea Makes Significant Progress in Building New Experimental Light Water Reactor (ELWR)," *38 North*, November 14, 2011, available from <http://38north.org/2011/11/elwr111411/>.

potential for North Korea to build a copy of the 50 MWe graphite moderated heavy water reactor similar to one that was near completion in 1994. While it would need to be rebuilt from scratch, it could produce enough plutonium for up to 10 weapons per year. The reactor might take five years to build, if Pyongyang decides to significantly increase its plutonium production capability.

Uranium Production

For years, many believed North Korea operated a clandestine uranium enrichment program. While asserting its right to enrich uranium, however, North Korea denied that the program existed until 2009, when it stated that it would begin developing enrichment technologies to provide fuel for a new light water civilian reactor. In 2010, an unofficial U.S. delegation led by Hecker was invited to what North Korea claimed to be a gas centrifuge enrichment plant operating at Yongbyon. Hecker later reported that the plant likely had 2,000 Pakistani P-2 design centrifuges in six cascades, with a capacity of 8,000kg SWU/year.²⁶ As such, he calculated that the plant could be configured to produce up to about 40kg of 90% highly enriched uranium (HEU) per year. In 2013, satellite images showed that the facility had been expanded to accommodate roughly double the number of potential centrifuges. If it fills out those centrifuges, one assessment suggests that North Korea could soon produce anywhere from 16 to 68kg or roughly two weapons worth of HEU annually from the new facility.²⁷

26. Siegfried S. Hecker, "A Return Trip to North Korea's Yongbyon Nuclear Complex," *Center for International Security and Cooperation*, Stanford University, November 20, 2010, available from cisac.fsi.stanford.edu/sites/default/files/HeckerYongbyon.pdf.

27. David Albright and Robert Avagyan, "Recent Doubling of Floor Space at North Korean Gas Centrifuge Plant: Is North Korea doubling its enrichment capacity at Yongbyon?" *Institute for Science and International Security*, August 7, 2013, available from isis-online.org/isis-reports/detail/recent-doubling-of-floor-space-at-north-korean-gas-centrifuge-plant/10#2.

Estimating production rates for HEU is fraught with more uncertainty than estimating plutonium production due in part to uncertainty regarding the configuration, efficiency, and consistency of the enrichment process. More importantly, however, there are doubts that the Yongbyon plant is the only one of its kind. The speed of construction, size, and apparent sophistication of its disclosed centrifuge facility suggest to some that North Korea likely has at least a pilot-scale plant elsewhere. In fact, the U.S. Special Envoy for North Korea told the IAEA in 2010 that the United States believes North Korea has other clandestine uranium enrichment facilities outside of Yongbyon.²⁸ Some also argue that North Korea may have gathered materials over 10 years to build up to 10,000 centrifuges, and that related illicit procurements continue to pass through China.²⁹ Complicating the picture even further are reports that North Korea could now be building its own centrifuges using indigenous rather than imported technologies, which would make it nearly impossible to get an accurate estimate of its HEU production capabilities.³⁰

The Institute for Science and International Security released a study in 2012 that ran calculations on five different enrichment scenarios to estimate the range of HEU North Korea could produce. As a baseline, the analysis starts with only the 2,000-centrifuge production plant in Yongbyon that Hecker saw in 2010 and assumes that only LEU for energy was being produced there. The worst-case

28. Amb. Glyn Davies, "U.S. Statement to the IAEA: DPRK," IAEA Board of Governors Meeting, Vienna, Austria, December 2-3, 2010, available from <https://web.archive.org/web/20130216221403/vienna.usmission.gov/101202dprk.html>.

29. Albright and Warlond, p. 14.

30. Choe Sang-Hun, "North Korea Learning to Make Crucial Nuclear Parts, Study Finds," *The New York Times*, September 23, 2013. David Albright and Olli Heinonen dispute these findings. See, "In Response to Recent Questionable Claims about North Korea's Indigenous Production of Centrifuges," October 18, 2013, available from isis-online.org/isis-reports/detail/in-response-to-recent-questionable-claims-about-north-koreas-indigenous-pro/10.

scenario posits that two 2,000-centrifuge production plants outside of Yongbyon were started sequentially, one in 2005 and another in 2008, based on cited reports. In this scenario, centrifuges from the first plant were relocated to the Yongbyon facility in 2009 to produce LEU. The second facility could then act as a finishing plant, producing HEU from LEU feedstock enriched at Yongbyon. Based on the different scenarios, they calculate that North Korea could have had anywhere between 0-16 weapons worth of the HEU through 2011.³¹

In short, we could see North Korea's nuclear arsenal grow in a frightening way over the next 20 years. Table 2 shows that it could have enough material for an arsenal of around 65 weapons with minimal additional investment by that time. Of course, there are a number of assumptions built into this estimate that have not been confirmed. One, it assumes IAEA SQ for North Korean weapon designs. It also includes a baseline of 4-7 weapons in North Korea's current stockpile plus a rough estimate of a one-weapon-per-year plutonium production capability at the 5 MWe reactor and an estimate of two-weapons-per-year production of HEU at the known centrifuge enrichment facility at Yongbyon, assuming that the facility is operating 4,000 centrifuges.

31. Albright and Warlond, p. 2.

TABLE 2. Possible Size of North Korea's Arsenal in 20 Years: A Rough Low End Estimate			
Source Material	Current Stockpile	Future Weapons	Total in 20 years
Plutonium	4-7 weapons (assumes IAEA SQ)	~1 per year operating only the 5MWe reactor	24-27 weapons
HEU	0-16 weapons (assumes IAEA SQ)	~2 per year operating only the 4,000-centrifuge facility at Yongbyon	40-56 weapons
Total			64-83 weapons

If North Korea's weapons require less material than IAEA SQ, as some suggest could be the case, then the number of weapons in its arsenal in 20 years could increase to well over 100. Similarly, should North Korea complete construction and use its 25-30 MWe experimental light water reactor to produce weapons grade plutonium and also rebuild a 50 MWe graphite moderated heavy water reactor, its stockpile could increase exponentially. The same could be said if North Korea in fact has a larger uranium enrichment program than the 4,000-centrifuge facility at Yongbyon or decides to expand over the coming years.

**TABLE 3. Possible Size of North Korea's Arsenal in 20 Years:
Additions to Low End Estimate**

Low end estimate in 20 years	If less material than IAEA SQ is needed per weapon	If DPRK increases fissile material production (using IAEA SQ per weapon)	If less material than IAEA SQ is needed per weapon and DPRK increases material production
Pu weapons 24-27	48-54 weapons (assumes 4kg per weapon)	~1.5 weapons per year operating 25-30 MWe reactor (30 total additional weapons) ~10 weapons per year operating a 50 MWe graphite reactor (takes 5 years to build with 150 total additional weapons)	~384-387 (assumes 4kg per weapon)
HEU weapons 40-56	66-93 weapons (assumes 15kg per weapon)	~2 weapons per year operating an additional 4,000-centrifuge facility beyond currently known facility at Yongbyon (40 total additional weapons)	~132-186 (assumes 15kg per weapon)
Total in 20 yrs ~64-83	114-147	~289-308	~516-573

Table 3 shows how decreases in the amount of fissile material North Korea needs to build each weapon and/or increases in fissile material production could dramatically impact the size of its arsenal. If North Korea was able to produce weapons using only 4kg of Pu and 15kg of HEU, as Albright and Warlond suggest could be the case, it could have between 114-147 weapons in 20 years.³² Expanding its Pu and HEU production capabilities as discussed above in the worst-case scenario, North Korea could have an arsenal of 289-308 weapons. If it is able to expand its production and build weapons using less-than-IAEA SQ, North Korea could produce an astounding 516-573 weapons. Clearly, the 50 MWe graphite reactor that Hecker worries about North Korea reconstructing would be the single greatest contributor to an expanded arsenal. Fortunately, there is no current evidence that North Korea is planning to move in that direction. It is also worth noting that these worst-case calculations, of course, do not take into account technological, economic, or political constraints nor does it consider whether North Korea would desire such a large arsenal. Indeed, it is hard to believe North Korea would ever deem that large of an arsenal is necessary or viable.

The point here is that North Korea may face significant challenges if it decides to build a nuclear arsenal but producing enough fissile material is likely to be low on that list over the next generation. Even the more modest estimates of North Korea's possible arsenal size of 64-83 weapons in 20 years would approach at least one nuclear stockpile estimate for India (110) and Pakistan (120).³³

32. Albright and Warlond provide an expanded range of weapons based on the amount of required fissile material needed per weapon in "North Korea's Estimated Stocks of Plutonium and Weapons Grade Uranium."

33. Hans M. Kristensen and Robert S. Norris, "Global nuclear weapons inventories, 1945-2013," *Bulletin of the Atomic Scientists* 69, no. 5, September/October 2013, pp. 75-81.

Weapon Design

North Korea has tested five nuclear devices—in 2006, 2009, 2013, and two in 2016. The first test was widely considered a partial failure for a number of reasons. One is that North Korea reportedly informed China beforehand that it expected a yield of about four kilotons but the test produced less than one.³⁴ The second and third tests are commonly thought to have been more successful with progressively higher estimated yields of “a few” to upwards of 10 kilotons, respectively. Other than that, there is little substantively known about North Korean weapon designs, but there are a few core principles that allow us to consider the limited available information.

First, there are two types of basic weapons that are commonly discussed.³⁵ A “gun-barrel design” uses high-explosives to blow one subcritical piece of fissionable material from one end into another subcritical piece held in the other end to create a supercritical mass. An “implosion” design uses a solid spherical core of subcritical fissile material that is compressed with high explosives into a critical mass. A chain reaction is then set in motion with the introduction of neutrons. It is widely thought that plutonium cannot be used in a gun-barrel device because it emits so much stray radiation that a chain reaction would likely start before a supercritical mass is reached, resulting in a fizzle rather than a large explosion.³⁶ Since radioactive debris collected from its first test was consistent with a plutonium core, North Korea is thought to have tested an implosion device. That would also be consistent with reports on North Korea’s

34. Mark Mazzetti, “Preliminary Samples Hint at North Korean Nuclear Test,” *The New York Times*, October 14, 2006, available from www.nytimes.com/2006/10/14/world/asia/14nuke.html?_r=0.

35. This section is based on Samuel Gladstone and Philip J. Dolan, *The Effects of Nuclear Weapons*, Washington, DC: U.S. Department of Defense, 1977, pp. 13-18.

36. Also see, Stephen M. Younger, *The Bomb: A New History*, New York: HarperCollins, 2009, p. 23.

weapon design efforts dating back three decades.³⁷

Greg Jones notes in his chapter that conventional wisdom suggests that a country's first nuclear weapon will be a simple or crude design—as a proof of concept or demonstration—before developing smaller and lighter designs. When North Korea tested its first weapon, many analysts thought that it was following a similar path and concluded from the low yield that it was a fizzle. Even the successively more powerful second, third, and fourth tests produced low yields relative to the first tests of all previous nuclear powers (starting at 12 kt). As a result, some experts believed that North Korea was still trying to master a “simple fission” device and was far from an effective weapons capability.³⁸ Other analyst, however, suggested that the early tests might not have been for a simple design at all.³⁹ Rather, they argued, North Korea could have tested a smaller and lighter design toward a warhead that can fit on a missile. Still others speculated that North Korea may have tested early designs toward a boosted fission device or the trigger for a thermonuclear weapon.⁴⁰ That would be consistent with North Korea's own claims to have tested a hydrogen bomb in early 2016 and with some estimates suggesting that its fourth nuclear test produced a yield somewhere between 20-30 kt.⁴¹ While some experts believe

37. *North Korean Security Challenges: A Net Assessment*, p. 115.

38. Choi He-Suk, “Estimates Differ on Size of N.K. Blast,” *Korea Herald*, February 14, 2013, available from www.koreaherald.com/view.php?ud=20130214000765.

39. Jeffrey Lewis, “North Korea's Big Bang,” *Foreign Policy*, February 13, 2013, available from foreignpolicy.com/2013/02/13/north-koreas-big-bang/; Albright and Warlond, pp. 24-25; and David Albright and Andrea Stricker, “ISIS Statement on North Korean Nuclear Test,” February 12, 2013, available from isis-online.org/isis-reports/detail/isis-statement-on-north-korean-nuclear-test/.

40. John Pike, “‘Primitive’ but dangerous skills,” *New York Times Room for Debate* (blog), April 7, 2009, available from roomfordebate.blogs.nytimes.com/2009/04/07/how-hard-is-it-to-fire-a-rocket/?_r=0.

41. Jack Kim, “South Korea says North's nuclear capability ‘speeding up’, calls for action,” *Reuters*, September 11, 2016.

this is currently out of North Korea's reach for a number of technical reasons, likely requiring further tests and a reliable source of tritium, such capability might not be too far of a stretch over the next 20 years.⁴²

For Hecker, North Korea's HEU program seems inconsistent with the presumed priority of developing a weapon that can be delivered on the U.S. homeland because it is generally thought to be easier to miniaturize a weapon for missile delivery using plutonium. He argues that HEU weapons require more fissile material and more high explosives than plutonium based weapons. However, he speculates that if Pakistani nuclear scientist A. Q. Khan shared his country's HEU implosion design and test data, the North Koreans may have seen a quicker and more assured path to miniaturization as well as the added bonus of having an HEU program that is easier than plutonium production to hide.⁴³

Delivery Systems

North Korea has long had an ambitious program to build missiles with various ranges and payloads.⁴⁴ It is thought to be developing two inter-continental range missile (ICBM) systems. The first is a multi-stage *Taep'o-dong-2* (TD2) rocket that North Korea successfully launched in December 2012 to put a satellite into orbit. While the TD2 is ostensibly for peaceful space-related purposes, U.S. analysts fear that it could be configured to deliver a nuclear warhead on

42. Jeffrey Lewis, "Can North Korea Build the H-bomb?" *38 North*, June 11, 2010, available from 38north.org/2010/06/can-north-korea-build-the-h-bomb/. Also, see Hugh Chambers, "Producing tritium in North Korea," *Trust & Verify*, no. 152, January-March 2016, available from <http://www.vertic.org/media/assets/TV/TV152.pdf>.

43. Hecker, "North Korea reactor restart sets back denuclearization."

44. Joseph S. Bermudez, Jr., "A History of Ballistic Missile Development in the DPRK," Occasional Paper No. 2, Monterey, CA: Center for Nonproliferation Studies, Monterey Institute for International Studies, 1999.

the United States.⁴⁵ The second is a road-mobile ICBM (KN-08) that North Korea displayed during a military parade in 2012 but it is not yet clear how far along the missile is in the development-to-deployment process.⁴⁶

North Korea has tested medium-range *Nodong* missiles on several occasions, dating back to 1993, and there are now two reported variants of the *Nodong*.⁴⁷ Some have long suspected that North Korea likely has the ability to deliver a nuclear warhead on the earlier design up to 1,300km, which could reach all of South Korea and Western Japan. A newer variant was displayed during a 2010 parade that experts note shows improvements that suggest it could deliver up to 800kg about 1,600km.⁴⁸ That would give North Korea the ability to strike all of Japan, including U.S. assets in Okinawa. Both versions of the *Nodong* are thought to be liquid-fueled, low-accuracy, counter-value weapons with little utility against point or military targets. A recent DOD report suggests that North Korea

45. Department of Defense, *Military and Security Developments Involving the Democratic People's Republic of Korea: A Report to Congress Pursuant to the National Defense Authorization Act of 2012*, Washington, DC: Office of the Secretary of Defense, February 15, 2013, p. 9, available from https://www.defense.gov/Portals/1/Documents/pubs/Military_and_Security_Developments_Involving_the_Democratic_Peoples_Republic_of_Korea_2015.PDF.

46. Some believe that the mockups illustrate an aspirational capability that is still under development. See Jeffrey Lewis and John Shilling, "Real Fake Missiles: North Korea's ICBM Mockups are Getting Scary Good," *38 North*, November 4, 2013, available from <http://38north.org/2013/11/lewis-schilling110513/>. U.S. Vice Chairman of the Joint Chiefs, Admiral James Winnefeld recently stated: "We believe the KN-08 probably does have the range to reach the United States and the —our assessment of—of where it exists in its lifetime is something that would remain classified." See, Department of Defense, "DOD News Briefing on Missile Defense from the Pentagon," March 15, 2013, available from <http://archive.defense.gov/Transcripts/Transcript.aspx?TranscriptID=5205>.

47. *North Korean Security Challenges: A Net Assessment*, pp. 133-135.

48. *Ibid.*

likely has fewer than 50 *Nodong* missiles.⁴⁹

Also on display during the 2010 parade was a lengthened version of the R-27—a Soviet designed submarine-launched ballistic missile—referred to as the *Musudan*. In 2016, North Korea conducted a series of *Musudan* test launches demonstrating that it had modified the missile for mobile land launch.⁵⁰ Estimates suggest that it could have a range of up to 2,400km carrying a payload of about 650kg. It is reported to use a liquid propellant with a circular probable error of 2km. Similar to the *Nodong*, then, it is more for threatening cities than hardened military or point targets. If the range and accuracy estimates are correct, the only new targets this system really offers North Korea with any confidence are cities in non-U.S. and non-allied countries in Asia, like China and Russia, with a low potential for targeting U.S. military assets in Guam. This suggests one of a number of potential motivations: The North Koreans either want a redundant capability for the *Nodong-2010*, they want to expand the range of country targets for a more multi-azimuth strategy, or there are internal bureaucratic/technological motivations outside of its strategic value.

An aggressive series of North Korean missile tests over recent years suggests that it is pursuing two new capabilities—submarine launch ballistic missiles (SLBM) and solid-fueled rocket engines. In 2014, satellite imagery revealed North Korean efforts to build a vertical launch test stand for missiles that could be fired from submarines.⁵¹ It conducted at least 12 tests through 2016, including one in August of that year that flew about 500 km toward Japan, demonstrating that it had made considerable technological progress (North Korea calls this missile the *Pukkuksong-1*, often designated as the KN-11 by Western analysts). One aerospace engineer and close North Korea

49. *Military and Security Developments Involving the Democratic People's Republic*.

50. See *North Korean Security Challenges: A Net Assessment*, pp. 140-143

51. Joseph S. Bermudez, Jr., "North Korea: Test Stand for Vertical Launch of Sea-Based Ballistic Missiles Spotted," *38 North*, October 28, 2014, available from www.38north.org/2014/10/jbermudez102814/.

watcher observed that the pace and method of testing suggests that North Korea might have an initial operational SLBM capability as early as the second half of 2018. However, it may be a few more years after that before it has an operational sea-based deterrent that must also include a seaworthy and tested submarine.⁵² In early 2017, North Korea tested what some analysts believed to be a new variant of the *Pukkuksong* (*Pukkuksong-2*) for surface-to-surface launch that also demonstrated that it has made advances in using solid-propellant. If true, North Korea in the coming years could begin deploying missiles that are more mobile and can be launched more quickly than liquid-fueled rockets. Some analysts estimate that, once operational, the *Pukkuksong* missiles could reach a maximum range of anywhere from 1,200 to 3,000 km.⁵³

Most North Korea watchers believe that the country faces significant technical hurdles before it can deliver a nuclear weapon using an ICBM. One such hurdle is the need to develop a re-entry vehicle and warhead components that can withstand the heat and tumult of atmospheric travel. That hurdle is lowered for short and regional missiles, although the warhead would still need to be rugged enough to survive the rigors of flight. While there is no available evidence to suggest North Korea has tested such a capability, one report speculates that North Korea may have received data related to warhead flight from Pakistan, which conducted such tests of its own missiles that are derived from the *Nodong*.⁵⁴ This would have provided Pyongyang with a valuable head start toward an operational medium-range nuclear capability.

In order to deliver a nuclear weapon with any confidence using its air force, North Korea would likely need to modernize its Soviet-

52. John Schilling, "North Korea's SLBM Program Progresses, But Still Long Road Ahead," *38 North*, August 26, 2016, available from <http://38north.org/2016/08/slbm082616/>.

53. "Solid fuel believed used in North Korean missile, setting stage for mobile, stealthy arsenal," *The Japan Times*, February 14, 2017.

54. See *North Korean Security Challenges: A Net Assessment*, pp. 133-135.

era bombers and overcome formidable and growing U.S.-ROK air defenses. This does not seem to be a viable or reliable method of delivery in the short to medium term. However, it does have alternative delivery methods besides missiles. It might look to deliver a weapon by ship, exploiting its submarine capabilities, or it could infiltrate South Korea using special operations forces (SOF) to deliver weapons behind the DMZ. It might also build large, simple weapons that it could transport by truck to fixed locations during conflict. Lastly, it could attempt to deliver nuclear or at least radiological munitions by artillery. These are largely speculative although there is some evidence that North Korea is at least thinking about such tactical uses for nuclear weapons.⁵⁵

North Korea is similarly investing in ways that could increase the survivability of its missiles against pre-emptive attacks. For instance, North Korea has long shown interest in transporter-erect launchers for mobile missiles that make tracking and targeting difficult—the KN08, *Nodong*, *Musudan*, and some shorter-range missiles are thought to be mobile. Additionally, South Korean sources recently announced that North Korea has been constructing missile silos since the mid-2000s and some are located near the border with China.⁵⁶ While there is no readily available evidence to corroborate this claim in the literature or online sources, silos would be considered “hard targets” because the missile would be underground, requiring greater accuracy and/or higher yield ordinance to ensure their destruction.

55. For one exploration of possible delivery methods, see Peter Hayes and Scott Bruce, “Translating North Korea’s Nuclear Threats into Constrained Operational Reality,” in Gregory J. Moore, ed., *North Korean Nuclear Operationality*, Baltimore: Johns Hopkins University Press, 2014, pp. 15-31.

56. “North digs silos for missiles in Mt. Paektu area: Government sources say nearness to China is strategic advantage,” *Korea Joongang Daily*, October, 10 2012, available from koreajoongangdaily.joins.com/news/article/article.aspx?aid=2978649.

TABLE 4. Delivery Systems

	Potential Targets	Current Status
<i>Taep'o-dong-2/Unha</i>	United States	Not operational
KN08	United States	Not operational
<i>Musudan</i>	China, Russia, possibly Guam, Japan	Not operational
<i>Nodong-2010</i>	Japan, South Korea	Operational (<50)
<i>Nodong</i>	South Korea, Western Japan	Operational (<50)
Short range (Scud) missiles	South Korea	Operational (<100)
<i>Pukkuksong</i>	China, Japan, Russia, South Korea, possibly Guam	Not operational
Boat/Submarines	South Korea	N/A
Truck	Defensive	N/A
"Landmines"	Defensive	N/A
SOF	South Korea	N/A

Alternative Nuclear Futures

This section maps out the different nuclear strategies or postures that North Korea could adopt over the next generation. They include a political or diplomatic strategy aimed at extracting international concessions; a catalytic strategy intended to internationalize a conflict on the peninsula; assured strategic retaliation; and, nuclear war-fighting strategy.⁵⁷ These different strategies take into consideration the primary strategic goal that would presumably

57. This is an extension of Vipin Narang's excellent work in "Posturing for Peace? Pakistan's Nuclear Postures and South Asian Stability," *International Security* 34, no. 3, Winter 2009/2010, pp. 38-78.8.

guide nuclear decisions and investments; the relative transparency of nuclear capabilities that would likely be needed; the relative arsenal size and diversity of weapon systems; when and under what conditions they might be used against which targets; the command and control procedures for carrying out related decisions; and, the primary challenge each strategy would inevitably confront. Table 5 highlights these characteristics.

Political/Diplomatic

It is generally assumed that a state's nuclear strategy or posture is aimed at security or deterrence related goals. But, this might not always be the case. North Korea has used its nuclear program at times to garner international economic and energy assistance, gain international and domestic prestige, shape domestic politics, and increase diplomatic leverage. These goals share one important characteristic: Operational, militarily viable nuclear capabilities are not necessary. To achieve these goals, North Korea only needs to invest what is minimally necessary to satisfy different constituencies or to maximize leverage/profit.

A nuclear posture that is oriented primarily toward political or diplomatic goals requires very little transparency. This type of posture is not overly concerned with deterring an adversary, so it does not necessarily require the demonstration of a nuclear weapons capability. Rather, the demonstration of the technical means for a nuclear weapons program would likely suffice for symbolic or bargaining purposes to extract international concessions. Since there is no requirement for a functioning arsenal, this strategy has few demands in terms of operational complexity or command and control. The major problem such a strategy faces, however, is that it likely offers a diminishing margin of return—as a source of prestige, international bargaining or bureaucratic leverage—on investments. Even a nuclear posture that is aimed at maximizing monetary profit through trade faces a limited and narrow market that can likely sustain investments only so far.

Catalytic

This posture's primary goal is to internationalize the conflict and prompt third party—typically super-power—assistance or intervention to restrain one's adversary. The two examples often used to illustrate this model are Israel's "nuclear signal" during the Yom Kippur War and South Africa's nuclear program during the 1980s.⁵⁸ In both cases, some argue, the primary goal was to encourage U.S. involvement in regional conflicts rather than to directly deter adversaries. That is, the specter of regional nuclear war would frighten the United States into intervening and restraining adversaries.

A catalytic posture requires a higher level of transparency than a nuclear posture that is primarily aimed at political or diplomatic goals because nuclear war must be credible. However, the minimum transparency is still low because the goal is not necessarily to convince an adversary that it faces the threat of nuclear retaliation. Rather, the goal is to raise the potential costs of conflict more generally where third party interests would be at risk. Thus, the minimum requirement would be demonstration of the technical means for a nuclear weapons capability not just a nuclear weapons program.

Perhaps, this would consist of conveying the ability to use a handful of counter-value weapons under highly centralized command and control. Requiring a low level of operational sophistication, the weapons do not necessarily even need to be assembled but could be stored on stand-by to create the mere impression that war could escalate. The problem for this posture is that it is essentially a gamble on third party intentions as well as the adversary's calculation that the third party will intervene and that the resulting intervention would outweigh the benefits of conflict.

58. Avner Cohen and Terence McNamee, *Why Do States Want Nuclear Weapons? The Cases of Israel and South Africa*, Oslo: Norwegian Institute for Defence Studies, 2005. However, recent scholarship casts doubt on the catalytic nature of Israeli actions in the 1973 Arab-Israeli War. See Bridge Colby, et. al., *The Israeli "Nuclear Alert" of 1973: Deterrence and Signaling in Crisis*, Alexandria, VA: Center for Naval Analyses, 2013.

**TABLE 5. Alternative Nuclear Futures at a Glance:
Minimum Requirements for Four Models**

Nuclear Model	Primary Goal	Relative Transparency
Political/Diplomatic	Bargaining/revenue /prestige/bureaucratic and domestic politics	Lowest
Catalytic	“Catalyze” third party assistance or intervention	Low
Assured Strategic Retaliation/Limited Deterrence	Deter strategic/ nuclear attacks and coercion	Medium -Demonstrate survivable second strike
War-fighting	Deter broad range of threats, including lower-level conventional attacks	High -Demonstrate survivable second strike and first strike capabilities/ will

**TABLE 5. Alternative Nuclear Futures at a Glance:
Minimum Requirements for Four Models, Continued**

Relative Arsenal Size/Diversity	Operational Complexity	Problems
None	None	Diminishing margin of return on investments
Small -Hand full of Counter-value weapons	Low -Central authority -Weapons may/may not be assembled	Relies on third party intentions and adversary calculations
Medium -Enough counter-value weapons to threaten unacceptable retaliatory costs	Medium -Central or delegated authority -Weapons may or may not be assembled	Credibility gap against conventional threats
High -Large, diverse arsenal (counter force and counter value) for first use in a range of scenarios with reserve of second strike forces	High -Pre-delegation and rapid deployment during crises -Planning integrated into military doctrine -Alert status is high	Expensive and significant pressure on C2 that could lead to inadvertent escalation

Assured Strategic Retaliation or Minimum Deterrence

This posture is aimed at deterring strategic attacks and coercion that threaten state or regime survival. Assured strategic retaliation depends foremost on developing survivable second-strike nuclear forces that can render an adversary's strategic assets vulnerable and pose unacceptable costs. China is often thought to have relied on this type of posture for at least three decades.⁵⁹ Meanwhile, North Korean investments in mobile and hardened nuclear-tipped missiles suggest it may be moving in this direction—a survivable assured retaliation against the United States and its allies.

A medium level of transparency is necessary for this posture because the aim is to convince an adversary that you can endure and retaliate against a first strike, even during heightened crises. It requires demonstrating and disclosure of technical capabilities so that one's adversary has little doubt about the ability to retaliate following a first strike. However, other aspects associated with operations and command and control can remain hidden. For instance, China has long demonstrated its technical capabilities but it has kept hidden details regarding its command and control, the size of its arsenal, deployment patterns, etc. It presumably wants adversaries to know that it can strike high value targets, but it employs a shroud of opacity to enhance survivability of a relatively limited arsenal.

More generally, this posture calls for a larger arsenal than what is minimally necessary in the two discussed above because some redundancy is needed to ensure enough weapons survive a first strike to threaten an adversary with unacceptable costs. However, the arsenal can be comprised solely of counter-value weapons since it does not need to hold at risk a range of different targets or need to engage in nuclear war-fighting. It also requires a higher level of operational sophistication. Procedures for delegated or alternate launch authority would likely be put in place to protect against first or decapitating

59. M. Taylor Fravel and Evan S. Medeiros, "China's Search for Assured Retaliation: The Evolution of Chinese Nuclear Strategy and Force Structure," *International Security* 35, no. 2, Fall 2010, pp. 48-87.

strikes. However, the weapons do not necessarily need to be pre-assembled—assured retaliation does not need to be immediate. Thus, the command and control structure can still be highly centralized, at least during peacetime. The main limitation with this posture is a credibility gap for deterring lower levels of conflict when facing a nuclear-armed and conventionally superior adversary that is able to respond in kind.

Nuclear War-fighting

This model is intended to deter strategic attacks as well as conventional ones by threatening rapid first use of nuclear weapons in the event of conflict. This is what some might call a nuclear war-fighting posture because it requires survivable second-strike capabilities like the assured retaliation posture to deter strategic attacks and an ability to disperse and deploy nuclear weapons quickly to be released for battlefield use. Because this posture envisions battlefield use for nuclear weapons, the strategy can also be used to offset or defeat an adversary's conventional forces. Therefore, it can be used to coerce not only to deter an adversary. North Korean statements and actions toward building a more robust and sophisticated arsenal suggests that it might have this type of posture in mind as a long term goal.

A high level of transparency is needed to make this posture credible for deterrence purposes. To adopt this model, North Korea would need to demonstrate multiple technical capabilities, highly complex deployment patterns, and command and control to emphasize a high-alert status with pre-delegated launch authority, at least during crises. In order to address varying conventional conflict scenarios, the size of the arsenal would have to be much larger and more diverse, including counter-force capabilities. The major drawback for this posture is that maintaining a diverse, large arsenal with a complex operating system can be exponentially expensive and it also presents significant pressures that can lead to unintended esca-

lation or loss of command and control.⁶⁰

North Korea's Nuclear Direction

North Korea's nuclear posture continues to evolve and its direction remains uncertain. But one reading of the evidence suggests an ambitious and dangerous trajectory (see Table 6). In the past, North Korea may have valued political and diplomatic goals above others. Andrei Lankov argues in fact that "on balance, this goal [diplomatic blackmail] seems to be even more important than using the nukes as a strategic deterrent."⁶¹ The practice of nuclear diplomacy began in the 1960-70s in an effort to manipulate China and the Soviet Union but the target of blackmail shifted to the United States and its allies in the 1990s. Between 1994 and 2007, for instance, it froze or disabled elements of its program in exchange for energy assistance, food aid, diplomatic talks, security assurances, sanctions relief, and economic concessions. Some of those trades constrained North Korea's ability to produce nuclear weapons. However, international and U.S. concessions dried up around 2008 when the Obama administration stated that it "will not buy this horse for a third time."⁶² In other words, there was a declining margin of return on investments for North Korea's brand of nuclear diplomacy.

In accord with a political-diplomatic posture, North Korea's nuclear capabilities remained unproven and far from transparent through-

60. Scott D. Sagan, *The Limits of Safety: Organizations, Accidents, and Nuclear Weapons*, Princeton, NJ: Princeton University Press, 1993.

61. Andrei Lankov, *The Real North Korea: Life and Politics in the Failed Stalinist Utopia*, New York: Oxford University Press, 2013, p. 149. In a recent conversation, however, he clarified that the primary motive for North Korea has shifted over time from military to diplomatic and back to military.

62. David E. Sanger, "U.S. Weighs Intercepting North Korean Shipments," *The New York Times*, June 7, 2009, available from <http://www.nytimes.com/2009/06/08/world/asia/08korea.html>.

out the 1990s and most of the early 2000s.⁶³ Without much of an arsenal, operations of the nuclear program were likely controlled and under centralized authority. The Nuclear-Chemical Defense Bureau, an organ of the Ministry of People's Armed Forces with direct report to the supreme leader, was thought by some to have been responsible for managing the nuclear inventory.⁶⁴ Even later, in 2009, the International Crisis Group assessed that the weapons had not been transferred to the KPA. Rather, the supreme leader through an independent yet still unidentified institution closely guarded them.⁶⁵

North Korea's nuclear posture may have shifted toward a catalytic model shortly after its first nuclear test in 2006. The specter of nuclear war has become a routine feature during crises on the Peninsula in an apparent attempt to galvanize outside intervention. By threatening to escalate conflict to nuclear war, for instance, North Korea has stimulated Chinese, U.S., and even Russian actions to restrain South Korea following provocations, such as after the brazen attacks in 2010. The major powers, especially the United States and China, have a lot at stake in stability. The prospect of a wider, nuclear war in Korea could draw them in on opposing sides. The resulting costs for both would be extremely high, while neither faces particularly high costs for returning to the status quo and stability. North Korea may realize this and exploit their mutual interests and fears by utilizing its nuclear weapons to "rock the boat." However, recent experience suggests this strategy might not be reliable over time. Chinese patience shows signs of having limits when it comes to North Korea's nuclear saber rattling. Moreover, the United States and South Korea are developing a deterrence and defense strategy

63. It announced that it had a nuclear arsenal in 2003 and there were outside reports that it may have had a couple of weapons before then.

64. Andrew Scowbell and John M. Sanford, *North Korea's Military Threat: Pyongyang's Conventional Forces, Weapons of Mass Destruction, and Ballistic Missiles*, Carlisle, PA: Strategic Studies Institute, 2012.

65. International Crisis Group, p. 12.

aimed specifically at neutralizing the North's nuclear threat. It would be a gamble for Pyongyang to rely on outsiders to restrain South Korea in the future.

In line with a catalytic posture, North Korea's nuclear program has become more transparent through tests, military parades, media releases, and public statements since 2006. It has demonstrated a growing although still ambiguous capability, with only a few potential weapons in its arsenal. Some experts have assessed that North Korea could deliver a nuclear warhead on a short to medium range missile, even if with only low levels of accuracy and confidence.⁶⁶ Its nuclear threats have become less subtle and have even threatened the United States, although few believe it actually has the capability to do so. Leaders in Pyongyang have also signaled their intent to bolster nuclear operations and command and control but with continued emphasis on centralized authority. In March 2012, for instance, North Korea upgraded the Missile Guidance Bureau in charge of short and long-range missile developments to the status of Strategic Rocket Forces Command, which is somewhat autonomous from the KPA with a direct report to Kim Jong Un and the KPA General Staff. Its commander was also elected to the Worker's Party Central Military Committee, chaired by the supreme leader. Some believe this could be the new home for North Korea's nuclear forces.⁶⁷ The point here is that North Korea's posture has started to change since 2006 and, since then, has taken on a more "catalytic" quality than in the past.

To be sure, leaders in Pyongyang might have even higher ambitions for its nuclear program. Investments in a survivable and more robust nuclear arsenal suggest that it may be striving for an assured retaliation capability in the near-to-midterm with a longer-term goal of adopting an asymmetric or nuclear war-fighting posture. As highlighted above, North Korea has the infrastructure to significantly

66. Albright and Warlond, p. 10.

67. *East Asia Strategic Review*, Tokyo: National Institute for Defense Studies, 2013, p. 146.

increase the quantity and quality of its arsenal over the coming years. It rhetorically targets strategic centers in the United States, ROK, and Japan and an increasingly capable missile program will sooner or later put those targets within reach unless there is a dramatic change in course. It is also trying to improve the survivability of those delivery systems by emphasizing mobility, deception, and hardening.

A larger and more survivable counter-value arsenal would be consistent with an assured retaliation posture. Aspirations for such capabilities are reflected in North Korea's policy adopted by the Supreme People's Assembly (SPA) in 2013:

“[Nuclear weapons] serve the purpose of deterring and repelling the aggression and attack of the enemy against the DPRK and *dealing deadly retaliatory blows at the strongholds of aggression...*”⁶⁸

Given current doubts about North Korea's nuclear capabilities, it may feel the need to conduct more tests to prove and demonstrate an assured retaliation capability to make sure the United States and South Korea get the message. As for operational planning, the SPA Law also makes clear that launch authority remains highly centralized for the time being; “nuclear weapons of the DPRK can be used only by a final order of the Supreme Commander of the Korean People's Army...”⁶⁹

While North Korea's investments and recent policy statements suggest it may be building an assured retaliation posture, there are signs that it also has an asymmetric or nuclear war-fighting goal for the future. The SPA “Law on Consolidating Position of Nuclear Weapons State” expands the role of its nuclear weapons beyond deterring high-end attacks to also deter and repel lower levels of

68. “Law on Consolidating Position of Nuclear Weapons State Adopted,” *KCNA*, April 1, 2013, available from <https://web.archive.org/web/20140723060405/www.kcna.co.jp/item/2013/201304/news01/20130401-25ee.html>, emphasis added.

69. *Ibid.*

aggression using its nuclear weapons:

“The DPRK shall take practical steps to bolster up the nuclear deterrence and nuclear retaliatory strike power both in quality and quantity *to cope with the gravity of the escalating danger of the hostile forces’ aggression and attack.*”⁷⁰

As already discussed, it has the current infrastructure and investments in place not only to grow its arsenal in terms of quantity and quality but also in terms of diversity, if it is indeed producing HEU. It could look to field a range of weapons for counter-value and counter-force targets in order to address different conventional conflict scenarios while retaining a strategic deterrent. Of course, this would require a much more sophisticated command and control system that would likely entail a high alert status, some pre-delegated authority, and integration of nuclear forces into its broader military doctrine. Indeed, the Central Committee of the Workers’ Party of Korea released a report one day before the SPA Law directing the military to begin such planning:

The People’s Army should perfect the war method and operation in the direction of raising the pivotal role of the nuclear armed forces in all aspects concerning the war deterrence and the war strategy, and the nuclear armed forces should always round off the combat posture.⁷¹

To summarize, Table 6 on page 42 illustrates North Korea’s nuclear trajectory. The primary goal for its nuclear program may have been political or diplomatic, in the past, as it was willing to trade elements of its program during the 1990s and early 2000s. Those days appear to be over. North Korea has demonstrated a growing, although still ambiguous, capability since 2006. With only a hand

70. Ibid.

71. “Report on Plenary Meeting of WPK Central Committee.”

full of weapons estimated to be in its arsenal, it has threatened nuclear war during crises ostensibly aimed at encouraging Chinese and U.S. involvement. But it aspires for a more robust posture. It is making investments and has articulated intentions to build a larger and more survivable counter-value arsenal that would be consistent with an assured retaliation posture. Meanwhile, recent policy statements indicate that it may have ambitions for an asymmetric escalation posture.

What's Next? North Korea's Nuclear Program in 20 Years

What does North Korea's nuclear direction mean for the size, shape, and character of its future arsenal? It is worth recalling that North Korea could have the infrastructure to produce at least 64 but as many as 83 weapons with relatively little additional investment over the next 20 years. That number could easily exceed 100, if North Korea can design weapons using less fissile material than the IAEA SQ, as some have suggested; and it could grow to 200-500, if it increases its fissile material production capabilities as some fear that it might. As such, North Korea's nuclear posture will not likely be limited by its size. Even an arsenal of 60-80 weapons may be sufficient for North Korea to implement an asymmetric escalation strategy.

In the near term, North Korea would likely focus on efforts to bolster its strategic deterrent against the United States if it is, in fact, pursuing an assured retaliation posture. Some believe it can already or might soon be able to deliver a nuclear warhead on short medium range missiles to strike cities in South Korea and Japan.⁷²

72. Press reports claim that the U.S. intelligence community assesses that "North Korea has not...fully developed, tested, or demonstrated the full range of capabilities necessary for a nuclear-armed missile." See Ernesto Londoño, "Pentagon: North Korea likely has nuclear warhead for its ballistic missiles," *Washington Post*, April 11, 2013, available from www.washingtonpost.com/world/national-security/pentagon-north-korea-could-have-nuclear-missile/2013/04/11/72230dea-a2eb-11e2-82bc-511538ae90a4_story.html.

That may have some deterrent effect on U.S. decision-making but North Korea's leaders would likely want a more robust deterrent by threatening its main adversary with unambiguous and unacceptable retaliatory costs. To do this, North Korea may believe that a couple dozen nuclear tipped missiles that can strike the United States would be sufficient. After all, China's intercontinental ballistic missile (ICBM) force is thought to have numbered only in the twenties well into the 1990s.⁷³ However, growing U.S. missile defenses could lead North Korea to a higher number and/or pursue penetration aids—which, in turn, would very likely spur additional U.S. national missile defenses.

To adopt an assured retaliation posture, North Korea would likely continue to improve its missile delivery systems, survivability, and command and control. Its first priority would logically be to develop proven and tested ICBM technologies so that few doubt its missiles can reach proximate targets in the United States. We may see continued progress on its *Taep'o-dong* missiles to include modifications for warhead delivery. But since these are fixed location, liquid fueled missile systems, they could be vulnerable to a first strike. Underground silos could make the systems less vulnerable or at least increase the scale of a potential disarming attack for the United States. More likely, North Korea will push forward its KN08 enterprise because these systems can be routinely dispersed to increase survivability. The TELs can similarly exploit underground tunnels, caves, and North Korea's rough mountainous terrain for deception, evasion, and sheltering. Testing the propulsion and guidance systems for a mobile TEL base as well as fixed location ICBM forces would be important.

Additionally, it might also believe that it is necessary to improve, test, and communicate that it can miniaturize a device for a warhead. Sustaining plutonium production could be critical for this, since many experts believe plutonium is better suited than uranium for missile delivery by providing better yield-to-weight ratios.

73. Fravel and Medeiros.

Even though Hecker and others speculate that A. Q. Khan may have shared his country's HEU implosion design and test data with North Korea, offering a quicker and more assured path to miniaturization, it is worth recalling that Pakistan never gave up the plutonium pathway.⁷⁴ Pakistan's plutonium production may yet be central to its warhead modernization program.⁷⁵ North Korea might similarly see plutonium as its surest path to delivering an atomic weapon 10,000km away.

Like countries before it, North Korea might try to offset the inaccuracy of its ICBMs through higher yield and more efficient warheads. At any rate, it would likely seek higher yields in order to demonstrate that it can pose unacceptable costs with even a few weapons on target to account for U.S. defenses or system errors. North Korea is unlikely to have the wherewithal to develop thermonuclear weapons in the near-to-mid-term but some speculate that it might be able to develop boosted-fission designs in the not-too-distant future. Jeffrey Lewis suggests that this would require additional testing but not much.⁷⁶ He argues that China successfully tested a boosted fission weapon with only its third test, and Pakistanis claim to have included a boosted fission weapon in its first round of tests. While North Korea may want to move in this direction, such weapons require tritium, lithium-6, deuteride, or other fusion fuels.⁷⁷ An exhaustive search in the literature and on-line sources does not provide evidence that would suggest North Korea has a domestic or international source for such fuels.

74. Hecker, "North Korea reactor restart sets back denuclearization."

75. Narang.

76. Jeffery Lewis, "Can North Korea Build the H-bomb?" and "Setting Expectations for a DPRK Test," *Arms Control Wonk* (blog), January 29, 2013, available from lewis.armscontrolwonk.com/archive/6200/setting-expectations-for-a-dprk-test.

77. Gladstone and Dolan, pp. 20-25.

TABLE 6. North Korea's Nuclear Direction

Nuclear Model	Past	Present
Political/Diplomatic	Trade elements of unproven program for concessions -1994 Agreed Framework -Six Party Talks -Fuel and Food Aid (Yongbyon)	
Catalytic		Demonstrated but still ambiguous capability, combined with over-the-top threats during crises to coerce and "catalyze" U.S. and Chinese
Assured Strategic Retaliation/Limited Deterrence		
War-fighting		

TABLE 6. North Korea's Nuclear Direction, continued

Emerging (5-10 years)	Over the Horizon Ambitions (10-20 years)
Developing survivable strike capabilities targeting ROK, Japanese, and U.S. cities	
	Parallel Development Policy of Economy and Nuclear Weapons and the April 1 Nuclear Law on Consolidating Nuclear Weapon State

Size and Diversity of Weapons, Increasing Transparency, Operational Complexity

As mentioned above, North Korea recently upgraded the Missile Guidance Bureau in charge of short and long-range missile developments to the status of Strategic Rocket Forces Command. It remains a direct report to Kim Jung Un, which follows the SPA Law directing that nuclear weapons can be used only by a final order from the Supreme Commander. This suggests that centralized authority over the arsenal is still closely held. While an assured retaliation posture does not require pre-delegated authority during peacetime, it does require an arsenal that can survive first disarming as well as decapitating strikes to then retaliate. So, North Korea's forces would need to disperse and/or take shelter to wait out an attack but then emerge, communicate, and launch with or without orders. This means that some delegated authority must be provided at least during crises in the event that leadership is taken out. Such command and control operational concepts can be complex. They often require clear guidance and exercises that are made public in order to send a deterrence message. They should also require robust communication capabilities beyond radio-frequency equipment, which can be disabled during conflict. Leaders would not want commanders to mistake failed communications for decapitation and unnecessarily launch their missiles. Moreover, leaders would want to maintain positive control and coordination over launches during conflict. Robust and survivable communications would be important to fully implement an assured retaliation posture. North Korea could make these types of investments over the coming years.

In 20 years, North Korea might adopt a more ambitious war-fighting posture to compensate for its inferior conventional military amid much stronger neighbors and adversaries. Its prospects for winning a conventional war against South Korea and/or the United States, particularly if it is prolonged, are increasingly slim. As such, leaders in Pyongyang show signs that they may rely more and more on nuclear weapons to deter conventional conflict and even coerce the United States and its allies by threatening first strikes. To do so, they would presumably want counter-force weapons to blunt enemy advances and quick strategic options that could sway the conventional

fight on the peninsula, while holding survivable retaliatory strike options in reserve to deter nuclear attack from the United States or others.

As highlighted earlier, HEU could at some point provide North Korea with a range of options using relatively simple weapons. It could set “atomic landmines” or use trucks loaded with rudimentary devices to deliver weapons to block corridors into North Korea. Additionally, it might exploit its arsenal of short range missiles or SOF to target approaching forces, reserves, or supply lines. It would not necessarily take many of these weapons to cover the main passageways, slow advances, or complicate operations for an advancing army. These weapons would also not necessarily need to be particularly high yield weapons and there might not be any requirement for testing a simple Gun Barrel type of weapon. Recall that the United States did not test the very first weapon of this design before it was used on Hiroshima. North Korea might nonetheless find testing useful as a deterrence signal.

Meanwhile, the *Nodong* and *Musudan* missiles are already thought by many to be capable or near-capable of delivering nuclear warheads on strategic centers in the region, such as Busan, Okinawa, and Guam. North Korea might think that striking such targets could slow the flow of U.S. forces to the peninsula, but without increased accuracy or higher yield weapons, confidence in achieving the desired military objective would be low. Or it could seek other delivery means. For instance, using simple design options, North Korea might attempt to deliver a weapon to key ports by ship or by exploiting its submarine fleet.

To be sure, North Korea would still need to have a reserve of second strike retaliatory forces to implement war-fighting posture. It would want to be confident that it could deter the full retaliatory response from the United States by threatening it with unacceptable costs if the United States launches a strategic strike. Should North Korea cross the nuclear threshold, however, the stakes would likely be significantly higher for the United States and it might be willing

to take on additional risks. So, the couple dozen boosted weapons that could be sufficient for an assured retaliation posture might not be adequate for war-fighting. To be confident in strategic deterrence even during a conflict in which it uses nuclear weapons, North Korea may be pursuing thermonuclear designs. In fact, North Koreans have said as much and have dubiously claimed to have tested a “hydrogen bomb.” Those statements have largely been dismissed because such designs seem out of its technological reach but it may not be out of the question for very long and, particularly, in twenty years’ time.⁷⁸ North Korea would likely require a number of tests for its own design as well as deterrence purposes, but that would likely be another constraining factor given its limited territory and close, watchful neighbors.

78. Lewis, “Setting Expectations for a DPRK Test.”