

# **A Comprehensive History of North Korea's Nuclear Program: 2018 Update**

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## **US Diplomacy – G2**

In early 2018, US-North Korean relations began a rapid and major turnaround mirroring significant progress in inter-Korean ties. This early period was marked by a decline in overt threats from the US government, signaling a turn from the “fire and fury” rhetoric and threats of nuclear war from 2017. In March, President Trump accepted Kim Jong Un’s invitation (relayed through South Korean officials) for a summit meeting. CIA Director Mike Pompeo met with Kim in Pyongyang at the beginning of April. Pompeo returned to Pyongyang in May as Secretary of State for a second meeting with Kim. Following that meeting, US-DPRK working-level talks took place in Panmunjom, but failed to gain traction on substantive issues. After abruptly canceling the summit in late May, President Trump reversed course and received Kim Jong Un’s special representative, Kim Yong Chol, at the White House on June 1 to put the June meeting back on track.

On June 12, President Trump met with Kim Jong Un in Singapore, where the two leaders signed a joint statement laying out three major principles--normalizing bilateral relations, establishing a permanent peace regime, and denuclearizing the Korean peninsula, very much the wording Pyongyang had wanted. Immediately following the summit, President Trump declared the suspension of US-ROK joint military exercises, a move that drew considerable criticism in the US, but which USFK commander General Vincent Brooks took in stride. And, in spite of the fact that President Trump was heavily ridiculed for his post-summit, mission-accomplished boast that “America and the world can sleep well tonight” because he had ended any nuclear threat from North Korea, the summit dramatically lowered tensions on the Korean Peninsula.

Progress in talks quickly hit a wall when, at a July meeting between Secretary Pompeo and Kim Yong Chol, the US side called for the North to produce a full declaration of its nuclear weapons program, to which Pyongyang responded angrily. The rest of the year was up and down. Though there were occasional, carefully modulated threats and complaints from both sides, the overall message was of continued commitment to negotiations, with the Secretary of State and the President publicly preserving space for a resumption of talks. In October, Pompeo again traveled to Pyongyang to meet with Kim Jong Un. Both the front and back channel meetings throughout the year gave US officials a more realistic sense of the personalities and the position of the other side, though Washington could not break through Pyongyang’s resistance to opening working-level talks. By year’s end, the US had softened its position on the need for an immediate, detailed, complete accounting by the North of its nuclear and missile programs, and the State Department was reconsidering restrictions on travel to the North by US humanitarian NGOs. At the same time, the Trump administration maintained its support of the maximum pressure policy and its position that sanctions relief would only follow serious, concrete denuclearization steps.

The dramatic reduction of tensions resulting from the Singapore Summit moved the color code from R3 in 2017 to G2 in 2018. We elected to code this G2 and not G3 due to Washington's continued insistence on maximum pressure and sanctions as well as steps backward earlier in the year with respect to humanitarian efforts with the DPRK.

### **NK Diplomacy - G2**

In early 2018, North Korea initiated serious diplomatic overtures to Washington on the heels of steps to open talks with South Korea. As early as February the North appeared prepared with a planned meeting of Kim Jong Un's sister, Kim Yo Jong, with Vice President Pence at the Winter Olympics in Seoul, but the US seemed uninterested. But in March, Kim Jong Un offered to meet President Trump for talks. In April, he met with then-CIA Director Mike Pompeo in Pyongyang, a few weeks before the Worker's Party Third Plenum, at which Kim declared an end to (not merely a moratorium on) nuclear and long-range missile tests. Since negotiations had not even begun, this represented a highly unusual set of unilateral concessions by a North Korean leader. In May, the North invited foreign journalists to observe the destruction of test tunnels at its nuclear test site at Punggye-ri. Kim also met again with recently appointed Secretary of State Pompeo, and released three Americans who had been previously imprisoned in the North. In June, after a bumpy couple of days caused by tough sounding—though actually carefully modulated—public protests from DPRK Foreign Ministry officials, the two sides went ahead with their first-ever summit. The summit declaration laid out three main principles – improving relations, establishing peace, and moving toward “denuclearization of the Korean Peninsula.” (A fourth principle, returning the remains of US military from the Korean war, was added at the last minute.) In July, diplomacy immediately stalled in the first post-summit high-level talks during Secretary of State Pompeo's visit to Pyongyang. After Pompeo departed, the North issued an angry Foreign Ministry spokesman's statement accusing the US of “brigandish-like” demands for a complete accounting of the DPRK nuclear program while ignoring its own obligations under the Singapore agreement.

During the rest of the summer and through the remainder of the year, Pyongyang issued a series of commentaries criticizing Washington, pondering the effect of the US domestic political situation on the President's freedom of action, and even warning about the possibility that without a change in the US position on sanctions, “some people” in Pyongyang were considering reviving the previous “byungjin” policy, i.e. once again to concentrate attention and resources on the nuclear weapons program. Nevertheless, the criticism was carefully fashioned to give Kim Jong Un maximum flexibility to offer to resume talks and buffer President Trump from the criticism. As a positive counterpoint, Kim Jong Un continued to feed positive offers into the discussion. In September and October, he offered the verified dismantlement of at least the major facilities at the nuclear center at Yongbyon, contingent on unspecified “corresponding” US actions. He also offered to allow experts back into the nuclear test site at Punggye-ri to further confirm that site's status, and to dismantle the North's space launch facility at Sohae—all offers that remained on the table as the year came to a close.

North Korea conducted no nuclear tests and no missile launches of any kind in 2018, instead focusing on diplomacy with Washington, Seoul and Beijing. The Singapore Summit combined with these actions led us to move the color code from R3 in 2017 to G2 for 2018.

### **Yongbyon Presence – R3**

No foreign inspectors or observers were allowed to visit the nuclear facilities at Yongbyon in 2018.

### **Plutonium – R3**

Plutonium is produced in the 5 MWe reactor and separated to make it weapon usable in the plutonium reprocessing facility. Both facilities were kept operational in 2018 with improvements being made to the secondary cooling system for the reactor because of chronic cooling problems.

The reactor operated in January and February, but appears to have been shut down to unload spent fuel in March or early April. The spent fuel generated during reactor operations from the summer of 2016 to early 2018 appears to have been reprocessed beginning in May to separate an estimated 5 to 8 kg weapon-grade plutonium. The total burn-up and plutonium content of the spent fuel are uncertain because it is difficult to determine the details of reactor operation by satellite imagery alone. The estimate is also complicated by the fact that North Korea likely substituted some lithium-6 tubes for fuel rods in order to produce tritium for thermonuclear fuel. Such substitutions will result in somewhat less plutonium production.

North Korea produced little additional plutonium in the 5 MWe reactor the rest of the year because it was shut down for part of the year in addition to occasional periods of low-power operations and/or tests of the cooling system. A new secondary cooling system was constructed during that time.

Satellite imagery indicates continued development of the Experimental Light Water Reactor (ELWR), although it is very likely still not operational. This reactor is designed to produce electricity, but could be used to produce additional weapon-grade plutonium by introducing uranium-238 targets into the reactor to produce plutonium.

Thus, we keep the color code at R3 because North Korea likely increased its 2017 estimated plutonium inventory of 20 to 40 kg by 5 to 8 kg. In 2018, it produced little additional plutonium in the 5 MWe reactor and none in the ELWR that could be separated in future years. Yet current activities at the reactors point to getting the 5 MWe reactor back on line and preparing the ELWR for start of operations.

### **HEU – R3**

All indications are that in 2018 North Korea continued operations of its Yongbyon centrifuge facility and a suspected covert facility (or facilities). Our previous estimate still holds that annual production rates for full operation allow North Korea to add roughly 150 kg of weapon-usable HEU to its inventory. Consequently, the North Korean HEU inventory

likely increased to 400 – 650 kg from our 2017 estimate of 250 – 500 kg, with the proviso that these estimates are highly uncertain.

Overhead imagery points to continued operation in 2018 of the Yongbyon centrifuge facility, which likely contains 4,000 P-2 centrifuges. The observations are consistent with normal practice, as centrifuge facilities typically operate 24/7 unless there is a failure. As we have pointed out before, North Korea most likely has one or more covert centrifuge facilities, but as of 2017, the size and location had not been publically identified.

In 2018, several open-source reports identified a suspected centrifuge facility at Kangsong, sized similarly to that in Yongbyon. Although there are still many uncertainties about that site, it or other covert sites are believed to roughly double the output of the Yongbyon site. Our previous estimates assumed that most of the uranium yellow cake produced from the North's uranium ore deposits is chemically processed at Yongbyon, then enriched to low-enriched uranium levels (3 to 5 % U-235) at the Yongbyon centrifuge facility, and then shipped to a covert site (or sites) to boost to weapon-grade HEU (roughly 90 % U-235). Our probabilistic model indicated that the most likely annual capacity for HEU production is 175 kg/year with a net addition of 150 kg weapon-usable HEU. With all the uncertainties surrounding uranium enrichment in North Korea, we believe that this is still the most likely, albeit highly uncertain, estimate.

Consequently, we estimate that North Korea added 150 kg of HEU in 2018 for an inventory of 400 – 650 kg. David Albright of the Institute of Science and International Security estimated 230 – 760 kg as of the end of 2017, with the proviso that it could be as large as 1,000 kg if the North has a full second centrifuge facility operational. We therefore continue to assign the R3 color code for HEU.

### **Tritium/Li-6 – R2**

We estimate that only small quantities of tritium were added to North Korea's stockpile. And since tritium decays rather quickly (half-life of 12 years), it must be replenished on a regular basis. Tritium can be produced in the 5 MWe reactor by inserting Li-6 targets. It must then be separated in hot cell facilities, either those in the IRT-2000 reactor complex or those that possibly exist in the new facility at the Fuel Fabrication Facility complex. Construction and ongoing maintenance activities were observed at that facility in 2018, which may also be purposed in part for lithium-6 production.

It is possible that tritium was produced in the 5 MWe reactor in 2017 and in January/February 2018 and then separated at the IRT-2000 hot cell facilities in 2018. We assign an R2 color code because we believe the overall tritium stockpile remains limited to just a few fusion devices (either boosted fission bombs or hydrogen bombs).

### **Weaponization – R2**

We define weaponization as designing, building, and testing of nuclear weapons. We would expect the nuclear weapon design activities to have continued during 2018, with particular emphasis on miniaturization and survival of warheads for ICBM delivery. We also expect that the production of warheads most likely continued during the year. Kim Jong Un's 2018 New Year's instruction to his nuclear experts to 'mass produce' nuclear weapons and

missiles was more of an aspiration than reality since North Korea is seriously limited by its small inventories of fissile materials.

Kim's April declaration to end nuclear testing (he pledged to end, not just to observe a moratorium) greatly limits North Korea's ability to enhance the sophistication of its nuclear weapons. Kim underscored the seriousness of his pledge by destroying portions of the remaining functional testing tunnels at the Punggye-ri site in front of a contingent of international journalists. Unfortunately, negotiations with Washington have not yet advanced to the stage to take Kim up on his offer to allow inspections by technical experts to assess how irreversible the destruction of the testing tunnels is.

It was and remains our assessment that North Korea cannot reach the United States with a nuclear warhead. More nuclear tests and more missile tests are required to do so. Therefore, without additional nuclear and intercontinental-range missile tests, North Korea will be not be able to go beyond its likely current capability to deliver nuclear warheads with its SCUD-type short-range and Nodong medium-range missiles. An end to nuclear testing also greatly constrains North Korea's ability to field a functional hydrogen bomb. Whereas the September 3, 2017, nuclear test may well have been a two-stage thermonuclear—that is, hydrogen—bomb, one test does not make a hydrogen-bomb arsenal, much less an operational weapon. In 2017, North Korea appeared well on its way to establish such a capability, but without a resumption of nuclear tests, we believe they will fall short.

The combination of a halt in intercontinental-range missile tests and an end to nuclear tests leads us to lower the color code from R3 to R2.

### **Nukes Summary – R2**

In this section we combine assessments of nuclear materials production, weapon production, sophistication and destructive power of nuclear warheads, and adaptability of such warheads to delivery systems.

As described above, North Korea likely increased its inventory of fissile materials in 2018 by separating as much as 5 to 8 kg of weapon-grade plutonium and producing another 150 kg of weapon-usable HEU. With this increased fissile materials inventory, North Korea could produce an additional 5 to 7 nuclear weapons to add to the roughly 30 we estimated that they could produce by the end of 2017. Such an estimate represents the number of nuclear weapons North Korea could build, rather than the number it has actually built and fielded. North Korea likely keeps a significant fraction of its fissile materials in reserve to allow for replacements or improvements of its nuclear arsenal.

We assume that North Korean nuclear experts continued to work on all phases of the North's nuclear weapon program. In other words, we expect continued design and non-nuclear testing activities to attempt to further miniaturize its nuclear warheads, and to enhance their deliverability, reliability, safety, and security. However, without the benefit of additional nuclear tests and long-range missile tests, increased sophistication and deliverability on long-range missiles will be difficult to achieve. Plutonium and tritium are

the key ingredients for more sophisticated warheads and their production was very much restricted.

We judge these limitations to the technical improvements in the North's nuclear arsenal to more than offset the increase in fissile materials that could allow it to increase the number of nuclear devices, particularly since most of these would use HEU and likely be limited to less capable nuclear warheads. Consequently, we lower the color code from R3 to R2.

We also note that our estimates for fissile materials inventories sufficient for 35 to 37 nuclear bombs falls in the range of 20 to 60 that have been publicly reported. We note that this range is possible because of the uncertainties in estimating HEU inventories, but our best estimate is centered at 35 to 37.

### **Missiles Summary – R2**

North Korea's dramatic increase in the number and sophistication of missile tests beginning in 2014 came to an abrupt end in 2018. In April, Kim Jong Un announced that his country no longer needed to test nuclear weapons or long-range missiles and would close the nuclear test site. North Korea did not test-launch missiles of any range in 2018. To underline the new policy, there were no long-range ballistic missiles shown in the September 9, 2018, military parade celebrating the 70th anniversary of North Korea's founding.

To appreciate the significance of the halt in missile testing, it is instructive to look back at 2017 when the North conducted 23 test launches, including the introduction of three new longer-range missiles and one new solid-fueled, medium-range missile. The halt in testing leaves North Korea with only the short-range SCUD-type missiles and medium-range Nodong missiles as reliable, well-tested missile systems. Consequently, we downgrade the color code from R3 in 2017 to R2.

The intermediate-range Hwasong-10 (Musudan) missile appears to have been abandoned after a dismal test record in 2016. It appears to have been replaced by the Hwasong-12 missile, which in 2017 failed in three of six attempts. The submarine-launched, solid-fuel, medium-range Pukguksong-1 missile has not been tested since February 2017 by which time it had failed three out of six attempts. A new larger submarine for the new missile is reportedly under construction at the Sinpo naval shipyard, but has not yet been completed. In addition, a large new base for these new submarines is being built just south of Sinpo but it too has not been completed. Overall, work appears to have slowed down on the SLBM program in 2018. A land-mobile version of this missile, the Pukguksong-2, was successfully launched once in a lofted trajectory in 2017. The KN-08 ICBM paraded in earlier years was never flight-tested and also appears to have been abandoned. Two Hwasong-14 ICBMs were flight-tested successfully in lofted trajectories in July 2017. These were followed by the very large Hwasong-15 ICBM, also tested in a lofted trajectory in November 2017.

In addition to Kim's decision to stop flight-testing, he pledged to shut down the Dongchang-ri (Sohae) launch site and to destroy an engine test stand. North Korea has, indeed, dismantled two facilities that are related to their missile program. The most significant is

the partial dismantling of their liquid rocket engine test facility at Sohae, the largest such facility in North Korea. This facility was used to test fire new engines before installing them into flight hardware. The upper portion of the test stand has been taken down but the steel structure and concrete pilings are still in place. The second dismantled site is a canister missile ejection tower used for the Pukguksong-2 located at the Riku-dong near Kusong. Although these actions are important concessions, they are not major impediments to the North's missile program because they could be rebuilt in a few months. What is more surprising is Kim's pledge to shut down the Sohae launch site because that would greatly diminish the North's ability to conduct a peaceful space program.

As impressive as North Korea's missile tests were in 2017, none of the intermediate missile or ICBM systems are close to operational systems, particularly for nuclear warhead delivery. It is our assessment that North Korea cannot deliver a nuclear warhead with any measure of confidence to the US mainland. Much more flight-testing of the intercontinental-range missiles is required. We also note that even once missiles have been adequately flight-tested, as has the US Minuteman III, they still need to be test launched to ensure effectiveness, readiness, and accuracy. For example, the US conducted four unarmed test launches of the Minuteman III from Vandenberg Air Force Base in California toward Kwajalein Island in the Pacific in 2017 and three in 2018, one of which had to be destroyed over the Pacific for an unspecified in-flight anomaly.

It is our assessment that the abrupt end to missile testing at a time of rapid progress on several new missile systems, including ICBMs, SLBMs, and solid-fueled ballistic missiles sets back the North Korean missile program significantly. Yet, the predominant message carried in American news media was that North Korea is expanding its missile and nuclear program. Such reports were typically triggered by the latest open-source satellite imagery that revealed various missile sites either still being maintained or being expanded. The reports implied, as one news article headlined, a "great deception" by Kim Jong Un. That is, contrary to the announcement at the Singapore Summit that missile launch site were to be shut down and an engine test stand destroyed, North Korea was clandestinely increasing its missile capabilities at covert sites. In reality, it is not surprising that North Korea has never openly disclosed its missile bases, not least because these would be targets of US strikes in the event of a war. Besides, in the North everything related to the military is 'secret.' That perhaps as many as 20 such sites have now been identified by open source analysts simply demonstrates that North Korea has taken its missile program and strategic rocket forces seriously. The bottom line is the end of all missile tests in 2018 led us to change the color code from R3 to R2.

### **ROK-DPRK Relations – G3**

At the end of 2017, the Moon Jae In administration made secret overtures to the Kim Jong-un regime. Kim Jong-un responded positively in his 2018 New Year Speech, proposing to send North Korean athletes to the South as part of a joint delegation for the 2018 Winter Olympics in Seoul. A few days later, he signaled in no uncertain terms that he saw President Moon Jae In as his legitimate counterpart with whom he was fully prepared to meet. Kim sent his sister, Kim Yo Jong, to lead the North's delegation to the February Olympics and to personally deliver his message to President Moon. Continuing working

level meetings led to the first summit between Moon Jae In and Kim Jong Un at Panmunjom on April 27. This was followed by a second summit, called on the fly in May at the suggestion of Kim Jong Un, in order to put US-North Korean summit talks back on track after they were called off by President Trump. In September, the two sides opened a liaison office in Kaesong, followed a few days later by a third inter-Korean summit between Moon and Kim in Pyongyang. This third summit marked a distinct turning point in inter-Korean relations that had been gaining momentum throughout 2018. In a highly symbolic gesture, Kim took President Moon to the top of Mount Paektu where the two posed for historic photos. The summit made progress fleshing out several proposals for inter-Korean cooperation, including cross-border exchanges, disarmament of the Joint Security Area, and numerous areas of economic cooperation, including special economic zones and the establishment of rail and road connections across the DMZ. Implementation of these measures requires specific waivers from UNSC sanctions, which have only slowly and incrementally been forthcoming. In addition, at the summit the two militaries signed a separate comprehensive military agreement covering a wide range of confidence-building and tension-reduction measures along the DMZ. At the third summit, Kim Jong Un had agreed to visit Seoul by the end of 2018, but that visit was postponed with no public explanation from the North Korean side.

### **Sino-DPRK Relations – G2**

Following years of poor Sino-DPRK relations during the Kim Jong-un era, as Kim moved to initiate talks with Seoul and Washington in early 2018, Beijing decided it was in its interest to improve ties with the North. Early in the year, Chinese media discussed in nervous terms the implications of a warming in US-DPRK ties. In March, only weeks before the first North-South Summit, Kim Jong Un traveled to Beijing for his first heads-of-state meeting with President Xi Jinping. The two leaders held their second meeting in May in Dalian shortly before the US-DPRK Singapore Summit. The Chinese wanted assurances that the North Koreans were not going to agree to anything inimical to China's interests, and the North wanted to make sure that the Chinese would not do anything to betray them in the middle of a period of sensitive negotiations, as happened in 1992 when China suddenly recognized South Korea. The two sides held a third meeting in June in Beijing. At their first meeting in March, Kim had invited President Xi to visit the North, and Xi had accepted. There was an expectation that Xi's trip would take place in September to attend the DPRK's 70th Anniversary of its founding, but a lower-rank official, the CPC Politburo Standing Committee Member, Li Zhanshu, was sent instead. It now appears that Xi will visit some time in 2019. Throughout 2018, there was evidence of some loosening of Chinese trade restrictions mandated by UN Security Council resolutions, but overall sanctions pressure remained high, despite the public signs of thawing of Sino-DPRK political relations. At the UN, China along with Russia has pressed for the Security Council to revisit the whole issue of sanctions in view of the changing situation on the peninsula.

### **Sanctions – R3**

The sanctions regime remained relatively unchanged in 2018. While Russian and Chinese enforcement of sanctions may have relaxed to a degree and North Korea continued to implement sanctions evasion measures, including ship-to-ship transfers of petroleum, the US continued to drive a hard line on implementation and enforcement of existing UN

sanctions, pressuring China, Russia, and regional allies. No additional UN sanctions were levied on North Korea. At various times in 2018, the US Department of the Treasury's Office of Foreign Assets Control issued additional sanctions against individuals and entities for violating UN Security Council resolutions. By the summer, the US also clamped down on humanitarian relief for North Korea including not allowing US humanitarian workers to go to North Korea.

### **DPRK Economy – G2**

The North Korean economy appeared to be stable, if not improving, in 2018. Chinese enforcement of sanctions relaxed to some degree. Sino-North Korean trade appears to remain below pre-2014 levels, but nevertheless sustains the bulk of North Korea's imports and exports. Overall, North Korea's diplomatic offensive in 2018 reduced the strategic pressure on its economy, even if sanctions enforcement did not lighten immediately to a notable degree. In April 2018, Kim Jong Un declared the dual-track *byungjin* policy to be a success and in doing so shifted the strategic line to focus on improving North Korea's economy. The market reforms that were implemented many years prior continued to create efficiencies, and North Korea saw progress in major constructions projects, investment projects in the energy sector, and in the growth of semi-private business groups.

In 2018, the situation has improved for the North's economy, at least strategically. The main threat in 2015 to 2017 was the denial of economic cooperation by China. This threat has been largely overcome. China has become more willing to again serve as the key source of North Korean imports and as the major destination for its exports. Meanwhile, long-term investment projects in the energy sector, namely new or remodeled power stations, are being finished, potentially improving the electric energy supply for private households and the business sector. And while 2018 went by without any major economic reforms, the ones that were enacted in 2012 to 2014 continue to bear fruit. One visible sign is intensified road traffic in particular north of the capital Pyongyang, exemplified though a growing number of newly built gas and rest stations and an increasing number of minibuses and smaller trucks. Structurally, the trend of large, horizontally integrated business groups – one can look at these as North Korean chaebols – has continued. These could play a similar role to those in South Korea in the 1960s and 1970s, i.e. as semi-private agents of public purpose. Overall, the economic situation in North Korea has not worsened.

### **Imports – R2**

Open source reporting has not identified any major imports of nuclear or missile-related technologies in 2018. However, it is likely that North Korea has continued significant efforts to import missile-related technologies. Continued imports of rocket engines from Russia and Ukraine are possible, as are transporter-erector-launcher (TEL) vehicles from China. During the past few years, UN Security Council sanctions and the US-led Proliferation Security Initiative made it more difficult for North Korea to acquire sensitive materials and equipment on the black market, but these resulted in North Korea becoming increasingly clever in circumventing these measures. The annual reports of the UN Panel of Experts established subsequent to the UNSC resolutions on North Korea provide excellent reports on North Korea's import attempts and successes.

**Exports - R1**

Open source reporting has not identified any exports of nuclear or missile-related technologies in 2018. Exports of nuclear and missile-related technologies have become increasingly more difficult, although North Korea continues to become more sophisticated in circumventing UN and US sanctions. Exports in the nuclear arena are also curtailed by the loss of customers such as Iraq, Syria, and Libya. In addition, Pakistan has greatly curtailed all of its dealings in these areas with North Korea since the A.Q. Khan network, which operated a black-market nuclear proliferation ring headquartered in Pakistan, was broken up in 2004.

**U.S. Financial Aid**

2018: \$0