

North Korea's denuclearization: Status and prospects

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North Korea nuclear program - 2017

Governs size of
arsenal

Governs sophistication
of arsenal

Governs threat
arsenal poses

**Bomb-grade
Pu or HEU**

Weaponization

Delivery system

- Most difficult part
- Reactors (**Pu**) or enrichment (**HEU**)

Hydrogen bombs

- **Tritium**
- **Deuterium**
- **Li-6D**

Design, build, test









- Physics, computers
- High explosives
- Detonators
- Initiators
- Machining
- Assembly
- Explosives tests
- Arming, fuzing, firing
- Nuclear testing

- Plane
- Boat
- Van
- Missile

Threat of war was high in 2017 because of political threats and rapidly advancing nuclear and missile programs.

North Korea Nuclear Program

3 shades of green (dark best), 3 shades of red (dark worst)

Year	US Diplomacy	DPRK Diplomacy	Yongbyong Presence	Plutonium	Uranium enrichment	Tritium/Li6	Weaponize Design/build/test	Nukes (Summary)	Missiles
1992 Bush I	G1	G1	G1	G2	G1	G1	R1	R1	R1
1993 Clinton	G2	G2	G1	G2	G1	G1	R1	R1	R1
1994	G3	G3	G1	G2	G1	G1	R1	R1	R1
1995	G3	G3	G3	G3	G1	G1	R1	G3	R1
1996	G3	G3	G3	G3	G1	G1	R1	G3	R1
1997	G2	G2	G3	G3	R1	G1	R1	G3	R1
1998	G2	G2	G3	G3	R1	G1	R1	G3	R1
1999	G3	G3	G3	G3	R1	G1	R1	G3	G1
2000	G3	G3	G3	G3	R1	G1	R1	G3	G1
2001 Bush II	R2	G2	G3	G3	R1	G1	R1	G3	G1
2002	R3	G2	G3	G3	R1	G1	R1	G3	G1
2003	R2	R2	R3	R3	R1	R1	R2	R2	G1
2004	R2	R1	R3	R3	R1	R1	R2	R2	G1
2005	R1	R1	R3	R3	R1	R1	R2	R2	R1
2006	R1	R2	R3	R3	R1	R1	R2	R2 	R1
2007	G2	G1	R3	R3	R1	R1	R2	R1	R1
2008	G2	G1	R3	R3	R1	R1	R2	R1	R1
2009 Obama	R1	R1	R2	R1	R2	R2	R2	R2 	R1
2010	G1	R1	R3	R1	R2	R2	R2	R2	R1
2011	G1	G1	R3	R1	R2	R2	R2	R2	R1
2012	R1	R1	R3	R1	R2	R2	R2	R2	R1
2013	R2	R1	R3	R2	R2	R2	R2	R2 	R1
2014	R2	R1	R3	R2	R3	R3	R2	R2	R1
2015	R1	G1	R3	R3	R3	R3	R2	R2	R2
2016	R1	R3	R3	R3	R3	R3	R3	R3  	R2
2017 Trump	R3	R3	R3	R3	R3	R3	R3	R3   	R3

By end of 2017 all indicators turned dark red

North Korea Nuclear Program – Technical Focus (Stanford University CISAC)

Year	US Diplomacy	DPRK Diplomacy	Yongbyon Presence	Plutonium	U enrich.	Tritium/Li-6 (H-bomb fuel)	Weaponize Design/build/test	Nukes (Summary)	Missiles
1992	G1	G1	G1	G2	G1	G1	R1	R1	R1
1993	G2	G2	G1	G2	G1	G1	R1	R1	R1
1994	G3	G3	G1	G2	G1	G1	R1	R1	R1
1995	G3	G3	G3	G3	G1	G1	R1	G3	R1
1996	G3	G3	G3	G3	G1	G1	R1	G3	R1
1997	G2	G2	G3	G3	R1	G1	R1	G3	R1
1998	G2	G2	G3	G3	R1	G1	R1	G3	R1
1999	G3	G3	G3	G3	R1	G1	R1	G3	G1
2000	G3	G3	G3	G3	R1	G1	R1	G3	G1
2001	R2	G2	G3	G3	R1	G1	R1	G3	G1
2002	R3	G2	G3	G3	R1	G1	R1	G3	G1
2003	R2	R2	R3	R3	R1	R1	R2	R2	G1
2004	R2	R1	R3	R3	R1	R1	R2	R2	G1
2005	R1	R1	R3	R3	R1	R1	R2	R2	R1
2006	R1	R2	2018 marks a halt and some rollback					R2	R1
2007	G2	G1						R1	R1
2008	G2	G1						R1	R1
2009	R1	R1	R2	R1	R2	R2	R2	R2	R1
2010	G1	R1	R3	R1	R2	R2	R2	R2	R1
2011	G1	G1	R3	R1	R2	R2	R2	R2	R1
2012	R1	R1	R3	R1	R2	R2	R2	R2	R1
2013	R2	R1	R3	R2	R2	R2	R2	R2	R1
2014	R2	R1	R3	R2	R3	R3	R2	R2	R1
2015	R1	G1	R3	R3	R3	R3	R2	R2	R2
2016	R1	R3	R3	R3	R3	R3	R3	R3	R2
2017	R3	R3	R3	R3	R3	R3	R3	R3	R3
2018	G2	G2	R3	R3	R3	R2	R2	R2	R2

North Korea Nuclear Program – Policy Focus (Stanford University CISAC)										
Year	US Dipl.	DPRK Dipl.	YB Presence	Nukes	Missiles	N/S Relation	N/Sino Rel.	Sanctions	NK Economy	US Fin. Aid
1992	G1	G1	G1	R1	R1	G3	R2	R1	R2	\$0
1993	G2	G2	G1	R1	R1	G2	R1	R1	R2	\$0
1994	G3	G3	G1	R1	R1	R2	R1	R1	R3	\$0
1995	G3	G3	G3	G3	R1	R1	R1	R1	R3	\$9.7M
1996	G3	G3	G3	G3	R1	R1	R1	R1	R3	\$30.3M
1997	G2	G2	G3	G3	R1	G1	R1	R1	R3	\$82.4M
1998	G2	G2	G3	G3	R1	G1	R1	R1	R3	\$122.9M
1999	G3	G3	G3	G3	G1	G3	G1	R1	R3	\$287.2M
2000	G3	G3	G3	G3	G1	G3	G2	R1	R2	\$138.7M
2001	R2	G2	G3	G3	G1	G1	G2	R1	R2	\$132.97M
2002	R3	G2	G3	G3	G1	G2	G2	R1	R2	\$140.9M
2003	R2	R2	R3	R2	G1	G1	G2	R1	R1	\$27.78M
2004	R2	R1	R3	R2	G1	R1	G1	R1	R1	\$36.4M
2005	R1	R1	R3	R2	R1	G1	G1	R1	R1	\$5.7M
2006	R1	R2	More diplomacy indicators turn green. DPRK economy remains stable.					R1	R1	\$0
2007	G2	G1	More diplomacy indicators turn green. DPRK economy remains stable.					R1	R1	\$45.1M
2008	G2	G1	More diplomacy indicators turn green. DPRK economy remains stable.					R1	R1	\$224.7M
2009	R1	R1	R2	R2	R1	R2	G1	R1	R2	\$24.6M
2010	G1	R1	R3	R2	R1	R3	G2	R1	R1	\$3.5M
2011	G1	G1	R3	R2	R1	R3	G2	R1	R1	\$0.9M
2012	R1	R1	R3	R2	R1	R3	G2	R1	G1	\$0
2013	R2	R1	R3	R2	R1	R2	R2	R2	G1	\$0
2014	R2	R1	R3	R2	R2	R2	R2	R2	G1	\$0
2015	R1	G1	R3	R2	R2	R2	R2	R2	G2	\$0
2016	R1	R3	R3	R3	R3	R3	R2	R2	G2	\$0
2017	R3	R3	R3	R3	R3	R2	R2	R3	G2	\$0.9M
2018	G2	G2	R3	R2	R2	G3	G2	R3	G2	\$0

Denuclearization status in 2018

Governs size of
arsenal

**Bomb-grade
Pu or HEU**

- Reactor, reprocessing facility and centrifuges operational.
- Likely increased Pu and HEU inventories for 5-7 more bombs for estimated total of 35-37.
- Tritium inventories limited.

Governs sophistication
of arsenal

Weaponization

- End of nuclear testing.
- Closing test site halts progress on hydrogen bombs and limits miniaturization.

Governs threat
arsenal poses

Delivery system

- End of long-range missile testing, moratorium on rest, rolls back long-range missile threat.

Rapid escalation of nuclear and missile advances halted.
Rolls back the threat we judged the North's program to pose in 2017.

Risk based approach to North Korea denuclearization

Nuclear and missile assets/activities

	Specific facilities or activities
Nuclear weapons	Nuclear arsenal
Personnel	Scientists, engineers
Nuclear tests	Nuclear tests
	Tunnels
	Test infrastructure
Missile Tests	IRBM & ICBM
	SLBM & Solid rocket motors
	New engine tests
	Short & med.-range missiles
	Space Launch Vehicles
Plutonium	Inventory
	5MWe reactor
	ELWR
	IRT-2000
	Reprocessing Facility
	Metal fuel fab facilities
Fusion (H-bomb) fuels	Tritium
	Lithium-6
Uranium Enrichment	HEU inventory
	YB centrifuge facility
	Covert centrifuge facilities
No export	Nuclear & missile technology

- The assets and activities listed provide a framework for designing and tracking the denuclearization progress.

- In May 2018, we proposed a phased risk management approach to denuclearization by identifying those assets and activities that must be eliminated (*shown in red in the next chart*) and those that can be managed (*shown in yellow*). The chart helps focus on the most immediate and pressing risks shown in red. The phased approach will provide an effective way to build trust and interdependence.

- The mosaic is meant to provide an overall sense of what is manageable and what must be eliminated.

- The specific steps provide examples of a framework for negotiations.

- Negotiations should be designed toward a more definitive goal than 'denuclearization' – namely, the elimination of nuclear weapons and their means of production and delivery.

- Negotiations will have to match these steps with commensurate steps toward normalization, tension reduction, and what the North terms "trust building."

A risk management framework to elimination – May 2018

Risk posed by nuclear assets/activities – red (very high, must be addressed), yellow (moderate – can be managed)

	Specific facilities or activities	HALT - short term < 1 year	ROLL BACK- medium term 2 to 5 years	ELIMINATE or SET LIMITS - long term – 6 to 10 years
Nuclear weapons	Nuclear arsenal	Cap	Declare & reduce	Eliminate & verify. Join NPT
Nuclear personnel	Scientists, engineers, techs	Assist in halting operations	Assist in roll back	Redirect to civilian programs
Nuclear tests	Nuclear tests	Moratorium/suspend	Ban	Ban (sign CTBT)
	Tunnels	Suspend activity	Close	Destroy
	Test infrastructure	Suspend activity	Dismantle	Dismantle & verify
Missile tests	IRBM & ICBM	Moratorium/suspend	Halt, declare & monitor	Ban tests, missiles & developm.
	SLBM & Solid rocket motors	Moratorium/suspend	Halt, declare & monitor	Ban tests, missiles & developm.
	New engine tests	Suspend	Halt & monitor	Ban tests and development
	SR & MR Missiles	Short term suspension	TBD – set allowable limits	TBD – set allowable limits
	Space Launch Vehicles	Short term suspension	TBD – establish protocol	TBD – establish acceptable limits
Plutonium	Inventory	Cap	Cap, declare & monitor	Eliminate
	5MWe reactor	Halt	Dismantle	Decommission
	ELWR	Halt or don't start	Inspect & future TBD	TBD
	IRT-2000	Halt	Dismantle	Decommission, possibly replace
	Reprocessing facility	Don't operate	Dismantle front end (no new fuel)	Dismantle & decommission
	Metal fuel fab facilities	Don't operate	Dismantle	Decommission
Fusion (H-bomb) fuels	Tritium	Halt reactors (as above)	Dismantle reactors & hot cells	Eliminate
	Lithium-6	Halt production	Dismantle production facilities	Eliminate
Uranium enrichment	HEU inventory	Limit (halt support facilities)	Cap, declare & monitor	Eliminate
	YB centrifuge facility	Halt & inspect	Inspect & future TBD	TBD
	Covert centrifuge facilities	Limit (halt support facilities)	Declare & inspect	Eliminate
No export	Nuclear & missile technology	No-export pledge	No nuclear export. Join MCTR	No nuclear export. Join MCTR

Progress toward “denuclearization.”

- In May 2018, we identified the most important initial steps toward denuclearization to be: no nuclear tests, no intermediate or long-range missile tests, no more production of plutonium and highly enriched uranium, and no export of nuclear weapons, materials, or technologies.
- We suggested that North Korea consider front-end loading as much of the denuclearization process as possible.
- In fact, in 2018, even in the absence of formal negotiations, North Korea took the extraordinary step of ending nuclear tests and missile tests, the two most important steps we identified.
- Not surprisingly, in the absence of negotiations, North Korea continued to produce fissile materials and to maintain or, in some cases, enhance its missile bases.
- In the next chart, we indicate those areas in which North Korea has already taken positive actions toward denuclearization in blue. The ELWR and IRT-2000 status in light blue are simply continuation of non-operational status from prior years – but importantly, they did not start operations.
- These actions, taken at a time during which North Korea had been rapidly increasing the sophistication of its nuclear weapons and missiles and their destructive power and reach, not only halted that rapid advance but also rolled back the threat we judged the North’s nuclear and missile programs to pose in 2017.

A risk management framework to elimination

Red (very high, must be addressed), yellow (moderate – can be managed), blue (done in 2018)

	Specific facilities or activities	HALT < 1 year	ROLL BACK 2 to 5 years	ELIMINATE or SET LIMITS long term – 6 to 10 years
Nuclear weapons	Nuclear arsenal	Cap	Declare & reduce	Eliminate & verify. Join NPT
Nuclear personnel	Scientists, engineers, techs	Assist in halting operations	Assist in roll back	Redirect to civilian programs
Nuclear tests	Nuclear tests	Moratorium/suspend	Ban	Ban (sign CTBT)
	Tunnels	Suspend activity	Close	Destroy & verify
	Test infrastructure	Suspend activity	Dismantle	Dismantle & verify
Missile tests	IRBM & ICBM	Moratorium/suspend	Declare , disable & monitor	Destroy missiles, no developm.
	SLBM & Solid rocket motors	Moratorium/suspend	Declare, disable & monitor	Destroy missiles, no developm.
	New engine tests	Suspend	Halt & monitor	Ban tests and development
	SR & MR Missiles	Short term suspension	TBD – set allowable limits	TBD – set allowable limits
	Space Launch Vehicles	Short term suspension	TBD – establish protocol	TBD – establish acceptable limits
Plutonium	Inventory	Cap	Cap, declare & monitor	Eliminate
	5MWe reactor	Halt	Dismantle	Decommission
	ELWR	Halt or don't start	Inspect & future TBD	TBD
	IRT-2000	Halt	Dismantle	Decommission, possibly replace
	Reprocessing facility	Don't operate	Dismantle front end (no new fuel)	Dismantle & decommission
	Metal fuel fab facilities	Don't operate	Dismantle	Decommission
Fusion (H-bomb) fuels	Tritium	Halt reactors (as above)	Dismantle reactors & hot cells	Eliminate
	Lithium-6	Halt production	Dismantle production facilities	Eliminate
Uranium enrichment	HEU inventory	Limit (halt support facilities)	Cap, declare & monitor	Eliminate
	YB centrifuge facility	Halt & inspect	Inspect & future TBD	TBD
	Covert centrifuge facilities	Limit (halt support facilities)	Declare & inspect	Eliminate
No export	Nuclear & missile technology	No-export pledge	No nuclear export. Join MTCR	No nuclear export. Join MTCR

Expedited elimination of nuclear weapons through cooperative military-to-civilian conversion

- The approach suggested here is based on our belief that North Korea will not give up its weapons and its weapons program until its security can be assured. Such assurance cannot be achieved simply by an American promise or an agreement on paper, it will require a substantial period of co-existence and interdependence – therefore the three time horizons that may stretch to 10 years.
- If the North insists on retaining civilian nuclear programs and peaceful space access, the incremental risk posed by these can be managed if adequate verification measures are developed. Although an electricity-producing light water reactor can potentially be diverted to plutonium production and a medical isotope research reactor can do the same, the risks are manageable. They are less than those posed by North Korea's current plutonium production reactor. Likewise for space launch vehicles, which under proper verification protocols will not advance the North's ICBM program nearly as much as the missile buildup in prior years.
- An agreement to have North Korea retain a civilian nuclear program and peaceful space program also solves the nuclear and missile personnel redirection issue. In addition to transitioning to civilian activities, the technical staff can help to decommission and clean up the facilities dedicated to the weapons program. One can envision a professional staff reorientation along the lines of the Nunn-Lugar program with Russia.
- We also suggest that the best verification measures will result from cooperative civilian nuclear programs and space programs. That is, pursuing these ventures cooperatively between North Korea, South Korea and the U.S. (perhaps later with others) will provide a presence of technical personnel at the North's facilities that will allow adequate verification.
- **Having North Korea retain civilian nuclear and space programs is shown in green in the next chart. In addition to the benefits mentioned above, allowing North Korea to retain these programs may help to shrink the time scale for elimination of the nuclear weapons program.**

An accelerated risk management framework to elimination – military to civilian conversion

Red (very high), yellow (moderate), blue (done in 2018), green (potential civilian cooperation)

	Specific facilities or activities	HALT 3 months	ROLL BACK < 2 years	ELIMINATE or SET LIMITS < 5 years
Nuclear weapons	Nuclear arsenal	Cap	Declare & reduce	Eliminate & verify. Join NPT
Nuclear personnel	Scientists, engineers, techs	Assist in halting operations	Assist in roll back	Redirect to civilian programs
Nuclear tests	Nuclear tests	Moratorium/suspend	Ban	Ban (sign CTBT)
	Tunnels	Suspend activity	Close	Destroy & verify
	Test infrastructure	Suspend activity	Dismantle	Dismantle & verify
Missile tests	IRBM & ICBM	Moratorium/suspend	Declare , disable & monitor	Destroy missiles, no developm.
	SLBM & Solid rocket motors	Moratorium/suspend	Declare, disable & monitor	Destroy missiles, no developm.
	New engine tests	Suspend	Halt & monitor	Ban tests and development
	SR & MR Missiles	Short term suspension	TBD – set allowable limits	No nuclear capable missiles
	Space Launch Vehicles	Short term suspension	TBD – establish protocol	Joint ROK space program?
Plutonium	Inventory	Cap	Cap, declare & monitor	Eliminate
	5MWe reactor	Halt	Dismantle	Decommission
	ELWR	Halt or don't start	Inspect & future TBD	LWR prototype?
	IRT-2000	Halt	Dismantle	Replace for isotope production
	Reprocessing facility	Don't operate	Dismantle front end (no new fuel)	Dismantle & decommission
	Metal fuel fab facilities	Don't operate	Dismantle	Decommission
Fusion (H-bomb) fuels	Tritium	Halt reactors (as above)	Dismantle reactors & hot cells	Eliminate
	Lithium-6	Halt production	Dismantle production facilities	Eliminate
Uranium enrichment	HEU inventory	Limit (halt support facilities)	Cap, declare & monitor	Eliminate
	YB centrifuge facility	Halt & inspect	Inspect & future TBD	Technical, economic, political ?
	Covert centrifuge facilities	Limit (halt support facilities)	Declare & inspect	Eliminate
No export	Nuclear & missile technology	No-export pledge	No nuclear export. Join MTCR	No nuclear export. Join MTCR