

Analysis of the KN-25 Multiple Rocket Launcher System after the 9 March 2020 DPRK Test



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"Modern warfare is precisely the warfare of artillery pieces and the combat preparations of the artillerymen are exactly those of the People's Army." - Kim Jong Un, 12 March 2020 [1]

The Democratic People's Republic of Korea, hereinafter referred to as North Korea, launched at least two "super-large calibre" multiple rocket launcher (MRL) rounds into the Sea of Japan or East Sea on 9 March 2020. The rockets flew a distance of 200km and reached a peak altitude of 50km [2]. It is the sixth confirmed test launch of the system, with a total of at least 12 such rockets having been launched since it was developed [3]. North Korea has not publicly announced the name of the system, however it is referred to as KN-25 by the US Government [4]. The KN-25 is likely the biggest MRL developed in the world. It has some unique design features worth discussing and the relatively frequent launch activities involving it underline the importance the North Korean military planners attach to it.

A Unique Design Feature



North Korea's "super large calibre MRL" rocket, codenamed KN-25, has six wrap-around fins. Every two of the fins form a pair of brackets.
Photo: KCTV

The KN-25 has a feature that has not been observed on other MRL or short range ballistic missiles: the bracket-shaped wrap-around fins at the bottom end.

The wrap-around fin is a common feature adopted by MRL designers. When held in place, the fins take minimal space inside the launch tubes. Normally, the MRL rounds will be given an initial spinning momentum imparted by the spin rails inside the tube. Once the rear of the rocket leaves the tube, the wrap-around fins are put into place by springs and further stabilise the projectile through spinning.



Picture shows Taiwan's MK15, MK30 and MK45 MRL rounds with both folded and unfolded wrap-around fins.

Photo: <https://www.ettoday.net/news/20120901/97081.htm?redirect=1>

But the six rear fins on each KN-25 round are wrapped in opposite directions to each other. They are designed not to impart the spin motion, making it the world's only MRL with this unique bracket-shaped wing design. In this regard, the wrap-around fins are not unlike the fixed wings on some ballistic missiles.

Unlike its predecessor KN-09 [5], the KN-25 launch tubes also do not have visible spin rails. Judging from these characteristics, it seems that North Korean engineers have decided that, for a rocket of KN-25's size, the benefit of a three-axis stabilised body outweighs the simplicity of a rolling-body design. Thus, it is possible that the four small control surfaces near the KN-25 warhead are the rocket's attitude control surfaces. This is unlike typical spinning-body precision guided MRLs whose control fins are only used for the purpose of precision strikes, i.e. finetuning of the trajectory.



The KN-09 has visible spin-rails on the launching tubes. The rocket is spin-stabilised during its entire flight, with four small control surfaces near its warhead to finetune the trajectory. This design is employed in many precision-guided MRLs around the world. Photo: Xu Tianran, 10 October 2015, Pyongyang

However, that does not necessarily mean that the KN-25 adopts three-axis stabilisation during the entire flight. The KN-25's maximum range has surpassed some typical short range ballistic missiles. Even in a relatively depressed trajectory, the KN-25 has reached the upper layer of the stratosphere where air density is very low. How can it control itself above altitudes where the aerodynamic control surfaces are not very useful? The control surfaces at the forebody of the missile are too small for such a purpose at high altitude. Thus, it is possible that the control surfaces will impart a rolling motion before the missile enters very low-density altitude and de-spin after the missile re-enters an atmosphere that is dense enough for aerodynamic control for three-axis stabilisation.

Of course, despite the lack of spin rails and the bracket-shaped wings, the possibility that the missile being stabilised through spinning throughout its trajectory by the small control surfaces alone cannot be completely ruled out at this point.

General Description

Each KN-25 round has an estimated diameter of ~600mm, and is approximately 8.2m long and weighs about 3 tons [6]. These dimensions make the MRL system significantly bigger and heavier than the existing large MRL systems listed in the table below [7].

Type & developer	Calibre (mm)	Length (m)	Warhead/mass ratio	Max range (km)	Guidance mechanism	Number of tubes
M1985/1991 North Korea ⁷	240	5.2 (Fajir-3's data)	90kg/407kg=22.1% (Fajir-3's data)	60-70	None	6 to 22
Fajir-5 Iran ⁸	333	6.485	175kg/915kg= 19.1%	75	None	4
WS-1 China ⁹	302	4.737	150kg/524kg=28.6%	100	None	4
WS-1B China ¹⁰	302	6.2	150kg/725kg=20.69%	180	None	4
WM-80 China ¹¹	273	4.582	150kg/505kg= 29.7%	70	None	8
9M528 Smerch, Russia ¹²	300	7.6	243kg/815kg= 29.8 %	90	Simplified inertial guidance set coupled with gas generators	6/12
M26 basic tactical rocket US ¹³	227	3.94	156kg/306kg= 50.98%	31	None	12

From the table, we can tell that many MRL rounds have to sacrifice their payload in order to increase range. The US M270 MRL system initially emphasised throw-weight over range, while other developers, such as North Korea, had to prioritise range over throw-weight, otherwise the MRL would not be able to reach the desired targets.

However, as the range increases, the firing accuracy declines to a point where some sort of precision guidance is needed to compensate for the small warhead. Such is the case for the KN-09 and the KN-25, which, to date, have a maximum range of up to around 200km and 400km, respectively. Conventional wisdom [8] is that they are guided by an inertial guidance set coupled with satellite positioning system. According to KCTV reports, both have hit targets on an island near North Korea's Hodo Peninsula from a long distance.

It is worth noting that the calibre of the KN-25 is much bigger than that of other countries' large MRLs: China's biggest MRL in active service is a 370mm 8-tube MRL, and Brazil is reportedly developing a 450mm MRL (Astros SS-150) with a

maximum range of 150km [9].

The fact that the KN-25 is longer and heavier than some tactical short range ballistic missiles, such as the MGM-140 Army Tactical Missile System (ATACMS) and OTR-21 Tochka (NATO codename SS-21; KN-02 in North Korea), could also mean that Pyongyang wants the KN-25 to replace the KN-02. Here, the line between a MRL system and a short range ballistic missile has become indistinguishable.

Pyongyang's development of large MRL systems might be rooted in military planners' wish to have a weapon that can initiate a saturation attack from a long distance, complicating an adversary's ability to build an effective kill-chain.



A modified Tatra T813 8x8 truck is used to carry the KN-25 rockets. The same truck chassis is used by North Korea to carry 80 122mm "Grad" rocket rounds (40 tubes with reloads). In real combat the number of KN-25 rounds could be further reduced to two or three to improve mobility. Photo Source: KCTV

Number of Tests and Their Implication

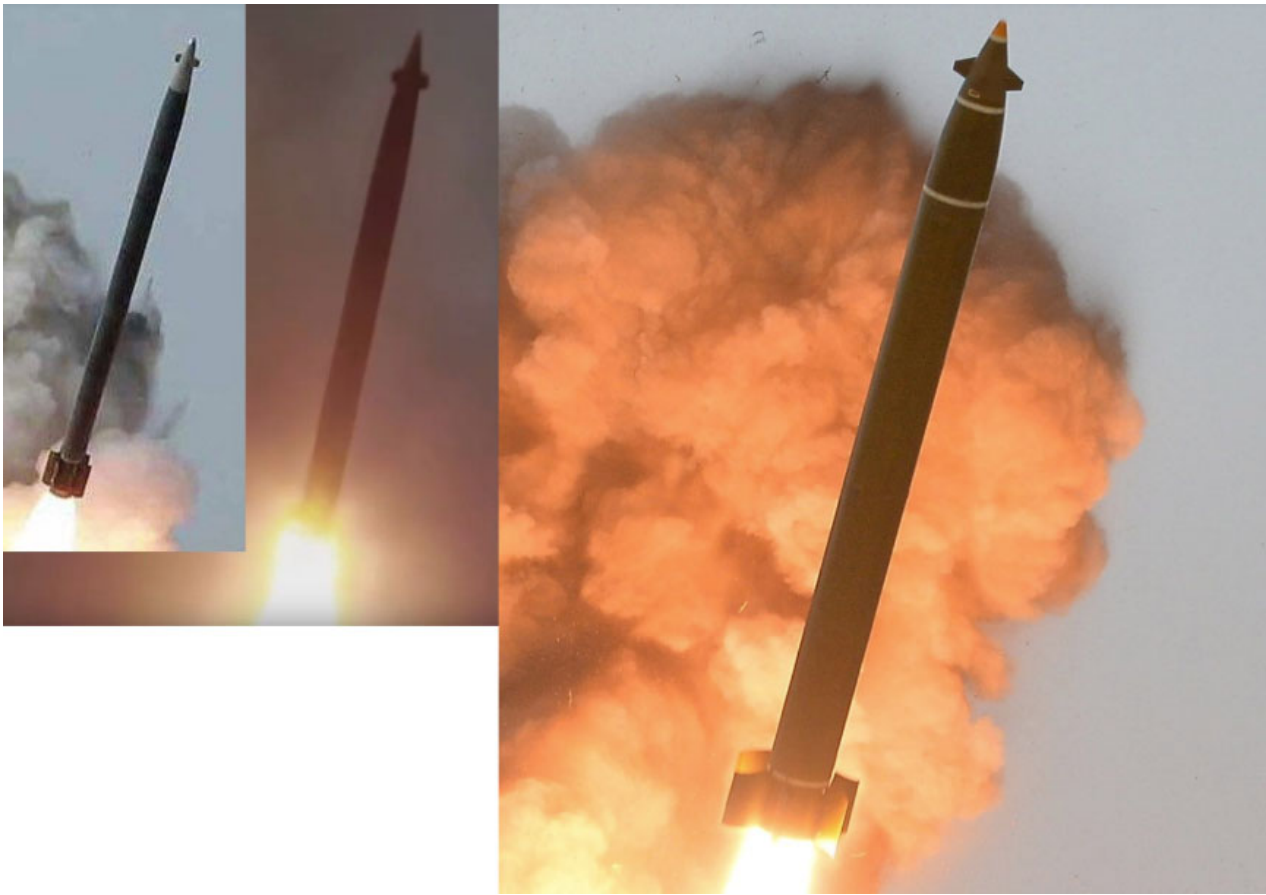
There still remains some confusion about the number of KN-25 tests. The most recent 9 March 2020 test would either mark the 6th test of the KN-25 and the 12th or 13th launch in total, or the 8th test and the 16th or 17th launch.

This uncertainty arises from ambiguous terms and manipulated images North Korea media used after its 31 July and 2 August 2019 MRL tests. In those two tests, North Korean media called the projectiles "large-calibre" MRLs, not "super large calibre" MRLs [10].

Suspected and confirmed KN-25 test launch activities:

Date	Term	Number of projectiles	Firing interval ¹⁷	Remarks
31 July 2019	Large calibre MRL	2	21 mins	Tracked chassis? Chassis and tubes heavily pixelated
2 August 2019	Large calibre MRL	2	24 mins	Tubes pixelated, possibly six tubes. Tracked chassis.
24 August 2019	Super large calibre MRL	2	17 mins	Confirmed KN-25 test. Truck chassis.
10 September 2019	Super large calibre MRL	2	19 mins	Confirmed KN-25 test. Truck chassis.
31 October 2019	Super large calibre MRL	2	3 mins	Confirmed KN-25 test. Truck chassis.
28 November 2019	Super large calibre MRL	2	30 seconds	Confirmed KN-25 test. Truck chassis.
2 March 2020	Super large calibre MRL	2	20 seconds	Operated by artillery soldiers, according to KCNA. A sign of KN-25 reaching Initial Operational Capability.
9 March 2020	Super large calibre MRL	2 or 3	1 min?	At least two rounds fired, according to KCNA photos.

Regarding firing intervals: Joseph Dempsey, "Assessment of the March 9 KN-25 Test Launch", 38North, 10 March 2020, <https://www.38north.org/2020/03/jdempsey031020/>. Here, analyst Joseph Dempsey cited a one minute interval between detected projectiles from a media report on the 9 March 2020 launch and suspected a launch failure may have occurred during this period. A launch failure of similar fashion in the 10 September 2019 test was discovered through his image analysis.



From left to right: KN-09; projectile launched on 31 July 2019; and KN-25. Photo Source: KCNA, KCTV

In an image released by North Korean media on 1 August 2019, the projectile's warhead looks thinner than that of the KN-25, but it also does not look like a KN-09 rocket. It is possible that North Korea doctored the image to create confusion, or that the photos unintentionally created a misleading visual effect. The possibility that the projectiles launched in late July and early August 2019 belong to another yet to be determined MRL prototype cannot be completely ruled out at this point.

However, whether there have been 12 or 17 launches in total, the number of tests of KN-25 is still lower than the 32 to 54 suspected rounds launched by the KN-09 in a span of three years until Pyongyang declared the system had completed its testing cycle, according to the author's own count below:

Suspected KN-09 flight test activities from May 2013 to March 2016 [11]:

Date	Number of projectiles fired	Range and remarks from South Korean media outlets
18-21 May 2013	6	"The ministry presumed the projectiles to be modified KN-02 guided missiles or rockets fired from 300 mm-caliber multiple rocket launchers." ¹⁸ Range 120 to 150km ¹⁹
26 June 2013	4	"Projectiles same as the ones launched in May that were very likely to be 300mm MRL." Range over 100km ²⁰
21 February	4	"New MRL." Range over 150km ²¹

2014		
27 February 2014	4	Range 220km. "More analysis is needed to determine the exact type of the projectiles, saying it could also be an improved version of the KN-02 or a new type of artillery bigger than 300 mm." ²²
4 March 2014	4	"Pyongyang launched four more beginning at 4:17 p.m. using a 300 mm KN-09 launcher from the same region, with a range of about 155 km, it said." ²³
18-21 May 2014	6	Cannot tell type. Could be KN-09 ²⁴ .
26 June 2014	3	Range 190km ²⁵ Rodong Sinmun pictures showed KN-02/SS-21. But KN-09 cannot be ruled out for two reasons: <ol style="list-style-type: none">1. Truck (cabin) used is a typical type used by the KN-09²⁶.2. No visible wings on the projectile in a in-flight picture²⁷
2 July 2014	2	Cannot tell the type exactly but could be KN-09. Range 180km ²⁸
14 August 2014	3	Cannot tell the type exactly but could be KN-09. Range 220km ²⁹
3 April 2015	4	Range 140km "What the North fired are believed to be KN-02 ground-to-ship missiles, factoring in their range, speed and trajectory," a JCS officer said on condition of anonymity. ³⁰ There seems to be a mistake in reporting because KN-02 is a ballistic missile, not a anti-ship missile. Without images it is hard to determine what was launched. They could be the KN-01 anti-ship missiles, KN-02 ballistic missiles, or the KN-09 MRL rounds.
10 October 2015		Public debut in parade
3 March 2016	At least 9 or 10, judging from pictures released by KCNA (2 to 3 launchers. One launcher fired all 8 rounds) ³¹	Source said "the projectiles flew 100 to 150 kilometers before falling into the sea and are believed to be 300 millimeter rockets or short-range missiles ³² ". Firing pictures released for the first time.

21 March, 2016	5	Range 200km, North Korea declared completion of KN-09 development ³³ . Were identified as ballistic missiles immediately after launch ³⁴ .
Total	32-54	

The shortened testing cycle probably means that the knowledge and experience gained in the KN-09 project has helped with the development of the KN-25. The rocket's unit price, presumably much higher than that of the KN-09, also limited the number of tests.

Additionally, North Korea has advanced its capability in developing, producing and handling composite solid propellant motors. Such technologies could also be used on older systems, such as the 240mm MRL, to boost their performances.



North Korea's workhorse 240mm MRL rocket still burns traditional double-base propellant. Many countries have replaced it with composite propellant to boost performance of existing MRLs. It remains unclear whether Pyongyang would choose to do the same. Photo Source: KCTV

[1] Koh Byung-joon, N.K. leader attends artillery fire competition, Yonhap News Agency, 13 March 2020, <https://en.yna.co.kr/view/AEN20200313000800325>

[2] Oh Seok-min and Choi Soo-hyang, N. Korea fires 3 short-range projectiles toward East Sea: JCS, Yonhap News Agency, 9 March 2020, <https://en.yna.co.kr/view/AEN20200309000454325>. Yonhap reported three were launched, but photos from KCNA can only confirm two have been launched.

[3] There still remains some confusion about the number of KN-25 tests. The most recent 8 March 2020 test would either mark the 6th test of the KN-25 and the 12th or 13th launch in total, or the 8th test and the 16th or 17th launch.

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[5] KN-09(KN-SS-X-9), missilethreat.csis.org, last updated 09 September 2019, <https://missilethreat.csis.org/missile/kn-09-kn-ss-x-9/>

[6] Michael Elleman, North Korea's Recent KN-25 Launches, 38North, 6 March 2020, <https://www.38north.org/2020/03/melleman030620/>

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[8] KN-09, Missile Defense Advocacy, <https://missiledefenseadvocacy.org/missile-threat-and-proliferation/todays-missile-threat/north-korea/kn-09>

[9] ASTROS-III multiple launch rocket system, Military-today, http://www.military-today.com/artillery/astros_iii.htm

[10] Koh Byung-joon and Oh Seok-min, N. Korea says it tested new rocket system, not missiles, Yonhap News Agency, 1 August 2019, <https://en.yna.co.kr/view/AEN20190801000655325>

[11] 18-21 May 2013: 박한나, N. Korea yet to develop large-caliber rocket launchers: Seoul, The Korea Herald, 20 May 2013, <http://www.koreaherald.com/view.php?ud=20130520000782>. N. Korea appears to be winding up short-range projectile launches: Seoul source, Yonhap News Agency, 21 May 2013, <https://en.yna.co.kr/view/AEN20130521009000315?section=search>. 26 June 2013: 朝鲜在朴槿惠访华前一日发射短程发射体 [North Korea launched short range projectiles before Park Geun-hye's China visit], Yonhap News Agency, Chinese language service, 1 July 2013, <https://cn.yna.co.kr/view/ACK20130701003800881>. 21 February 2014: 朝鲜今天试射30枚短程导弹 [North Korea fired 30 short range missiles today], Radio France International, Chinese language service, 22 March 2014, <http://www.rfi.fr/cn/%E6%94%BF%E6%B2%BB/20140322-%E6%9C%9D%E9%B2%9C%E4%BB%8A%E5%A4%A9%E8%AF%95%E5%B0%8430%E6%9E%9A%E7%9F%AD%E7%A8>. 27 February 2014: N. Korea fires 4 short-range ballistic missiles, Yonhap News Agency, 27 February 2014, <https://en.yna.co.kr/view/AEN20140227009352315?section=search>. 4 March 2014: Kang Seung-woo, N. Korea fires more missiles, The Korea Times, 4 March. 2014, <https://en.yna.co.kr/view/AEN20140304007651315?section=search>. 18-21 May 2014: North Korea continues to fire missiles, Associated Press, 21 May 2013, <https://www.abqjournal.com/201504/north-korea-continues-to-fire-missiles.html>. 26 June 2014: Kim Hyung-Jin, North Korea test-fires 3 short-range projectiles into Sea of Japan: South, Associated Press, 26 June 2014, <https://globalnews.ca/news/1417539/north-korea-test-fires-3-short-range-projectiles-into-sea-of-japan-south/>. CIA gründet Spezialeinheit für Nordkorea [CIA established special unit for North Korea], AFP, 17 May 2017, https://www.t-online.de/nachrichten/ausland/krisen/id_81134716/nordkorea-cia-spezialeinheit-soll-atomprogramm-ueberwachen.html. Nordkorea feuert Kurzstreckenraketen ab [North Korea fired short range rockets], NTV, 29 July 2014, <https://www.n-tv.de/politik/Nordkorea-feuert-Kurzstreckenraketen-ab-article13115526.html>. 2 July 2014: Kim Hyung-Jin, N. Korea fires projectiles before Xi's Seoul visit, Associated Press, 2 July 2014, <https://www.thejakartapost.com/news/2014/07/02/n-korea-fires-projectiles-xis-seoul-visit.html>. 14 August

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N. Korea's firing of barrage of projectiles underscores importance of U.N.

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