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The DPRK Missile Show

A Comedy in (Currently) Eight Acts

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The Democratic People's Republic of Korea (DPRK), commonly known as North Korea, continues to draw global attention with various missile launches. A substantial and unavoidably increasing threat seems to emanate from the DPRK's growing arsenal of indigenous ballistic missiles. But a closer view gives critical insights into how North Korea has so rapidly introduced its numerous missile types: There are serious indications that these rockets are neither indigenously designed nor produced. As a consequence, serious international treaties are required that efficiently contain the proliferation of missile technology and limit further progress of any missile programs of concern.

On April 5, 2009, the DPRK launched a large rocket designated Unha-2, claiming to place a satellite into Earth orbit. Though this ambitious objective failed – the third stage with its payload crashed into the Pacific Ocean –, the communist state seemed to have proven once again its admirable skills of rocket science. The global community was worried: With this rocket, North Korea finally seemed able to deliver nuclear warheads onto American soil.

In the public, the discussion quickly focused on the question if the rocket was indeed a satellite launch vehicle, or if the global community witnessed a concealed ballistic missile test. This event also initiated a new round in the North Korean missile poker: The DPRK not only presented the capabilities of its obviously extremely competent missile industry, but it also demonstrated the potential to develop continuously larger systems up to the scale of ICBMs, and to do this without significant efforts. The resulting image of North Korea as a nation of rocket scientists is further supplemented by its massive exports of ballistic missiles to other 3rd World countries, and by its quick and flawless reverse engineering of foreign missiles including their simultaneous improvement. This assessment is now seen as given and is not questioned anymore.

But irrespective from the evaluation of the recent Unha-2 launch, one should wonder how the DPRK was able to launch such an impressive rocket and barely missed mission success at the first try. Anyway, with the rocket's total length of about 30 m, a diameter of roughly 2.5 m and a launch mass of up to 80 t, North Korea's rocket capabilities now have to be seen on a level with China, Russia and the USA.

Taking a close look on the history of ballistic missiles in the DPRK, though, a very different conclusion can be reached. North Korean missile tests are extremely rare, and some aspects of the program are inconsistent, or even contradictory. Seen from a distance, the overall view is not coherent. Therefore, the following text reveals how the doubts about an indigenous DPRK missile program manifested into the authors' claim that North Korea solely depends on foreign assistance for all of their missiles.

The Method of Analysis

Naturally, the official North Korean statements on this topic are not too contributive. Global media reports on this issue can be simply wrong, and the comments of Western governments are not necessarily very objective. A factual analysis is therefore required. This can be done by a review of three different aspects that should each contribute to a consistent final result. These three aspects are the *country* with its economic and industrial capabilities, the missile *program* and, last but not least, the *missile* itself. If all three aspects generate a consistent result, then the total assessment seems to be correct. But if single aspects do not fit together, the accepted truth must be doubted and the topic should be revisited and scrutinized.

Publicly available information is absolutely sufficient for this purpose. North Korean missile launches are reported in Western media, the DPRK has released video footage of some of its launches, and some missiles can be seen at military parades, for example.

The Country – Capabilities

Taking a look at the DPRK is the first step of analysis. On the 2009 global ranking, the economic performance of this 3rd World country is situated between that of Costa Rica and Burma. On satellite images of North Korea at night, a pool of total darkness is visible, framed by the seas of lights of South Korea and China. Only the capital of Pyongyang is illuminated. The DPRK's food production is sufficient for only 80 % of its own population. There is a common explanation, though, for the country's obvious achievements on the field of missile technology: The country solely focuses its capabilities on its military-industrial complex that is primarily located in vast underground facilities.

The Program – Tests and Simulations

The missile program gives even more important clues on the true situation than the country's characteristics. Tests of large missile systems cannot be concealed, and thus, tests and their results are invaluable indications for a real program. Number and chronological order of flight tests are the most decisive characteristics of a serious missile program, because just as aircraft have to pass a rigorous test program during development, including hundreds of flights with thousands of hours in the air, new missiles also have to be rigorously tested and reworked before they are operational.

In this context, the question always surfaces why a single test should not be sufficient to prove the system's functionality. After all, every detail has been considered, modeled and simulated during development. If other countries insist on numerous tests, it might be sensible from their point of view, but it should not be a necessity, as could be seen with North Korea after all.

This perfectly illustrates the difference between the dreams of missile engineers and reality, namely the dirty work with the exhausting process of actual and practical program realization, requiring endless testing and testing again.

Of course, a single successful test proves the functionality of the missile in principle – but not more. However, with different conditions – environment, temperature, shelf life, tolerances, … – the same missile may fail. Therefore, the whole range of possible situations has to be proven by tests.

And of course, every engineer tries to neutralize any uncertainties by detailed and extensive computations as far as possible, but a perfect and flawless design from scratch is simply impossible. On the one hand, the loads and stresses at operation are hardly predictable. On the other hand, the missile must be designed in a way that it barely withstands the loads. Metal sheets, for example, are designed as thin as possible to reduce mass, but only so thin that they bear the loads even under unfavorable conditions. And this is true not only for sheets, but for every single part of a missile without exception. The available margin between what the missile *can* endure and what the missile *has to* endure is very small, but it must be on the right side. For this, simulations alone are insufficient. Realistic tests are required to find and correct eventual failures. Additionally, there always is the problem of “unknown unknowns” that can only be addressed by actual flight tests. Therefore, there can be no development without tests, and not a single serious institution for missile development anywhere in the world has ever been able to do this.

During development, it is common to produce prototypes in small numbers called lots and not by single items, because production has to be trained just as any other activity. Some of these missiles have to be launched subsequently for functionality tests and to verify production methods. Usually, every newly designed missile – as every other high tech product – is not free of failures, and therefore, technical changes are implemented to improve the product. This again requires changes in production with resulting difficulties, which in turn inevitably requires further tests.

But tests are also required to determine the missile’s performance and accuracy. Computations can give a rough result, but due to the many unknowns, the result is not precise enough for actual operations. Once operationally deployed, the missile should be able to reliably hit the selected target, and this can only be guaranteed with previous tests under realistic conditions, including troop training. The East German army, for example, launched about 90 Scud B missiles during troop training in Kapustin Yar in the 1970s.

And there is still another aspect: The newly established production line has to prove its flawless production capabilities. Aside of extensive quality assurance, single flight tests are required again and again during serial production. These tests are called lot acceptance tests.

The necessary amount of testing can be seen by activities in Russia and the USA. Their early programs required about 100 tests for each missile type until deployment, and the world’s first ballistic missile – the German A4/V2 – completed a campaign of 400 flight tests until it was declared operational. Even after many decades of missile development with several generations of various missile types, test campaigns with at least a dozen launches are still required before operational capability can be achieved. Though the responsible institutions have amassed extensive experience in missile development, the early success rates of the test campaigns are still at about 50 %. The failure rate decreases only with time.

Tests are therefore an inevitable and decisive element of serious missile activities, and this is also true for 3rd World countries. If no tests are observed – and missile tests cannot be concealed –, then there either is no development program or the missile is not produced in serial production. Number, characteristics and chronological sequence of missile tests are clear indications for the evaluation of missile programs. A negligible number of tests shows that either the program is not (yet) an actual and serious weapon program, or the missiles are procured from external sources – proliferation!

The Missile – Characteristic Details and Reverse Engineering

The third and final aspect to be analyzed is the missile itself. Aside of the applied technology, correlations with other missiles are important to identify potential foreign assistance. This always leads to the question if the DPRK could do without indigenous missile development by duplicating single missile samples that are available to their engineers, which is also said to neutralize the need for an extensive test campaign. After all, there are so many cases of product piracy with copies that are almost identical to the source product.

Two cases must be distinguished here: A copy that exactly looks like the source product is quite simple to realize. This is sufficient for the majority of piracy cases, primarily in the areas of fashion items and consumer goods.

Complex machines such as rockets are totally different, though. A similar outer appearance is insufficient, flawless functionality has to be the main subject. That for, the reverse engineer must have access to the complete information and documentation that is required for manufacturing. This includes drawings, data, materials, specifications, production technologies and even relevant facilities and regulations for product manufacturing. Some aspects cannot be unlocked with only the final product at hand, especially parameters that cannot be measured directly, single production steps and unknown production technologies. The availability of required facilities and materials is also often ignored.

Reverse engineering is so difficult that there is not one single proven example for successfully reverse engineered missiles and rockets. UN inspections revealed that Iraq was not able to reproduce Soviet Scud missiles. And regarding rocket engines, even licensed production is not a guarantee for success as the US efforts for production of a Russian engine clearly showed. After many years, this project was finally cancelled due to unsolvable problems. Failure is even more likely for countries with poor industrial infrastructure and limited resources.

And two other aspects are often ignored. If a country has the capability to duplicate an existing missile, it also has the capability to develop its own missiles, and to do this without the limitations that come with the exact replication of existing technology. And if a country makes large profits with counterfeited products of another country, it should seem strange at least that no protests are filed against these actions. This is the case in any other field of technology – except for missiles, as it seems.

Thus, contrary to the widespread view, reverse engineering is impossible. Reports about successful reverse engineering should be dismissed. These cases clearly have to do with proliferation.

The Missile Show

With these foundations laid, it is time to take a look on the individual acts of the North Korean missile show.

Act 1

The first act started in the early 1980s, starring the Soviet R-17 missile, better known as Scud B. This device was developed in the late 1950s by the Makeev design bureau and outfitted with an engine developed by the Isaev design bureau. Both were renowned institutions of the huge Soviet missile development complex.

Scud B has a length of about 11 m, weighs almost 6 t and is able to throw a conventional or nuclear payload of 1 t across 300 km. This missile was continually produced in two Soviet factories from the 1960s to 1987, in Votkinsk and Zlatoust. Production capability in Votkinsk was 300 Scuds per year, and Zlatoust was designed for 1 000 per year in times of war, meaning that many thousand missiles were produced in total. 2 000 Scuds were used in Afghanistan, almost 1 000 were shipped to Iraq and another 1 000 to other countries (Libya, Syria, …). In the Soviet Union, outdated and decommissioned weapons were not destroyed but stored, and thus, huge stockpiles of this missile should still have existed at the late 1980s. This is further backed by the Russian offer of Aerophon in the 1990s – Aerophon was a modified Scud with terminal guidance, and it could have been offered only with the Scud missile body still available or in production.

The Soviet Union delivered Scud B to numerous states, Egypt among others. The number of Scuds that Egypt received is assumed as roughly 100. Egypt in turn transferred a couple of these missiles to the DPRK in the late 1970s or early 1980s. In 1984, North Korea fired three of these missiles for the first time, and two years later one single Scud was launched again.

At this time, the war between Iran and Iraq entered its critical stage. The Soviet Union already supplied Scuds to Iraq, but denied shipments to Iran. This was perfect for the DPRK, because their experts just had “quickly reverse engineered” the Egyptian Scuds. With Iranian funds, a North Korean production line was established over night, and from 1987 on Scud B was delivered in great quantities to Iran where they were used against Iraq without any known problems. Thus, the official Soviet R-17 production stop was seamlessly followed by the export of flawlessly performing North Korean R-17s.

But to simply replicate R-17 was not enough: The North Koreans reportedly also improved this missile. The resulting Scud B-PIP (Product Improvement Program) is said to have a longer range, though it is absolutely identical to the source product. This performance increase was never proven, though.

The degree of perfection of the North Korean Scud clones became obvious in 2002, when a North Korean freighter en route to Yemen was boarded by the Spanish navy in international waters, carrying a load of Scuds from North Korean production. The released imagery proves that Soviet and DPRK Scuds are absolutely identical, ranging from the Cyrillic markings and arbitrary technical details to the jet vane serial numbers that – as in the Soviet Union – were adopted from the missile's predecessor Scud A.

As early as 1999, a Scud drawing was found on another North Korean freighter named Kuwolsan that was searched by Indian authorities in an Indian harbor. On this drawing, the exact nominal Soviet engine thrust level was noted. Aside of this, the technical data published by Iran of the received DPRK Scuds is identical to the Soviet nominal data. And this data complies perfectly with the missiles' actual performance, as a video analysis of an Iranian Scud B launch in 2006 proved.

This leaves only one explanation: The North Korean Scud B missiles are not reverse engineered – they actually are original Soviet-Russian R-17s.

Act 2

The second part of the North Korean missile show is linked to the INF treaty that was signed in 1987 between USA and USSR. From now on, Russia was not allowed to develop, deploy or sell missiles with ranges between 500 and 5 000 km. But during the war in Afghanistan, the Soviets had developed and tested a new type of Scud missiles with a range of 500 km that was designated Scud C by the West. With the Soviet retreat from Afghanistan in 1989, this missile vanished from the public minds.

One year later, in 1990, after four years without a launch, the DPRK fired one Scud, this time with a range of 500 km. This device was also named Scud C by Western experts, but the striking similarity to the Soviet Scud C was ignored. After one more launch in 1991, the North Koreans were seemingly so content with their product to approve serial production, and within one year, the missile was exported in large numbers to Syria and Iran where it was also successfully launched.

The same that was previously observed with Scud B now happened with Scud C: A missile that was developed and produced in the Soviet Union is decommissioned. It instantly resurfaces in the DPRK without a test program, claimed to be an indigenously developed and produced missile.

Act 3

The third act followed shortly after. In 1993, four missiles were launched again in the DPRK. The exact missile types are still not known for sure, but one is said to have been the first appearance of a new rocket that would soon play a central role in the 3rd World arsenals. This missile, designated Nodong by the West, looks like an upscaled derivative of the Scud. Main diameter is roughly 1.3 m compared to Scud's 0.88 m, and the whole system is accordingly larger, heavier and offers more performance. Western sources projected a range of 1 300 km with a 1 t warhead. This single test – that only achieved a range of 500 km – was sufficient to make Nodong a highly demanded export item.

In the same year, a number of Russian missile experts from the Makeev design bureau tried to emigrate to North Korea. This was prohibited by Russian authorities, but it is not known if they found another way to the DPRK.

Since 1998, Nodong can be found in Pakistan by the name of Ghauri, and in Iran as Shahab 3, where it first appeared at a military exhibition, littered with numerous Cyrillic markings. Officially, Shahab 3 is an indigenous Iranian development that is close to Nodong, but is produced in large numbers in Iran.

Early evaluations of Nodong attributed a cluster of 4 Scud engines to the missile – after all, it was said that these engines were in production in the DPRK and thus readily available. But when Iran and Pakistan presented their missiles in public, it was clear that Nodong had only one engine. Consequently, this had to be a newly developed North Korean engine. The Western range estimations that were based on the engine cluster design were not affected by the revealed lower thrust single engine design – standard Nodong range in literature remained at 1 300 km.

Lucky chance revealed the true origin of the engine. In 2001, a Russian textbook was published in context with a training course for rocket production in Iran. This book contains the drawing of a manufacturing device for rocket engines. The decisive figures of the according engine – nozzle and throat diameter – perfectly match those of the Nodong engine, as photos of the Iranian Shahab 3 engine clearly show. It is a Soviet-Russian engine, and the characteristic details of the Isaev design bureau are clearly visible.

Engineering details and technical data of Nodong are strikingly characteristic for Soviet missile concepts of the late 1950s. At that time, competing design bureaus proposed, pre-developed and tested dozens of different missiles that never reached the state of serial production and disappeared in the fog of history. To give an example of the scale of Soviet rocket efforts at that time: Isaev alone developed more than a hundred different engines, of which several dozens entered serial production.

Thus, it seems clear that Nodong, as Scud B, is an early Soviet missile, perhaps the little known R-18 or R-19.

Act 4

In the fourth act, taking place in 1998, North Korea attempted to launch a small satellite for the first time. The rocket that was used for this mission, the so-called Taepodong 1, was seen only once at this very occasion, and never again. According to available imagery, the first stage was a Nodong, and the dimensions of the second stage seemed similar to Scud. But this stage was equipped with an engine with varying thrust level, a feature that no Scud engine is able to do. On top of this, a little third stage was mounted, carrying the presumed satellite payload.

The majority of the flight went according to plan, including both stage separation events – a procedure that is quite demanding; the Falcon 1 rocket of the US company SpaceX recently failed twice in a row at this challenge (they finally succeeded in the fourth attempt – they should have asked for North Korean support in the beginning). Just before reaching orbit, the third stage suffered an anomaly, and the satellite was lost.

But instead of a renewed launch attempt with an improved third stage – the logical path that every engineer on this planet would go –, the program was cancelled and the Taepodong 1 was never seen again.

Interesting enough, there also is a comparable Soviet counterpart to this rocket, namely the R-55 concept that is linked to Makeev.

Act 5

The fifth act was already heralded in 1999. Other drawings were found on the previously mentioned North Korean freighter Kuwolsan that showed an even more powerful derivative of the Scud, designated Scud D in Western literature. In 2000, Syria successfully launched a missile with striking similarity to these drawings. It was launched close to the border to Israel. Considering the consequences that a guidance failure would have had, with the missile flying towards Tel Aviv, it is highly probable that this missile's development was finished and the missile was deemed reliable.

There were no development tests of this missile in the DPRK. These tests must have taken place in another country, but there are no candidates except for Russia. Similar to Scud C, there might have been tests during the Soviet Afghan war where the Soviets reportedly launched thousands of Scuds over the years, but this is hard to verify today. Though the information situation about Scud D is meager at best, again all indications point towards North Korea and Russia.

Act 6

Act number six happened in secrecy. In 2005, there were media reports that North Korea had sold to Iran a reverse engineered and improved version of the Soviet submarine missile R-27/SSN-6 with a range of 2 500 km, now named BM-25. Compared to Nodong, this missile (that was coincidentally developed by Makeev and equipped with an Isaev engine) is a quantum leap in technology and performance. Photographic evidence was never released and tests were not required, of course. From then on, the BM-25 was seen as an operational part of the North Korean and Iranian missile arsenals, though it was never actually launched.

Act 7

The rest of the World was seemingly so impressed by the BM-25 that act seven took place with a North Korean military parade in 2007, where the DPRK presented a new small missile designated KN-02. Some experts saw a huge threat potential and attributed a range of several thousand kilometers. But a closer look would have been sufficient to identify this secret weapon: It was a Russian SS-21/Tochka with a range of 120 km.

Act 8

The failure of the first satellite launch attempt obviously bothered the North Koreans, thus leading to the eighth and hitherto final act of the show. As early as 1994 – four years before the flight of Taepodong 1 –, a large long range missile was reportedly sighted in the DPRK. According to a defector, this rocket's development was finished in 1999 and it was then stored in the North Korean underground facilities. Western experts soon surpassed each other in their range predictions: Starting from 3 000 km in 1994, the attributed range soon increased to 12 000 km, and this without any further information. The rocket, meanwhile designated Taepodong 2, was finally launched in 2006. Its performance was sobering, though, achieving a range of less than 10 km – the first stage suffered an anomaly about 40 seconds into flight.

The same day, five or six more rockets were fired into the Japanese Sea from other North Korean launch sites. Combined, these were almost as many launches in one day as in the 25 years before.

No photos and videos of Taepodong 2 were ever released. Therefore, the missile was not necessarily identical to the previously mentioned Unha-2 that failed almost three years later in April 2009, though this is widely assumed. The usual approach of the North Koreans always was the development of a completely new missile with a maximum of one or two flight tests. This is comparable to the approach of developing a new aircraft including new engines, then starting the engines once and flying a short aerodrome circling. After that, the design is discarded and a totally new aircraft is designed from scratch. It seems that, following the disaster of 2006 and assuming both missiles were the same, the “aerodrome circling” should be accomplished at least once with Unha-2.

Video footage was finally available of the Unha-2 launch. Not surprisingly, the rocket's design had absolutely nothing in common with previous North Korean designs. Technical details such as interstage structures or aerodynamic layout were totally different, and the third stage seemed to have been added afterwards. It seems pretty clear where this missile's origins lie.

While experts today still speculate about the true range of Unha-2 in a missile role, a new act of the North Korean missile show seems to be close at hand.

Act 9…?

Up to the present day, the majority of DPRK's missiles was launched from the launch complex of Musudan-ri in the country's east. This facility consists mainly of a storage hall and a little launch pad that are both connected with a dirt road. This layout is sensible, considering that an asphalt road would not have been required for the few launch campaigns that took place in the last three decades.

For some time now it is common knowledge that the DPRK builds a new launch complex in the west of the country. This includes an engine test stand with a size comparable to that of NASA in Huntsville, and a launch pad that is the same scale as Russia's or China's pads for manned space launches. There are media reports that a 50 m launch tower and a hangar have already been constructed, and a first rocket was said to be on its way by train to the launch complex. This is analogue to previous DPRK launch campaigns: Nodong and Taepodong 2 are also said to have been sighted at their respective launch sites several years prior to their first launch. This is the known North Korean approach to gain as much global attention as possible.

It will be seen if North Korea will soon give up its "Act 9 efforts" in a deal with the West, similar to its nuclear deal some years ago when it "discarded" its nuclear program for crude oil deliveries. By the way, the pattern of doubtful correlations can also be observed with North Korea's so-called nuclear tests, but this is a different story.

Summary

Today, there are at least seven different missile types of longer range available in North Korea – Scud B, Scud C, Scud D, Nodong, R-27/BM-25, Taepodong 1 and Taepodong 2/Unha-2. All were developed during the last three decades, each of them within a few years, and six are subject to the INF treaty. Some of the missiles have common roots, but their diameters vary significantly, ranging from 0.88 m over roughly 1.3 m and 1.5 m to about 2.5 m. This means that North Korea managed to develop at least four completely different lines of missiles to perfection and serial production, all of them with a negligible number of test launches. A total of roughly a dozen missile tests was actually observed before 2009, a number that is even today insufficient for only one military missile development in the USA, Russia, China or France. The repeating reports of North Korean "short range missile tests" are irrelevant – at those tests, the DPRK launches small anti ship missiles that were purchased in China or Russia. This has nothing to do with ballistic missiles.

It is often argued that the North Korean missiles are tested in other countries, namely Syria, Pakistan and Iran. This argument is insufficient. Combining all Scud B, C, D and Nodong launches in these countries, they are still not enough for a respective indigenous development, and the other missile types were never launched outside the DPRK. The choice of launch sites in the respective countries also is a clear indication: Pakistan tests its missiles close to Cashmere at the border to India, and as previously mentioned, Syria launched Scud D at the Israeli border. If the missiles head in the wrong direction – what is not uncommon at development tests –, this would have catastrophic consequences. Therefore, it must be assumed that these missiles had already had finished their development programs.

Aside of their small number, the sequence of North Korean tests is also noteworthy. There were only sporadic launches from 1984 to 2006, with a total of roughly ten. This was followed in 2006 and 2009 with an event of about a half dozen missile launches within a few hours, respectively, both including a large satellite launch vehicle. There might be a link to Iran's and Pakistan's orientation towards modern solid rocket technology. Russia can offer nothing on this market because of the imposed restrictions of the INF treaty – there are no old Soviet solid fueled missiles of this performance class, and new developments in this class are not allowed by INF – the required tests might be observed by the USA. Iran also increases its indigenous activities, resulting in a foreseeable loss of this source of funding. No wonder that the DPRK now has to demonstrate larger systems to stay in the proliferation game.

Conclusion

This is the visible North Korean situation: A country that has absolutely no other technical and economic merits offers a variety of quickly reverse engineered and indigenously developed high tech weapons, all of them with typical Soviet characteristics.

Every other country in the World had to rely on outside help of experienced institutions for their missile programs: China on Russia, India on the US and France, Pakistan on China and France, and so on. Even the US and the Soviets acquired German expertise after World War 2. Every country had foreign support for their missiles – except the DPRK.

It should be noted here that the common view of North Korea's reverse engineering capabilities seems to come from one single source in the late 1980s, without any further proof. Today, this source is reported to see these claims with different eyes.

To get back to the analysis method that was introduced at the beginning: The three aspects *country*, *program* and *missile* are not compatible. The DPRK has no capabilities on any other area than rocketry, the programs are invisible or nonexistent, but a selection of operational missiles is offered that should even have countries like France, for example, go green with envy.

It is also strange that Russia silently watches the DPRK cloning and selling Soviet products, thus earning hundreds of millions of dollars, and doing this without any financial compensation for the Russians.

These antagonisms can be explained on several ways. Some claim that in the age of computer simulations, a single test is enough to proof functionality of highly complex machines such as missiles. After that, the missile goes straight into serial production. But this obviously only works in the DPRK: The new Russian submarine missile Bulava, for example, seems to have failed in 7 of its 12 flight tests so far – operational deployment is far from any discussion.

There is a different explanation that is much simpler – a connection to Russian institutions. All of the North Korean missiles were procured from Russia or at least realized with foreign support. Some, as Scud B, might come from old stocks, single remainders of old Soviet prototypes certainly were among them, and others might still be in production. A guided North Korean licensed production of simpler components can also not be excluded. In any case, the indigenous contributions of the DPRK are small at best. It is not said, though, that the Russian government or the leadership of the institutions in question know of this: Much happens in dark alleys, as was illustrated by the example of the Gharbiya gyros for Iraq.

The DPRK will of course try to reverse engineer parts and components, and it will try to acquire the capabilities for indigenous development and production. Due to this, single engine tests should be observable, not only to demonstrate indigenous activities, but also to learn and to slowly increase the DPRK's competence on the missile sector.

But in the public opinion, this explanation is wrong, because – well, because it cannot be right. Because there is a well established view of North Korea that is also confirmed by defectors: The rockets are secretly designed, tested and produced in huge underground facilities, and these efforts are directed by an evil and megalomaniac villain who threatens the free world with his missiles.

How to best counter this type of threat should be known from the movies – just call James Bond.