



## PERSPECTIVES

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### The Puzzle of the North Korean ICBM

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**EXECUTIVE SUMMARY:** Uncertainty remains about North Korea's technological maturity and ability to launch nuclear warheads that could hit the US homeland, even after its recent success at launching the Hwasong-14 missile and the conducting of its most powerful nuclear test yet. The first-stage engine of the Hwasong-14 is a critical component in its possible operation as an intercontinental ballistic missile, but there are questions about how Pyongyang came by this engine, how many it possesses, and whether or not it can produce them on its own. These uncertainties are troubling not only with regard to North Korea, but also with regard to Iran. They have sobering implications about the possibility of monitoring and preventing the proliferation of weapons of mass destruction worldwide.

The success of the two test launches by North Korea of the intercontinental ballistic missile (ICBM) Hwasong-14 on July 4 and 28, as well as the powerful nuclear test on September 3, surprised and shocked the world, especially the US. This is because they suggest an eventual scenario in which Pyongyang is able to strike the American continent with nuclear weapons, a capability to which it might already be very close.

To this was added *The Washington Post* report of August 8, according to which the American intelligence community believes North Korea has successfully developed a miniaturized nuclear weapon that can be installed in the warhead of a ballistic missile. This achievement means Pyongyang is crossing the threshold to becoming a nuclear power. Contributing to the unease are Pyongyang's fiery declarations, including a statement on October 16 by North Korea's deputy ambassador to the UN that "the entire US mainland is within our firing range."

It is difficult to assess the truth of that statement, as North Korea's nuclear status is still ambiguous. These issues remain to be determined:

- 1) the ratio between Hwasong-14's flight range and the payload weight it can carry;
- 2) the weight and dimensions of the nuclear bomb North Korea has developed so far, and its ability to fit it into a missile warhead;
- 3) whether Pyongyang has developed a "reentry vehicle" (RV) capable of surviving a return into the atmosphere prior to hitting its target;
- 4) the missile's accuracy; and
- 5) the origin of the missile's first-stage (main) engine, the number of engines of this type possessed by North Korea, and its ability to manufacture them domestically.

American aerospace engineer John Schilling wrote in July that the Hwasong-14 is still unreliable and not yet capable of reaching Alaska or Hawaii. In his view, it will take another year or two of tests and development before the missile can carry a nuclear warhead capable of striking targets on the American West Coast.

Theodore A. Postol, Markus Schiller, and Robert Schmucker, in an August article in *Bulletin of the Atomic Scientists*, analyzed the flight trajectories of the two stages of the missile in the launches of July 4 and 28. According to their calculations, if the Hwasong-14 had been carrying a payload with a nuclear bomb, it is doubtful that it would have been able to hit Alaska, let alone the US mainland. The test missiles carried a very small payload compared to the weight of a nuclear warhead, and the heavier the payload, the shorter a missile's flight range.

However, Dr. Jonathan McDowell, a satellite launch expert at the Harvard-Smithsonian Center for Astrophysics, disagrees with this claim. In August, he stated that if the Hwasong-14 is launched at a lower-angle trajectory than the July 4 and 28 launchings, it could carry a payload up to 11,000 kilometers, which would enable it to hit almost all the US states. This is due to the high-powered thrust of the missile's second-stage engine, which would give it "a bit more push."

It is important to bear in mind that the weight and dimensions of the nuclear bomb North Korea intends to install in the Hwasong-14's warhead are unknown. Postol, Schiller, and Schmucker's claim – that a Hwasong-14 carrying a nuclear payload might not even be able to hit Alaska – was based on the assumption that the nuclear bombs developed by Pyongyang contain an enriched uranium core and therefore weigh approximately 500 kilos. But at least some North Korean nuclear bombs have a plutonium core and therefore

weigh significantly less. Moreover, the September 3 nuclear test showed Pyongyang's rapid progress in nuclear weapons development and the likelihood of its success in miniaturizing the bomb.

Images distributed by the North Korean news agency KCNA showed North Korean leader Kim Jong-un, prior to the test launch, observing a large, peanut-shaped, silver-colored device. According to KCNA, he was watching "the loading of a hydrogen bomb into the new ICBM." A wall in the background displayed a cross-section drawing of the missile's warhead and within it the photographed device.

While the device is similar to the US W87 thermonuclear bomb, it should be noted that the conical W87 warhead's cone base diameter is 56 cm, it is 180 cm long, and it weighs 200 to 270 kg. The device and warhead in the KCNA images appear to be larger and therefore heavier than the W87. Also, the device in the KCNA photos might be a mockup. Nor is there any certainty that the nuclear explosive device detonated in the September 3 test was the same as the device shown in the KCNA images.

Still, it is highly likely that the test was conducted on a device with a plutonium rather than an enriched uranium core, and boosted by hydrogen isotopes. It is therefore difficult to draw conclusions from the KCNA images regarding the weight of the North Korean bomb and the impact of that weight on the flight range of the Hwasong-14.

As to whether or not the photographed device was a mockup or the real thing, Joshua Pollack, editor of *Nonproliferation Review*, commented the day after the test: "Given the closeness in time between the exhibition of the device and the actual test, I wouldn't be surprised if that was the actual device ... They have very good reasons to show exactly what they've got, because they're trying to enhance their credibility. I give them the benefit of the doubt on this one."

One of the problems in the development of ICBMs is the RV's survival due to harsh environmental conditions, extreme temperatures in the thousands of degrees, and high deceleration pressure, all of which act on the vehicle during its descent into the atmosphere on its way to striking its target. The RV must be covered in an ablative heat shield, since as a result of the melting or vaporizing of the coating, the thermal energy dissipates into the atmosphere.

It is doubtful that Pyongyang has developed a reliable heat shield for the RV. After the launch on July 4, North Korean media claimed the test had proven the durability of the Hwasong-14 RV – but South Korean intelligence believes North Korea has not yet acquired sufficient expertise in RV technology as it lacks suitable testing facilities, such as wind tunnels.

The article by Postol and his colleagues also casts doubt on the North Koreans' having mastered RV technology. Their doubts were reinforced by a short video aired by the Japanese broadcaster NHK, which showed that at the end of the July 28 launch of the Hwasong-14, near the Japanese island of Hokkaido, the missile was shedding parts into the sea and apparently falling apart. Michael Elleman, a missile specialist at the International Institute for Strategic Studies, claimed that prior to the missile's return to earth, small objects were falling from it, apparently due to its premature disintegration, and concluded that "the Hwasong-14 RV did not survive during its second test." Both Elleman and McDowell believe North Korean technology has not yet matured to the point that it poses a real nuclear threat to the US.

There could be another explanation for the disintegration, however. An August 12 report by Ankit Panda in *The Diplomat* notes CIA estimates that the Hwasong-14 RV was lofted to an excessive apogee of about 3,700 kilometers. This means its reentry into the atmosphere was at a steep angle that accelerated its speed and caused its surface to overheat.

According to this assessment, North Korean RV technology has advanced sufficiently to allow a missile launch at a lower trajectory, requiring minimal energy and thus reducing the heating of the RV. If this is in fact the case, the missile will be able to hit targets in the US. As proof, the article states that when the missile was launched to an altitude of 2,800 km during the July 4 test, the RV survived at an altitude of at least one kilometer before returning to earth.

The parameter that defines the accuracy of a missile's impact is CEP (Circular Error Probability), the radius of the circle around the target where there is a 50% probability of its hitting. Hwasong-14's CEP estimates range from 30 km to 3-5 km. A Hwasong-14 at a CEP of 30 km, if launched at Los Angeles, would probably miss it, and the city would likely remain unscathed. But at a 3-5 km CEP, the missile could cause thousands of casualties in the city even if it does not score a direct hit.

Based on photos of the Hwasong-14, especially the one showing it on a Chinese-made mobile ballistic missile launcher that has a known length, Postol, Schiller, and Schmucker identified the missile's first-stage engine as an RD-250 type. That engine, which has an 80-ton thrust, was designed in Russia by the NPO Energomash in the 1960s for the R-36 missile, which was the backbone of the USSR's strategic missile arsenal during the Cold War. The production of the RD-250 engine was later transferred to the Yuzhmash plant in Dnipro, Ukraine.

In an August article in *The New York Times*, Michael Elleman focused on the Yuzhmash plant as the source of the RD-250 that ended up in North Korea. The transaction was shown against the background of the economic difficulties the

Ukrainian plant faced following the deterioration of relations between Russia and Ukraine due to the Crimea flare-up in 2014.

The identification of the RD-250 model as the first-stage engine of the Hwasong-14 (also installed as the engine for the Hwasong-12's single-stage medium-range missile) was based on the findings of German engineer Norbert Brügge, published on July 17. Brügge referred to a video image released for publication by North Korea, in which Kim Jong-un was photographed in late September 2014 as he watched an innovative rocket engine during its ground test. The engine was described as "the largest and most powerful to date." When Brügge examined the photograph of the engine and compared it to the diagram of the engine produced by the Yuzhmash plant, he found they were a good match in shape and dimensions, as well as in the position and size of the four Vernier steering engines surrounding the first-stage engine (the purpose of which is to direct the missile's flight trajectory after launch).

Elleman's conclusion that Russia's NPO Energomash was involved in transferring the technology to North Korea was further supported by the findings of UN investigators six years ago following the arrest of two North Koreans in Ukraine in July 2011 for attempting to steal secret information on advanced missile systems, liquid propellant engines, and the like. In his article, Elleman raised the questions of how the technology was transferred to North Korea and whether the Ukrainians continue to assist Pyongyang in this area.

Immediately following the article's publication in *The New York Times*, accusations flew between Moscow and Kiev over responsibility for delivery of the engine into North Korean hands. Volodymyr Groysman, Ukraine's prime minister, called the article a "provocation," while Oleksandr Turchynov, secretary of the National Security and Defense Council of Ukraine, called it "a Russian intelligence conspiracy". The Ukrainian space agency stated that all engines manufactured at the Yuzhmash plant were designed solely for the Russian space program and that all engines manufactured, as well as their documentation and blueprints, are in Russian possession.

Moreover, to refute the *NYT* article, the Ukrainian security services gave CNN footage and detailed information about the sting operation they had conducted in July 2011 to ensnare the two North Korean spies who were out to steal missile technology. They even allowed CNN to meet the spies, who had been imprisoned in Zhytomyr prison for eight years.

On the other hand, Russian Deputy Prime Minister Dmitry Rogozin has alleged that "the copying of Ukraine's rocket engines by North Korea would have been impossible without Ukrainian experts." In addition, as part of Russian propaganda efforts, the online publication *Russia Insider* displayed a video on

August 18 in which a prankster, posing as Turchynov, duped the director of the Yuzhmash plant, who innocently admitted that the plant had maintained ties with North Korea for 14 years but minimized their scope.

Whom does the US believe? A member of the American intelligence community told *Reuters*, "We have intelligence to suggest that North Korea is not reliant on imports of engines ... we judge they have the ability to produce the engines themselves." On the basis of that assessment, Ankit Panda concluded in an article on August 16 that the engines are manufactured in North Korea as part of a joint development program with Iran.

To support this conclusion, Panda used a November 2013 report from the US Treasury Department, according to which Iranian technicians from the SHIG organization (the Shahid Hemmat Industrial Group), which belongs to the Iranian Ministry of Defense, arrived discreetly in North Korea in 2013 to develop a new 80-ton thrust engine (the RD-250) together with their North Korean counterparts.

The second-stage engine of the Hwasong-14 is the R27, developed and manufactured at the Russian Makeyev plant for the SS-N-6, a Submarine-Launched Ballistic Missile (SLBM). These engines and their technology were transferred to the North Koreans, who fitted them to the Hwasong-10 medium-range ballistic missile (also known as the Musudan or BM-25). The Hwasong-10 was first revealed during a parade in Pyongyang in 2010, though its test launches have all failed so far. According to reports, the Iranian ballistic missile *Khorranshahr*, recently unveiled in Iran, is a copy of the North Korean Hwasong-10.

The uncertainties about North Korea's nuclear capability are very troubling in view of its threats to the US, South Korea, and Japan, and the fear of the outbreak of war in East Asia. These uncertainties are worrying not only with regard to North Korea, but also with regard to Iran. They have sobering implications about the possibility of monitoring and preventing the proliferation of weapons of mass destruction worldwide.

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