

## **A more in-depth, technical Q&A from Siegfried Hecker on North Korea**

North Korea announced on April 2, 2013, that it would restart its nuclear facilities, including its 5 megawatt-electric (MWe) nuclear reactor in Yongbyon, north of the capital, which had been disabled and mothballed since an agreement in October 2007.

Pronouncements from Pyongyang during the past few weeks have been ominous, including threatening the United States and South Korea with pre-emptive nuclear attacks. On April 2, 2013, a spokesman for North Korea's General Department of Atomic Energy told the Korean Central News Agency that at the March 2013 plenary meeting of the Central Committee of the Workers' Party of Korea: "A new strategic line was laid down on simultaneously pushing forward economic construction and the building of nuclear armed forces."

The pronouncement continued: "The field of atomic energy is faced with heavy tasks for making a positive contribution to solving the acute shortage of electricity by developing the self-reliant nuclear power industry and for bolstering up the nuclear armed force both in quality and quantity until the world is denuclearized."

We ask Stanford Professor **Siegfried Hecker** – former CISAC co-director and now a senior fellow at CISAC and the Freeman Spogli Institute – to weigh in. Hecker has been invited seven times to North Korea and he made international headlines when he returned from his last trip in November 2010 and announced the isolated North Asia nation had built a modern uranium enrichment facility.

**Q: How concerned should we be about North Korea's announcement that it will restart all its nuclear facilities? Does this fundamentally change the threat imposed by Pyongyang?**

**Hecker:** It does not immediately change the threat, but it really complicates the long-term picture. This announcement indicates that North Korea's nuclear arsenal is severely limited by a lack of fissile materials, plutonium or highly enriched uranium (HEU) to fuel its bombs. Despite its recent threats, North Korea does not yet have much of a nuclear arsenal because it lacks fissile materials and has limited nuclear testing experience. In the long term, it's important to keep it that way; otherwise North Korea will pose a much more serious threat. So, it is important that they don't produce more fissile materials and don't conduct more nuclear tests. The Kim Jong Un regime has already threatened to conduct more tests and with this announcement they are telling the world that they are going to make more bomb fuel. I should add that they also need more bomb fuel to conduct more nuclear tests.

**Q: What do you make of the previous threats to launch an all-out nuclear war against the United States and South Korea? Does North Korea have the technical means to do so?**

**Hecker:** I don't believe North Korea has the capacity to attack the United States with nuclear weapons mounted on missiles, and won't for many years. Its ability to target and strike South Korea is also very limited. And even if Pyongyang had the technical means, why would the regime want to launch a nuclear attack when it fully knows that any use of nuclear weapons would result in a devastating military response and would spell the end of the regime? Nevertheless, this is an uneasy situation with a potential for miscalculations from a young and untested leader.

**Q: Could you explain what you see as North Korea's capabilities in regard to putting nuclear warheads on short-, medium-, and long-range missiles?**

North Korea has conducted only three nuclear tests. The 2006 test was partially successful; the 2009 and 2013 tests likely were fully successful. With so few tests, the North Korean ability to miniaturize nuclear warheads to fit on its missiles is severely limited. After the first two tests, I did not believe North Korea had sufficient test experience to miniaturize a nuclear warhead to fit on any of its missiles. I believed the nuclear devices tested were likely primitive -- on the order of the Nagasaki device, which weighed roughly 5,000 kilograms. Official North Korea news outlets implied they were more advanced, and some Western analysts agreed. I stated that they needed additional nuclear tests to miniaturize.

**Q: After the test on February 13, Pyongyang announced that it had successfully tested a smaller and lighter nuclear device. North Korean news media also specifically stated that this was unlike the first two, confirming that the earlier tests involved primitive devices. The Kim Jong-un regime followed the claim of having smaller and lighter warheads with threats of launching nuclear-tipped missiles against the United States and South Korea.**

My colleague, CISAC Affiliate Nick Hansen, and I do not believe that the North Koreans have the capability to miniaturize a warhead to fit on a long-range missile that can reach the United States because the weight and size limits are prohibitive for them. They have insufficient nuclear test experience. Although last December they were able to launch a satellite into space, it is much more difficult to develop a warhead, fit it into a reentry body, and have it survive the enormous mechanical and thermal stresses of reentry on its way to a target. In April 2012, Pyongyang paraded a road-mobile long-range missile we call the KN-08. It may have been designed to reach as far as Alaska and the US West Coast, but to our knowledge it has never been test fired. There is some evidence that the first-stage engine may have been tested last year and early this year at the Sohae (Tongchang) launch site on North Korea's West Coast. North Korea would need a lot more missile tests as well as more nuclear tests to present a serious long-range threat.

**Q: What about what medium-range and short-range missiles -- ones that could reach South Korea or Japan?**

A road-mobile, intermediate-range ballistic missile we call the Musudan was apparently paraded in Pyongyang in 2007 and again in October 2010, when photos were actually released by official North Korean news media. The Musudan is believed to have a range of about 3,000 kilometers, meaning it could reach all of South Korea and Japan and come close to reaching Guam. As far as we know, this missile has also never been test fired. Western and South Korean news media reported that some of these missiles have apparently recently been moved to the Tonghae (Musudan) launch site on the East Coast and that North Korea may be preparing for test launches. However, overhead imagery from April 4 shows very little activity at the launch site, and we consider it unlikely that any kind of launch was planned for at least the next week. It is possible that North Korea may instead move these road-mobile missiles to the training base at

Kittaeoryong, several hundred kilometers to the south. This base has been used to launch most of the Scud and Nodong tactical missiles. In any case, for now the threat from medium-range missiles is also low.

The situation is not so clear for the short-range missiles that can reach South Korea and parts of Japan. The North Koreans are believed to have close to 1,000 short-range missiles, such as the KN-02, a version of the Soviet SS-21; various versions of the Soviet Scud; and the Nodong. These can reach distances from 70 to 1,000 kilometers with payloads ranging from 500 to 1,000 kilograms. But we know little about the sophistication of North Korea's warheads. They likely made some progress toward miniaturization with the third test, but we don't even know whether or not they switched from plutonium, which we believe they used for the first two tests, to a highly enriched uranium (HEU) device for the third test. However, thanks to Pakistan's A. Q. Khan, the North Koreans almost certainly have HEU designs for such a device that could fit on some of their short-range missiles. The reliability and accuracy of all but North Korea's shortest-range missiles is questionable. Without a serious testing program with instrumented dummy warheads and a more extensive nuclear testing program, it does not make much sense to consider launching a nuclear-tipped missile that could blow up in your own backyard.

**Q: So, in your opinion, is the U.S. placement of additional missile-defense systems in the region a reasonable response, or an over-reaction?**

In spite of the fact that we consider North Korea's capability to field any nuclear-tipped missile low, we simply don't know for sure. We also consider the likelihood that Pyongyang would decide to launch such a missile very low, because the launch would bring a devastating military response from the combined US and South Korean forces and spell an end to the Kim regime. Nevertheless, we have been surprised before by North Korea's capabilities, and we simply cannot rule out a miscalculation on the part of the new, inexperienced leader. Therefore, we consider it prudent to prepare missile-defense capabilities, both for Northeast Asia and for the United States. It is also important to try to head off North Korea's drive toward more and better bombs and better delivery capabilities. If we don't, the risk will increase.

**Q: If North Korea launches a missile from its East Coast in the general direction of Japan, will US radar and tracking systems be able to tell quickly whether the missile is a test aimed into the ocean or an attack on (say) Japan? In other words, would the prudent response to such a launch be to try to shoot down the missile, regardless?**

The radars on shore in Japan and on US and Japanese ships could quickly determine if a missile is headed to targets in Japan or South Korea, or to the open sea. In the recent past, Pyongyang has given notice when it was about to launch a missile that is expected to leave its territory. Hansen and I would expect the North Korean government to do the same this time. If it does, we don't think it would be prudent to intercept it, because tensions in the area are so high. However, if the North Koreans don't give notice, we favor shooting it down.

**Q: The Kim Jong Un regime has reiterated and apparently put into law that North Korea will not give up its nuclear arsenal. Does the current announcement really make things that much worse?**

**Hecker:** I have previously stated that North Korea has the bomb, but not yet much of an arsenal. It has been clear for some time that North Korea will not give up its nuclear weapons, so what we should have focused on is to make sure things don't get worse. I have stated it as the three No's: no more bombs, no better bombs and no export. We don't know much about North Korea's nuclear exports, but that potential is a serious concern. Pyongyang took a step toward better bombs with its successful Feb. 12 nuclear test, although it still has little test experience. The current announcement demonstrates that they will now redouble efforts to get more bombs by increasing their capacity to make plutonium and HEU. It won't happen quickly because these are time-consuming efforts – but it bodes ill for the future.

**Q: Let's look at the technical issues of the latest announcement. What do you think Pyongyang means by "readjusting and restarting all the nuclear facilities in Yongbyon?"**

**Hecker:** The restarting is easy to decipher: They plan to take the 5-MWe gas-graphite plutonium production reactor out of mothballs and bring the plutonium reprocessing facility back into operation. The "readjusting" comment is less clear. It may mean that they will reconfigure the uranium enrichment facility they showed to John Lewis, Bob Carlin and me in 2010 from making low enriched uranium (LEU at 3 to 5 percent for reactor fuel) to making highly enriched uranium (HEU at 90 percent for bomb fuel).

**Q: Was the new centrifuge facility you saw in 2010 making LEU?**

**Hecker:** Actually, we could not confirm that uranium enrichment centrifuge facility was operating, or that it was making LEU reactor fuel. However, that is what they told us – and in my opinion, they likely have produced, if any fuel, only LEU for their experimental light-water reactor (LWR) at that facility since then. So, this announcement may mean that they will now redirect that facility to making HEU.

**Q: How difficult would it be for North Korean to adjust its centrifuge facility to make HEU? And how much HEU could they make?**

**Hecker:** Not very difficult. It just requires reconfiguration of the various centrifuge cascades and adjusting operational procedures. That could be done very rapidly. They most likely had everything prepared in case they ever wanted to make this move. If they reconfigure, then based on our estimates, they could make roughly 40 kilograms of HEU annually in that facility – that's enough for one or two HEU bombs per year.

**Q: The KCNA announcement said the North Koreans would develop a self-reliant nuclear power industry as well. Don't they need the centrifuge facility to make LEU to do that?**

**Hecker:** Yes, they need LEU for the experimental LWR reactor fuel. However, based on what they told us in 2010, they had the capacity to make about 2 tons of LEU annually in the centrifuge facility. If they have operated it full time since we were there, they may have enough

fuel to operate the experimental LWR for several years. If that is the case, then they could afford to reconfigure the centrifuge plant now for HEU. The North Koreans will eventually need a much bigger centrifuge facility than the 2,000 centrifuges we saw if they follow through with larger LWRs that can make sufficient electricity to help alleviate their power shortages. In any case, such reactors are still more than a decade away.

**Q: Didn't you previously claim that they likely have another centrifuge facility?**

**Hecker:** On the basis of what I saw in November 2010, I concluded they must have a covert centrifuge facility (or facilities) and that it had likely been operational for years. That experience allowed them to build the Yongbyon facility as rapidly as they did, which was in a little more than one year. I also concluded they likely had previously produced HEU at a clandestine facility.

**Q: If they have already produced HEU at an alternate facility, then why would they need to "readjust" the Yongbyon facility?**

**Hecker:** That's not clear. I believed that the covert facilities were likely limited in enrichment capacity because they still need to import key materials and components. So, they may simply have decided that they need increased capacity to make HEU quickly and the simplest way to get that was to reconfigure the Yongbyon facility from LEU to HEU.

**Q: Is there any indication that they actually have an HEU bomb?**

**Hecker:** We really don't know. To the best of our knowledge, the first two nuclear tests in 2006 and 2009 used plutonium for the bomb fuel. We do not know what was used in the most recent test on Feb. 12. It could have been either HEU or plutonium. It would not surprise me if they have been pursuing both paths to the bomb; that's what the United States did during the Manhattan Project.

**Q: What did you learn about the 5-megawatt-electric (MWe) reactor during your November 2010 visit to Yongbyon? Will they really be able to restart it?**

**Hecker:** Lewis, Carlin and I were shown the beginning of the construction of the small experimental light-water reactor. The containment structure was just going up. I pointed to the 5-MWe reactor right next door and asked the chief engineer of the reactor, "What about the 5-MWe gas-graphite reactor?" He replied: "We have it in standby mode." I told him that people in the West claim it is beyond hope to restart. He chuckled and said, "Yes, I know, that's what they also said in 2003, and they were wrong then as well." The reactor had been mothballed since 1994 as part of the Agreed Framework. The North Koreans restarted it in 2003 without much of a problem and ran two more campaigns to make plutonium.

**Q: Will we know when they restart the reactor?**

**Hecker:** Yes, using satellite imagery we should be able to see the steam plume from the cooling tower as soon as they rebuild and restart it.

**Q: Didn't North Korea also have a 50-MWe reactor under construction? What happened**

to that?

**Hecker:** As part of the Agreed Framework in 1994, North Korea agreed to freeze the operation of the 5-MWe reactor and the construction of its bigger cousins, a 50-MWe reactor in Yongbyon and a 200-MWe reactor in Taecheon. We saw the 50-MWe reactor in 2004 and were told that they were evaluating what it would take to get it restarted. During later visits we were told and saw for ourselves that it was not salvageable. We were told the same was true for the Taecheon reactor. The North Koreans had been willing to trade these two gas-graphite reactors for the KEDO light-water reactors that the United States, South Korea and Japan had agreed to build at Sinpo. However, the deal fell apart when the Agreed Framework was terminated in 2003.

**Q: What would it take to restart the 5-MWe reactor and how soon could they do it?**

**Hecker:** The reactor has been in standby since July 2007. In June 2008, as a good-will gesture to Washington (and a reputed fee of \$2.5 million from the U.S., according to North Korean officials), Pyongyang blew up the cooling tower. They could rebuild the cooling tower in three months or so, or provide other means of cooling the reactor, possibly in conjunction with what they are building for the experimental LWR. In addition, based on our previous visits, we concluded that they also needed to do additional work to prepare the fresh 8,000 fuel rods required to restart the reactor. During one of my visits to Yongbyon, I was shown the fresh fuel rods produced before the Agreed Framework but never used. The North Koreans had 1,700 clad fuel rods ready to load in the 5-MWe reactor and another 12,000 bare fuel rods originally fabricated for the 50-MWe reactor under construction before the Agreed Framework. These 12,000 fuel rods are roughly 10 percent longer than the 5-MWe fuel rods, but we were told stacking nine sets, instead of 10, into the reactor core, could work. However, the bare uranium metal alloy rods will have to be clad with magnesium alloy. If they still have the requisite facilities operational, this may require six months to a year unless they run into unanticipated problems. They may also already have done some of the requisite works while the reactor was in standby.

**Q: How much plutonium could it make?**

**Hecker:** If they restart the reactor, they can produce about 6 kilograms of plutonium (roughly one bomb's worth) per year. What they may do is to run the reactor for two to four years, withdraw the spent fuel, let it cool for six months to a year, and then reprocess the fuel to extract the plutonium. In other words, from the time they restart the reactor, it would take roughly three to four years before they could harvest another 12 kilograms of plutonium. The bottom line is that this is a slow process.

**Q: Can they make 6 kilograms plutonium annually after that?**

**Hecker:** They only have enough fresh fuel for one full reactor load. They have perhaps another half a load of bare fuel rods beyond that. So, they would have to produce more fuel rods and clad them in order to keep producing plutonium in the reactor beyond the first two years. It is also interesting to note that they gutted the fuel rod metal fabrication plant and converted it into the new centrifuge facility they showed us in 2010. I am sure they moved the key pieces of equipment somewhere else. But since they converted the metal fuel fabrication building, they would have to reinstall the requisite equipment to make more metal fuel. They would also

require improved capabilities to make uranium hexafluoride, the precursor for uranium metal, since the initial capabilities had corroded beyond repair during the Agreed Framework. To get it all restarted would take quite a bit of work, but they would have several years to get the job done before they need the second load of fresh fuel rods. I don't think these are insurmountable obstacles.

**Q: How big is North Korea's plutonium stockpile?**

**Hecker:** After our 2010 visit, I estimated that they had 24 to 42 kilograms of plutonium, roughly four to eight bombs worth. If the 2013 nuclear test used plutonium, then they may have 5 or 6 kilograms less now. Because they have so little plutonium, I believed that they might have turned to uranium enrichment to develop the HEU path to the bomb as an alternative.

**Q: What about the reprocessing facility? Has it been in standby and can they restart it?**

**Hecker:** In 2009 they reprocessed the plutonium produced during the reactor campaign that ended in July 2007. They did so right after they expelled IAEA inspectors and the American technical team, which had been given access during a year of rapprochement in 2008. We were told in 2010 that the reprocessing facility was in standby. I expect that they have kept it maintained because they would have to restart it to process and package the waste from all three previous reprocessing campaigns. In any case, they won't need it for about three years or so, the time that it takes to run the reactor and then cool the spent fuel rods sufficiently so they can be handled to move them to the reprocessing facility.

**Q: Could they make plutonium for bombs in the experimental light-water reactor?**

**Hecker:** It's possible, but there are several obstacles. First, it is not yet operational and likely won't be for another 18 months to two years. This reactor has to be fueled with uranium oxide ceramic fuel pellets typically clad in a zirconium alloy. North Korea had little or no experience in any of these technologies prior to 2010. The fuel will also have to be enriched in Uranium-235 to a level of 3 to 5 percent, what we call LEU. During the 2010 visit they told us that they built the Yongbyon centrifuge facility to make LEU fuel for the LWR. As mentioned above, the reactor will not be operational for nearly two years. This would give them enough time to prepare the fuel. However, to get good weapons-grade plutonium, they would have to run the reactor for very short time periods so as not to accumulate plutonium isotopes, which make weapon production more difficult. That means they will have to constantly be making and loading new fuel. Another complication is that the reprocessing facility would need some technical modifications to reprocess the ceramic LWR spent fuel, compared to the metallic 5-MWe gas-graphite reactor spent fuel.

**Q: So you think it's unlikely that they will use the LWR for bombs?**

**Hecker:** Yes, it's possible, but unlikely. That is exactly why they are threatening to restart the old 5-MWe reactor. That one is good for bombs and bad for electricity. The LWR is good for electricity, but bad for bombs.