Nuclear Proliferation Concerns – The North Korea Case

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The genesis of DPRK's nuclear aspirations can be traced to the aftermath of the Korean War. To develop its own nuclear capability, North Korea initiated the building of a strong national cadre of nuclear technicians and scientists, which were trained mainly in the former Soviet Union. In 1955, North Korea founded the Atomic Energy Research Institute. The Soviets also helped the North Koreans establish a nuclear research center and built a 2 MWth IRT nuclear research reactor at Yongbyon, which began operation in 1969.

Throughout the 1970s, the DPRK continued to develop its nuclear capabilities, pursuing a dual track approach that was consistent with the idea of nuclear self-reliance, the Juche Ethos. While engaging in discussions to obtain Light Water Reactors (LWRs) from the Soviet Union, North Korea initiated parallel studies on graphite moderated gas cooled reactors by using publicly available information based on the British Magnox reactor design. In the 1970s, North Korea also carried outits first plutonium separation experiments at its newly built Isotope Production Laboratory (IPL). The North Koreans designed a reprocessing plant, which the chemical process was modeled after the Eurochemic plant. When negotiations to acquire four LWRs from the Soviet Union failed in mid-1980s, North Korea had already embarked on its indigenous nuclear program by constructing, the 5MWe reactor, a fuel fabrication plant, and a reprocessing plant at Yongbyon, with no known documented external help and with minimal foreign equipment procured. When the joint statement on the Denuclearization of the Korean Peninsula was concluded in December 1991, all three facilities had been operational for a number of years, with two additional (50 MWe and 200 MWe) graphite moderated gas cooled reactors were under construction.

The Juche thesis of Kim Il Sung stresses independence from great powers, a strong military posture, and reliance on national resources. Faced with an impoverished economy, political isolation from the world, and rich uranium deposits, nuclear power—both civilian as well as military—fulfills all three purposes.

This paper addresses the acquisition of nuclear technology by North Korea, and how it also became a nuclear proliferator providing Syria with gas-cooled graphite moderated reactor.

Uranium Enrichment Program

After expelling IAEA inspectors, North Korea announced in April 2009 for the first time that it was proceeding with its own uranium enrichment program. To reinforce its intentions, North Korea followed up with a letter to the UN Security Council in September of 2009 to confirm that

it was embarking on an enrichment phase. In November 2010, the North Koreans unveiled to Professor Siegfried Hecker[1], the Uranium Enrichment Workshop (UEW) in Yongbyon with 2000 centrifuge machines similar to the Pakistani P-2 centrifuge, built with maraging steel rotors. The scale, level of sophistication, and brazenness for the North Koreans to have built a (until then) secret enrichment facility at the same site of a previously IAEA-monitored building, took the international community by surprise. The plant is proof of North Korea's steady pursuit to include uranium enrichment as part of its domestic nuclear fuel cycle.

Before the 2009 North Korean announcement, the former Pakistani President General P. Musharraf had written in his memoirs, *In the Line of Fire*, that North Korean engineers were provided training at A.Q. Khan's Research Laboratories in Kahuta under the auspices of a government-to-government deal on missile technology. He also said that North Korea had received a small number of P-1 and P-2 centrifuges, special oils, and other equipment flowed from Pakistan. It has been speculated that Pyongyang had also received the blueprints for centrifuges and other related process equipment from the A.Q. Khan.

However, an earlier sign of possible North Korean interest to uranium enrichment exists. In the late 1980s North Korea acquired vacuum equipment from European companies. While such equipment was primarily meant for North Korea's fuel fabrication plant then under construction, some of the vacuum pumps and valves had specifications that could have been useful for uranium enrichment experiments. These procurement efforts were coordinated through the DPRK's Embassies in (East) Berlin and in Vienna. Mr. Yun Ho Jin, a North Korean diplomat based then in Vienna, was a key figure in organizing meetings with European vendors. His name emerges also in later proliferation cases[2].

North Korean companies involved in the 1980s acquisitions were Lyongaksan, and Daeson 6th Trading Corporation. The leadership and engineers of the Chongchongang Chemical Plant, whose location is not known, were also involved.

Information on North Korea's procurement activities in the late 1990s to the early 2000s showed its objective was to achieve a semi-industrial[3] scale enrichment capacity based on the Pakistani P-2 centrifuge design. In 1997, the North attempted to acquire large amounts of maraging steel suitable for manufacturing centrifuge rotors. In 2002/2003, Pyongyang was successful in procuring large quantities of high strength aluminum from Russia and the United Kingdom. A simple tally of the amounts and types of equipment and material sought by North Korea suggests that it planned to develop, at least, an A.Q. Khan HEU production scheme, which requires about 5900 centrifuges. That means a 5000 centrifuge strong enrichment capacity. (The rest is spares and those which do not pass quality control tests.)[4]

This appears not only consistent with a separate earlier enrichment offer A.Q. Khan had made to Libya, but the timing and pattern of acquisitions is also interesting. Iran, Libya and North Korea appear to have started initial acquisition of enrichment technology through vendors in Europe around 1987. Then, between 1993 and 1996, these countries turned to the A.Q. Khan network and acquired larger deliveries of raw materials and probably also obtained more advanced P-2 technology. It is also interesting to note that during this time frame, A. Q. Khan also contacts

with the Syrian authorities, which went, however, later to acquire graphite moderated gas cooled reactor.

Implications of North Korea's Enrichment Capabilities

The North Korean uranium enrichment efforts raise several questions. What is the actual size of its enrichment program? Are there other facilities than the UEW? Has North Korea been producing highly enriched uranium? Is North Korea proliferating; sharing the enrichment technology and providing enriched uranium to others? Is North Korea also developing nuclear weapons based on uranium?

It is highly likely that the UEW at Yongbyon is not the only uranium enrichment installation in North Korea. At least one other workshop would have been needed to serve as a testing facility bed P-1 and P-2 centrifuge cascades prior to the beginning of semi-industrial scale enrichment operations, which are seen at the UEW. Such an installation should have a few hundred centrifuges.

While no uranium hexafluoride (UF6) fabrication plant has been located in the DPRK, its existence has been traced as far back as 2000, when subsequent investigations revealed that North Korea had shipped UF6 to the Libyan enrichment program[5].

Concerns over enrichment of uranium to higher levels were prompted by the detection of HEU particles from aluminum samples handed over by the North Koreans to a US monitoring team in 2007 as part of the Six Party Talk agreement[6]. As contamination could have resulted from either tainted imported centrifuge equipment or from indigenous enrichment, its source remains unknown.

If commissioning of the UEW had been successful after the visit of Mr. Hecker, North Korea would have at present at least 3.5 tons of UF6, enriched to 3.5% U-235. This output is consistent with the annual needs of the 100 MWth LWR currently under construction. By 2013, there should be enough material, about four tons of uranium dioxide (UO2), for the first core of the 100 MWth LWR.

Such an enrichment plant could also be easily modified to produce HEU for nuclear explosives. Institute for Science and International Security, Washington DC, (ISIS), has recently completed a thorough analysis on possible stocks of plutonium and high enriched uranium in North Korea.[7]They conclude that by the end of 2011, North Korea had weapons grade uranium for 0 to 11 nuclear weapons, which, together with the estimates on existing plutonium inventories, meant that North Korea may have then had fissile material enough for 12 to 23 nuclear weapons.

What is the nuclear future of North Korea? There are several options with regard to uranium enrichment; enrich uranium only for the civilian LWRs, take the advantage of the civilian LWR to produce plutonium for military purposes, or dedicate uranium enrichment for military purposes only. A key question is whether North Korea would ramp up its enrichment capacities and to which extent. Those options and implications are illustrated in the ISIS paper, which

estimates that by 2016 North Korea can have fissile material stocks from 12 to 48 nuclear weapons depending on the scenario chosen by the DPRK.

Nuclear exports of North Korea

It appears that North Korea provided through the A. Q. Khan network Libya with 2 tons of UF6[8]. However, the plan was to deliver 20 tons of UF6, but it never got delivered due to the fact that Libya abandoned its nuclear weapons program in 2003. North Korea has also provided, at least, small quantities of UF6 to Pakistan. The fact that North Korea is now also proceeding towards the production of fissile material and its stocks are sufficient for a deterrence increases risks of selling, under difficult economical situation, enriched uranium or plutonium albeit the risks to be caught could be high.

The friendly relations between the DPRK and Syria originate from the Korean War, where Syrian military fought with the side of North Korea. In 2002, intelligence agencies noted top level Syrian, Iranian, and North Korean officials meeting in Damascus[9]. Harder evidence surfaced in 2006 when Israeli agents reportedly tapped to a lap top of a Syrian official extracting a wealth of information related to a nuclear reactor under construction in Syria[10]. This information[11] had clear evidence on the involvement of North Korea to a reactor at Al Kibar/Dair Alzour, which was destroyed in an Israeli air raid in September 2007. The full picture of the reactor project still remains to be revealed. The IAEA has requested to have access to three other sites in Syria, but the Syrian authorities have denied the access[12]. These sites could have been involved, inter alia, to fuel fabrication and spent fuel handling. However, North Korea should have been the most likely source of the first core loading of the Dair Alzour reactor. The whereabouts of fuel are unknown, but there has not been indications that the fuel had been manufactured in the fuel fabrication plant at Yongbyon.

There have been speculations about the involvement of Iran to nuclear activities and the Al Kibar project in Syria[13]. It has been claimed that Iran and North Korea have been cooperating in nuclear weapon design and testing[14], but hard evidence to that end is missing. However, we should note that the A.Q. Khan network had information related to nuclear weapon design including some more detailed documentation on latest Pakistani nuclear weapons available to its clients.

In recent years concerns have been raised regarding possible nuclear cooperation between North Korea and Myanmar[15]. The defectors interviewed have provided photography to support their claims. The images show equipment, which could be useful for uranium compound production, but they can also be applicable for non-nuclear purposes. Myanmar has denied allegations, but has not provided the IAEA access to sites, which the Agency has requested. In September 2011, Amb. Tin Win stated in the IAEA General Conference that ".. Myanmar is in no position to consider the production and use of nuclear weapons..." and that ".. Myanmar has halted its previous arrangement of nuclear research as international community may misunderstand Myanmar over the issue. The U.S. Government has raised its concerns with Myanmar. Amb. Glyn Davis recently stated that Myanmar is on right track over its arms ties with North Korea[16], but without providing any details.

China's role

In the 1980s China provided valuable support to the Pakistani nuclear weapons program by providing, inter alia, information on nuclear weapon design. In 1992, China provided Iran not only with nuclear technology, but also with two tons of uranium compounds which Iran used in its unreported uranium conversion and enrichment activities. When the IAEA inquired prior to 2003, about the possible delivery of such materials to Iran, China avoided to confirm the shipments.

During the 1990s, China started to strengthen its non-proliferation regime under international pressure. Although Chinese companies succeed to bypass export controls and sanctions, this can be seen more due to weak enforcement of the regulations rather than tacit authorization of the sales by the Chinese government[17]. It is also worth of noting that China is often seen as a transfer point for an intermediary dealing with, e.g. North Korea, Pakistan or Iran.

Conclusion

North Korean has been able, in spite of economical hardship, sanctions, and international isolation to develop indigenous independent uranium and plutonium based fuel cycle relying largely on its own resources. As a result, the international community does not know the entire content and status of its nuclear program.

North Korea has proliferated its nuclear technology and material to other countries through secret and largely bilateral deals, which are difficult to control. Like Iran, North Korea has taken the advantage of weak export control systems. There are indications, which remain to be confirmed, that North Korea might have received and provided others also with sensitive technologies related to nuclear weapon design.

There has been no easy solution to stop North Korea's proliferation risk and the nuclear challenge it continues to pose to its neighbors. North Korea's nuclear status and its possible next steps remain a potential flashpoint. But since one does not choose one's neighbors, countries in the region will have to continue to work together to, at the very least, manage any potential crisis scenarios with North Korea.

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[1] S. S. Hecker, "A Return Trip to North Korea's Yongbyon Nuclear Complex," Center for International Security and Cooperation, Stanford University, November 20, 2010.

[2] J. Solomon, "North Korean Pair Viewed as Key to Secret Arms Trade," *The Wall Street Journal Asia*, August 31, 2010.

[3] Semi-industrial enrichment plants are used to demonstrate that the process is working properly before proceeding with a full scale expensive investment. In the chemical industry, this is often called to a pilot plant. Semi-industrial plants have customarily about 1000 centrifuges when the full size enrichment plants can have tens of thousands of centrifuges.

[4] The total number could be as high as 7000 centrifuges, but a reserve for the replacement of failed centrifuges and small test cascades is also required.

[5] Application of Safeguards in the Democratic People's Republic of Korea, IAEA, Board of Governors General Conference, GOV/2011/53 – GC(55)24, September 2, 2011.

[6] G. Kessler, “New Doubts On Nuclear Efforts by North Korea,” *Washington Post*, March 1, 2007

[7] D. Albright and C. Walrond, North Korea’s estimated stocks of plutonium and weapon-grade uranium, ISIS, August 16, 2012.

[8] Implementation of the NPT Safeguards Agreement of the Socialist People’s Libyan Arab Jamahiriya, IAEA, GOV/2004/12, February 20,2004.

[9] Y. Katz and Y. Hendel,Israel vs Iran, The shadow war.Potomac Book, Washington, D.C., 2012, page 65.

[10] Y. Katz and Y. Hendel,Israel vs Iran, The shadow war.Potomac Book, Washington, D.C., 2012, page 66.

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[15] R. Kelley, Burma-DPRK Cooperation in Military Affairs, 38 North, May 5, 2011.

[16] U.S. says Myanmar “on right track” over North Korea arms ties, Reuters, October 22,2012.

[17] John Pomfret, Chinese firms bypass sanctions on Iran, U.S. says, October 18, 2010.

For Academic Citation:

Heinonen, Olli. "Nuclear Proliferation Concerns- The North Korea Case." November 2, 2012.