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IMAGERY BRIEF

Correlating the Operation of the Coal Plant to Reprocessing Activities at Yongbyon

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As of April 2016, there are growing indications that North Korea has separated, is separating, or will soon be separating plutonium from irradiated fuel at the Radiochemical Laboratory, a process commonly referred to as reprocessing. The irradiated fuel is from the 5 megawatt-electric (MWe) reactor, which restarted in 2013. As highlighted in a previous report, a government official who monitors the situation closely stated to the Institute for Science and International Security (ISIS) that it is possible that North Korea may have already started reprocessing the spent fuel from the reactor. Figure 1 shows the Radiochemical Laboratory site. Figure 2 is a close up of the Radiochemical Laboratory, which shows vehicle activity.

However, the absence of clear external signatures makes it difficult to confirm plutonium separation activities with commercial satellite imagery alone. In addition, the few plutonium separation signatures that exist can be hidden from visual observation.

An important signature often associated with reprocessing activities at the Radiochemical Laboratory is the status of the nearby coal fired steam generation plant. This coal plant is not a source of heat for the buildings at the Radiochemical Laboratory, as some have suggested; rather it is the source of industrial steam for the reprocessing activities taking place at the plant.[1]

According to Ri Hong Sop, the then Director of the Yongbyon Nuclear Center interviewed in Pyongyang by David Albright in 2007, North Korea "does not like to let others know when we are reprocessing." Therefore, he said North Korea took steps to hide activities related to plutonium separation, making it even more difficult to determine when such separation took place. Ri explained that the coal plant is rarely operational. He said that little steam is needed in the processes to separate plutonium. However, he also said that a large amount of steam is needed when the plant processes liquid radioactive wastes, which occurs after plutonium is separated.[2] One of the main uses of the steam is to generate heat for nuclear waste minimization and solidification. Thus, the steam is mainly used to address the aftermath of plutonium separation.

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[1] The analysis of historical imagery shows no correlation between the activities of the coal fired steam generation plant and low temperatures. Additionally, the recent 2016 imagery, which showed exhaust venting from the plant's stack, was taken on days in which the temperatures oscillated between 40° and 60°F, high enough to not require any heating, particularly in a country which regularly does not provide heat to government buildings in the winter months.

[2] See David Albright and Paul Brannan, "The North Korean Plutonium Stock, February 2007," ISIS Report, February 20, 2007, http://isis-online.org/uploads/isis-reports/documents/DPRKplutoniumFEB.pdf

A historical analysis of a large archive of commercial satellite imagery shows that this plant rarely operates, as would be expected if its main function is to provide heat to reprocessing operations. During the last 15 years, the Radiochemical Laboratory has rarely processed irradiated fuel. The imagery shows that the coal plant was active in January 2003, September 2005, and February, March, and April 2016 (see figures 2, 3, and 4). Both the January 2003 and September 2005 dates coincide with moments in which North Korea was suspected of reprocessing spent fuel from the 5 MWe reactor.

North Korea declared that it unloaded the core of the 5 MWe reactor twice, in 1994 and 2005.[3] After the 1994 unloading, the reactor's irradiated fuel was stored at the reactor site under a special storage arrangement for years. In 2003, after the collapse of the 1994 Agreed Framework, North Korea restarted the Radiochemical Laboratory. North Korean officials stated that the Radiochemical laboratory operated during the first six months of 2003 and in that period processed all of the approximately 8,000 stored irradiated fuel rods.[4] In addition, the only time there were reports of the detection of the noble gas krypton-85, a tell-tale emission during reprocessing, was a result of this 2003 reprocessing campaign.[5] In this case, the operation of the coal plant appears to have coincided with the start of reprocessing, and North Korea may have used the restarted coal plant to also signal that it was processing the irradiated fuel.

The 5 MWe reactor was restarted in early 2003, before or soon after plutonium separation started, and operated consistently according to analysis of commercial satellite imagery. The reactor was shut down in March 2005 to unload the fuel. After several weeks of cooling, the spent fuel was sent to the Radiochemical Laboratory and reprocessed starting in June 2005.[6] Satellite imagery shows that the coal plant was active in September 2005, thus supporting that reprocessing occurred, although in this case, plutonium separation may have occurred prior to the operation of the coal plant.

The 5 MWe reactor restarted, with a fresh core, in June 2005 and operated until 2007 when it was shut down as part of the agreements reached in the Six Party Talks. Subsequently, North Korea withdrew irradiated fuel from the reactor's core. As part of this agreement, North Korea also destroyed the 5 MWe reactor's cooling tower in June 2008. However, the agreement collapsed in 2009, and North Korea subsequently stated that it had restarted the plutonium separation plant and processed all the irradiated fuel in the last reactor core, extracting the plutonium.[7] Unfortunately there is not enough commercial satellite imagery available to determine the status of the coal plant during this timeframe.

This analysis indicates that the activity of the coal plant is correlated to reprocessing, but it remains unclear what its exact temporal relationship is to plutonium separation. Hence, it is difficult to determine whether the February, March, and April 2016 activity of the coal plant indicates that plutonium separation has occurred, is occurring, or will occur in the near future.

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[3] Although North Korea insists that the 1994 core was the original one that had been in the reactor since 1986, it is important to note that in 1994 IAEA inspectors found evidence that another core could have been discharged several years earlier, and the plutonium separated, when inspectors were not permitted to inspect the facilities at Yongbyon. Albright and Kevin O'Neill, *Solving the North Korean Nuclear Puzzle* (Institute for Science and International Security Press: Washington, D.C., 2000).

[4] Between 1994 and 2003, North Korea froze its plutonium production program under the Agreed Framework with the United States. Under this agreement, North Korea shut down the 5 MWe reactor and the Radiochemical Laboratory.

[5] See "The North Korean Plutonium Stock, February 2007," op. cit.

[6] See "The North Korean Plutonium Stock, February 2007," op. cit.

[7] See David Albright and Christina Walrond, "North Korea's Estimated Stocks of Plutonium and Weapon-Grade Uranium," ISIS Report, August 16, 2012, http://isis-online.org/uploads/isis-reports/documents/dprk_fissile_material_production_16Aug2012.pdf.

Determining when reprocessing is occurring becomes increasingly complicated also because of the difficulty of detecting the amount of fuel North Korea has unloaded from the 5 MWe reactor. At the end of 2014, about one year after the reactor's 2013 restart, there were some indications of fuel being unloaded.[8] However, not only were these indications ambiguous, what also remains unknown is North Korea's fuel re-loading strategy. Is North Korea still unloading the full core of fuel and then replacing it with fresh fuel? Or is it unloading part of the core while the reactor continues to operate, a strategy which is in line with fuel-loading strategies for this type of reactor?

Thus, the analysis supports that plutonium separation has or will likely happen. But considering only the operation of the coal plant makes it hard to be more precise. There are several possibilities:

- Waste from the previous reprocessing campaigns is now being processed to reduce volume or solidified in order to make room for more waste that would be generated in a new plutonium separation campaign slated to start soon;
- Some of the nuclear waste storage tanks are heated to avoid crystallization of chemicals;
- Temperatures in various processes are being adjusted as part of the preparation for operations; or
- Plutonium separation has occurred and the steam is being used to process waste.

Combined with increased activity at the Radiochemical Laboratory visible in imagery, the operation of the coal plant suggests that reprocessing has started or will soon start. In any case, reprocessing in the current period would be in line with the timeframe suggested by Director of National Intelligence James R. Clapper on February 9, 2016, where he said: "We further assess that North Korea has been operating the reactor long enough so that it could begin to recover plutonium from the reactor's spent fuel within a matter of weeks to months." Clapper's statement, the government official's comment above, and the recent activity of the coal plant raises concern that the plutonium separation has indeed started or will start soon. But the operation of the coal plant suggests that plutonium separation is now inevitable, even if we cannot predict exactly when it will happen.

[8] See David Albright and Serena Kelleher-Vergantini, "Yongbyon: Monitoring Activities during the Shutdown of the 5 MW Reactor," ISIS Report, December 5, 2014, http://isis-online.org/isis-reports/detail/yongbyon-monitoring-activities-during-shutdown-of-5-mw-reactor/10#images.

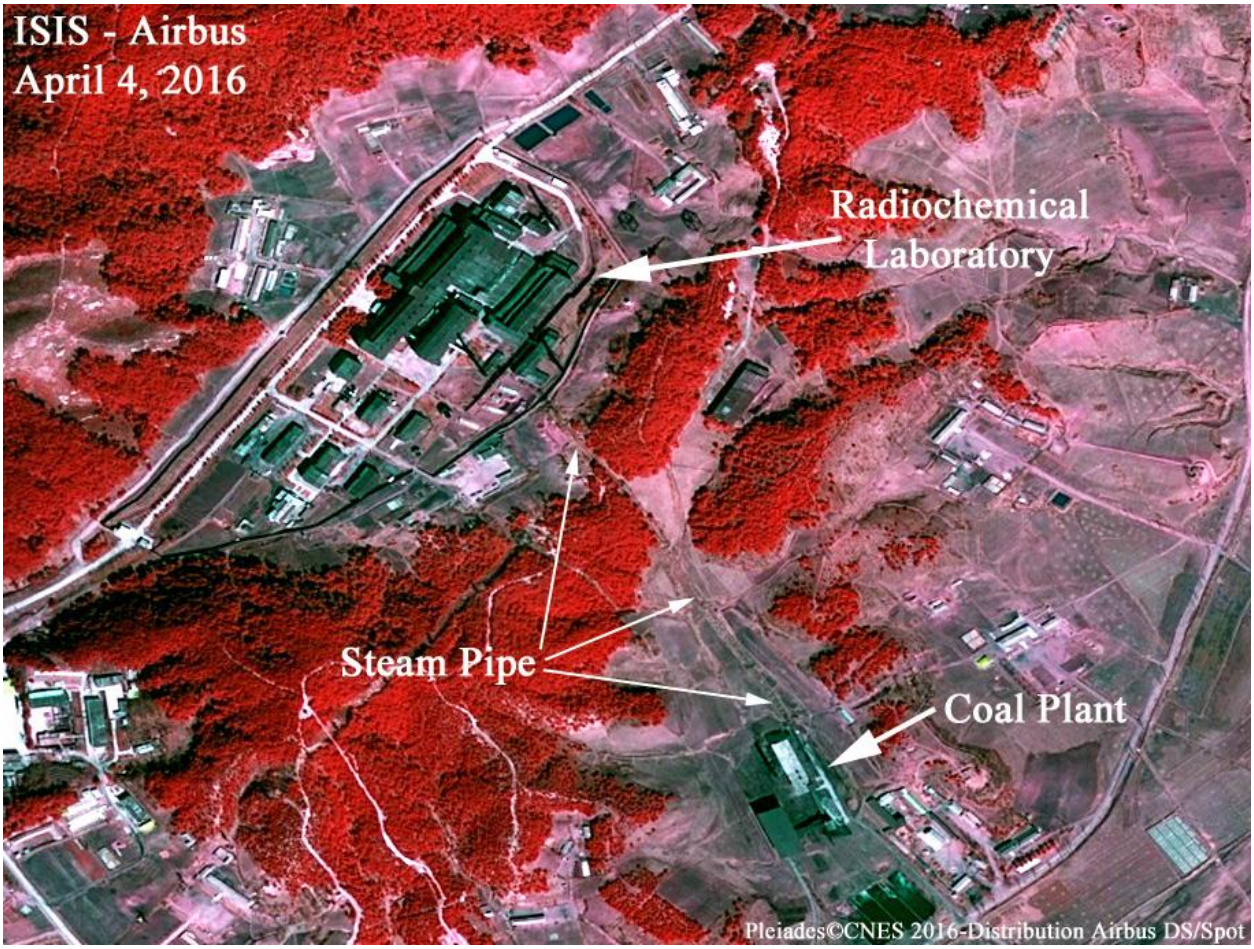

Figure 1. Airbus imagery showing North Korea's Radiochemical Laboratory and Coal Plant on April 4, 2016. The image has false coloring in which healthy vegetation appears red.

Figure 2. Airbus imagery showing North Korea's Radiochemical Laboratory on April 4, 2016.

Figure 3. North Korea's coal fired steam generation plant at Yongbyon on January 28, 2003.

Figure 3. North Korea's coal fired steam generation plant at Yongbyon on September 11, 2005.

Figure 5. North Korea's coal fired steam generation plant at Yongbyon on April 4, 2016.