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Cyber Attack, What Cyber Attack?
Iran's Rate of Enriched Uranium Production Remains Steady:
Centrifuge Enrichment and the IAEA February 25, 2011 Update

In seven previous reports, this author has outlined how Iran's growing centrifuge enrichment program could provide it with the ability to produce fissile material for nuclear weapons.[1] On February 25, 2011, the International Atomic Energy Agency (IAEA) released a further safeguards update.[2] This update shows that Western efforts to impede Iran's centrifuge enrichment program continue to be ineffective. Iran is maintaining a steady enriched uranium production rate of about 90 kilograms of 3.5% enriched uranium per month as well as about 2.5 kilograms of 19.7% enriched uranium per month.[3] Despite repeated press reports of cyber attacks in 2009 having slowed Iran's enrichment efforts, Iran's production rate of 3.5% enriched uranium actually represents a 60% increase over Iran's 2009 production rate.

As of February 5, 2011, Iran had produced 2,448 kilograms of 3.5% enriched uranium (in the form of 3,606 kilograms of uranium hexafluoride). With this quantity of 3.5% enriched uranium, Iran could produce more than the 20 kilograms of highly enriched uranium (HEU) needed for a nuclear weapon by batch recycling at the Fuel Enrichment Plant (FEP) at Natanz. With Iran's current number of operating centrifuges the batch recycling would take a little more than two months once Iran decided to initiate the process.

Iran has already started the process of converting its stockpile of 3.5% enriched uranium into the HEU needed for nuclear weapons, as is evidenced by its production of 19.7% enriched uranium. This is an intermediate step on the road to the production of HEU. As of February 11, 2011 Iran had accumulated a stockpile of about 29.5 kilograms of 19.7% enriched uranium (in the form of 43.6 kilograms of uranium hexafluoride). As of mid-February about 260 kilograms of 3.5% enriched uranium had already been processed into 19.7% enriched uranium, making Iran's stockpile of 3.5% enriched uranium about 2,200 kilograms. As Iran's stockpile of 19.7% enriched uranium continues to grow, the time required for it to be able to produce a weapons worth of HEU will continue to decline.

Iran has three known centrifuge enrichment facilities. Iran's main facility is the FEP at Natanz. The basic unit of Iran's centrifuge enrichment effort is a cascade which consists of 164 centrifuges, though Iran has begun to modify some cascades by increasing the

[1] My most recent prior report is: "Iran's Rate of Enriched Uranium Production Continues to Increase: Centrifuge Enrichment and the IAEA November 23, 2010 Update," November 30, 2010, http://www.npec-web.org/article_file/Irans_Rate_of_Enriched_Uranium_Production_140211_1436.pdf

[2] *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, GOV/2011/7, February 25, 2011.

[3] Iran has maintained its current production rate of 3.5% enriched uranium for the last six months and its current production rate of 19.7% enriched uranium for the last year. Note, to avoid problems with the fact that the length of a month is variable, we have adopted a uniform month length of 30.44 days.

number of centrifuges to 174 (all centrifuges installed up to now have been of the IR-1 type). Each cascade is designed to enrich natural uranium to 3.5% enriched uranium. As of February 20, 2011, Iran had installed 53 cascades containing approximately 8,000 centrifuges at the FEP. Of these 53 cascades, only 31 (containing 5,184 centrifuges) were being fed with uranium hexafluoride and therefore producing 3.5% enriched uranium.[4]

Also at Natanz, Iran has the Pilot Fuel Enrichment Plant (PFEP) which is used to test a number of more advanced centrifuge designs. These are usually configured as single centrifuges or small ten or twenty centrifuge test cascades. However, Iran has indicated that it plans to install two full cascades containing more advanced centrifuges (one cascade using IR-4 centrifuges and one cascade using IR-2m centrifuges) which could significantly increase the rate of Iran's production of 3.5% enriched uranium. In addition, there are two full cascades each with 164 IR-1 type centrifuges at the PFEP. These two cascades are interconnected and are being used to process 3.5% enriched uranium into 19.7% enriched uranium. Iran began producing 19.7% enriched uranium at the PFEP in February 2010.

Finally Iran is constructing an enrichment facility near Qom. Known as the Fordow Fuel Enrichment Plant (FFEP), this plant's construction was started clandestinely in violation of its IAEA safeguards. Its existence was only revealed by Iran in September 2009 after Iran believed that the plant had been discovered by the West. No centrifuges have yet been installed at FFEP.

Given that Iran has 5,184 centrifuges in operation at the FEP and stockpiles of about 2,200 kilograms of 3.5% enriched uranium and 29.5 kilograms of 19.7% enriched uranium, it can use batch recycling at the FEP to produce the HEU needed for a nuclear weapon. This process is illustrated in Table 1.

Two steps are required. In the first step, 3.5% enriched uranium is enriched to 19.7% enriched uranium. Iran would need to produce 158.2 kilograms of 19.7% enriched uranium (including 5 kilograms for the plant inventory in the second step). However, since it has already produced 29.5 kilograms of 19.7% enriched uranium, Iran would need only to produce an additional 128.7 kilograms. This step would require 1,520 kilograms of 3.5% enriched uranium as feed but Iran's current stockpile well exceeds this figure. In the second step, the 19.7% enriched uranium would be further enriched to the 90% level suitable for a nuclear weapon. Using Iran's currently operating centrifuges at the FEP, the batch recycling would take little more than two months.

Note however, that there would be nothing illegitimate about the first step of this process since Iran's current production of 19.7% enriched uranium at the PFEP has established

[4] The IAEA's description of the number of centrifuges being fed with uranium hexafluoride is rather ambiguous: "The 31 cascades being fed with UF_6 on that date contained a total of 5184 centrifuges, some of which were possibly not being fed with UF_6." *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, GOV/2011/7, February 25, 2011, p.3.

the principle that Iran is permitted to produce and possess such material. Only at the second step would Iran have violated the NPT but as the second step takes only about two weeks, there would be very little time for Western counteraction before the process was completed. Indeed since the FEP is not continuously monitored by the IAEA, the process could be well along or even completed before it was discovered.

Table 1

Time, Product and Feed Requirements for the Production of 20 kg of HEU by Batch Recycling at the FEP (31 Operating Cascades, 5,184 Centrifuges, 0.89 SWU per Centrifuge-Year)

Cycle	Product Enrichment and Quantity	Feed Enrichment and Quantity	Time for Cycle (Days)
First	19.7% 128.7 kg	3.5% 1,520 kg	49
Second	90.0% 20 kg	19.7% 153.2 kg*	12
Total			65**

* Includes 29.5 kilograms of 19.7% enriched uranium that Iran has already stockpiled.
**Includes four days to account for equilibrium and cascade fill time.

Nor is batch recycling of enriched uranium at the FEP the only pathway for Iran to produce the fissile material required for nuclear weapons. Iran could produce HEU at a clandestine enrichment plant. Since Iran continues to refuse to implement the Additional Protocol to its safeguards agreement, the IAEA would find it very difficult to locate a clandestine enrichment plant—a fact that the IAEA has confirmed.[5] While this has been a theoretical possibility since 2007, the discovery in September 2009 that Iran was actually building such a clandestine enrichment plant (the FFEP near Qom) has increased the salience of this concern.

A clandestine enrichment plant containing 23 cascades (3,772 centrifuges, 0.89 SWU per machine-year) could produce around 20 kilograms of HEU (the amount required for one nuclear weapon) each year. Since this option does not require any overt breakout from safeguards, the relatively slow rate of HEU production would not necessarily be of any concern to Iran. Such production could be going on right now and the West might well

[5] "While the Agency continues to verify the non-diversion of declared nuclear material at the nuclear facilities and LOFs declared by Iran under its Safeguards Agreement, Iran is not providing the necessary cooperation to enable the Agency to provide credible assurance about the absence of undeclared nuclear material and activities in Iran, and therefore to conclude that all nuclear material in Iran is in peaceful activities." *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, GOV/2011/7, February 25, 2011, p.10.

not know. A clandestine enrichment plant would need a source of uranium but Iran is producing uranium at a mine near Bandar Abbas.[6] Since Iran has refused to implement the Additional Protocol to its IAEA safeguards, this uranium mining is unsafeguarded and the whereabouts of the uranium that has been produced there is unknown.

A clandestine 23 cascade enrichment plant could also be used to convert Iran's stockpile of 3.5% enriched uranium into the HEU required for weapons. The 20 kilograms of HEU needed for a weapon could be produced in about four and one half months.[7] Further only about 600 kilograms of 3.5% would be required to produce 20 kilograms of HEU, so that current stockpile of about 2,200 kilograms of 3.5% enriched uranium would be more than enough for three weapon's worth of HEU, though this entire process would take more than one year to complete. Additionally, using its current stockpile in this fashion would require Iran to violate IAEA safeguards. The time required could be shortened by assuming that the clandestine enrichment plant contains more that 23 cascades but a very large clandestine enrichment plant appears to be implausible currently, given Iran's resources.

Overall Iran continues to make increasingly rapid progress towards acquiring the ability to produce fissile material for nuclear weapons completely unimpeded by any Western counteraction. While one can argue about the existence of possible Iranian clandestine enrichment facilities, the ability of Iran to produce HEU by batch recycling at the FEP at Natanz is undeniable. Using its current stockpiles of 3.5% enriched uranium and 19.7% enriched uranium, Iran can now produce a weapon's worth (20 kilograms) of HEU any time it wishes. With Iran's current number of operating centrifuges, the batch recycling process would take a little more than two months. As Iran produces additional 19.7% enriched uranium and/or brings additional centrifuges on line, this time will only decrease.

In the past few months there have been a number of articles in the press claiming that cyber attacks have significantly slowed Iran's uranium enrichment effort. However, as I have discussed elsewhere, Iran's rate of production of 3.5% enriched uranium belies these claims.[8] Iran is currently producing 3.5% enriched uranium at a rate that is 60% higher than it was in 2009 when these cyber attacks supposedly took place.

The reality is that the U.S. has failed to prevent Iran from gaining the ability to produce nuclear weapons whenever Iran wishes to do so. It is time to recognize this policy failure and decide what to do next, based on a realistic assessment of Iran's uranium enrichment efforts.

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[6] *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions in the Islamic Republic of Iran*, GOV/2011/7, February 25, 2011, p.9.

[7] Using tails of 0.4%.

[8] Gregory S. Jones, "The Pleasures of Self-Deception: The Fiction That Cyber Attacks Have Slowed Iran's Drive for Nuclear Weapons", January 26, 2011, http://www.npec-web.org/article_file/The_Pleasures_of_Self-Deception_Fiction_010211_1501.pdf