

ISIS REPORT

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ISIS Analysis of IAEA Iran Safeguards Report: Production of 20% Enriched Uranium Triples; Iran Increases Number of Enriching Centrifuges at Natanz FEP by Nearly 50% and Signals an Intention to Greatly Expand the Number of Centrifuges at Both Natanz and Fordow; Advanced Centrifuge Program Appears Troubled

by David Albright, Paul Brannan, and Christina Walrond

The International Atomic Energy Agency (IAEA) released on February 24, 2012 its latest report on the implementation of NPT safeguards in Iran and the status of Iran's compliance with Security Council resolutions. The following analysis highlights the IAEA's key findings, including: (1) Iran achieves a near three-fold increase in production of 19.75 percent LEU at Natanz and Fordow; (2) Iran installs approximately 8,000 additional IR-1 centrifuge casings at Natanz and Fordow, but does not install rotor assemblies (3) Iran increases number of centrifuges enriching at Natanz plant by nearly 50%; (4) the testing of advanced centrifuge production-scale cascades at the Natanz pilot testing is going far more slowly than expected; and (5) IR-1 centrifuge performance remains below par.

LEU production and centrifuge levels at Natanz Fuel Enrichment Plant (FEP)

Iran's total LEU production at the FEP through February 4, 2012 is reported to be 5,451 kg of low enriched uranium hexafluoride, including 580 kg estimated by Iran to have been produced since October 17, 2011. This total amount of low enriched uranium if further enriched to weapon grade is enough to make over four nuclear weapons. The FEP is Iran's primary enrichment facility, where the majority of its IR-1 centrifuges are installed. Activity at the Pilot Fuel Enrichment Plant, where Iran is enriching uranium up to the 20 percent level, is discussed below.

The average production of LEU at the FEP was 170 kg per month of LEU hexafluoride, a rate that has increased significantly from the last reporting period, where Iran produced 145 kg per month. However, Iran also used significantly more centrifuges to produce a marginal additional amount of product.

As of February 19, 2012, Iran had 54 centrifuge cascades installed with 9,156 IR-1 centrifuges and was enriching in 52 cascades containing a total of 8,808 IR-1 centrifuges. The IAEA noted that "not all of the centrifuges in the cascades being fed with uranium hexafluoride may have been working." At the end of the last reporting period, Iran was enriching in 15 fewer cascades and 2,600 fewer centrifuges. To achieve this increase in enriching centrifuges, Iran has re-connected about 1,000 IR-1 centrifuges, which had originally been installed and under vacuum in 2009.

In a new development, Iran placed an additional 6,177 empty IR-1 centrifuge casings at the FEP. It is unknown if Iran has enough raw materials to actually install this number of centrifuge rotor assemblies into the outer casings and make the centrifuges operational.

Uranium hexafluoride feed rates are not given for this reporting period. Figures 1-5 illustrate these trends at Natanz.

The number of centrifuges enriching at the FEP has increased by about 50 percent, but centrifuge performance remains below par. This situation can be understood by evaluating centrifuge output at the FEP in terms of separative work units (swu). ISIS derives this value from the declared LEU production. In the most recent reporting period, the LEU value is used with an assumption that the material is 3.5 percent enriched and the waste has a tails assay of 0.4 percent. The IAEA did not provide updated numbers in this report, but these older numbers can be used. Using standard enrichment calculators, 580 kg LEU translates to 1,426 kg of separative work units (swu), or 12.96 kg swu/day. On an annualized basis, this is about 4,732 kg swu per year (see Figure 6). The number of centrifuges declared as enriching was 6,208 at the beginning of the reporting period and rose to 8,808 at the end of the reporting period, corresponding with a swu/centrifuge-year of 0.76 and 0.53 respectively. For most of 2010, this value was about 0.9 kg U swu per year per centrifuge (see Table 1, which lists these values on a quarterly basis since the FEP started operation, and Figure 5, which displays this data graphically). These numbers imply that not all of Iran's centrifuges in cascades fed with uranium are actually enriching, and that these centrifuges are enriching less efficiently. **Despite** the overall increase in LEU production during this reporting period, Iran's IR-1 centrifuges are performing no better.

Deployment of Advanced Centrifuges at Pilot Fuel Enrichment Plant (PFEP) Delayed;, 19.75 Percent Enrichment Continues

Advanced Centrifuges Iran appears to be encountering problems in its testing of productionscale cascades of advanced centrifuge at the Pilot Fuel Enrichment Plant. Over the last reporting period, it maintained one164-machine cascade of IR-2m centrifuges in cascade 5. All 164 IR-2m machines were under vacuum and only being intermittently fed with uranium hexafluoride, an unexpected development. Iran continued work on its installation of IR-4 centrifuges in cascade 4, but, as of February 21, 2012 it had only installed 58 of 164 centrifuges in its planned IR-4 cascade, a decrease of 8 centrifuges from the end of the last reporting period. No uranium hexafluoride was introduced into the IR-4 centrifuges. According to IAEA information, Iran moves the IR-4 centrifuges in and out of the PFEP in a noticeable manner. This may imply significant problems with the IR-4 centrifuge design.

Iran also declared to the IAEA its plans to install three new types of centrifuges, called the IR-5, IR-6, and IR-6s as single machines at the PFEP. The designs specifications for the centrifuges are not disclosed in this report. Iran continues to feed natural uranium hexafluoride into single machines as well as ten and twenty machine cascades of IR-1, IR-2m, and IR-4 centrifuges.

19.75 percent LEU production Iran has designated two cascades at the smaller, aboveground pilot fuel enrichment plant for the production of LEU enriched to nearly 20 percent uranium-235 for the Tehran Research Reactor (TRR). One of these cascades enriches from 3.5 percent LEU to almost 20 percent LEU, while the second one takes the tails from the first one and outputs about 10 percent LEU and a tails of natural uranium. The ten percent material is fed into the first cascade in addition to 3.5 percent LEU. This process allows Iran to more efficiently use its 3.5 percent LEU stock.

Between September 14, 2011 and February 11, 2012, 164.9 kg of 3.5 percent low enriched uranium in the form of uranium hexafluoride was introduced into the two, interconnected cascades, a slight decrease from the last reporting period. Iran withdrew a total of 21.7 kg of nearly 20 percent LEU hexafluoride. During the reporting period, Iran produced 19.75 percent enriched uranium at a rate of 4.5 kg/month, about a 20 percent increase from the last reporting period but equal to the rate reported by the IAEA in May 2011. In total, Iran has fed 885.7 kg of 3.5% LEU to produce 95.4 kg 19.75% uranium since the beginning of operations in February 2010.

Fordow Fuel Enrichment Plant

The Fordow site now has four cascades of 174 IR-1 centrifuges each operating in two, tandem sets producing 19.75 percent LEU. Between December 14, 2011, when the first set started producing LEU until February 17, 2012, these sets of cascades produced approximately 13.8 kg of 19.75 percent enriched uranium at a rate of 6.46 kg 19.75 percent LEU hexafluoride per month. With the stockpile of 19.75 percent uranium produced at the Pilot Fuel Enrichment Plant at Natanz, Iran now has approximately 110 kg of 19.75 percent uranium. Its monthly production has increased to about 11 kilograms per month of 19,75 percent LEU hexafluoride, somewhat less than a three-fold increase. However, this level of production far exceeds Iran's need for enriched uranium for the Tehran Research Reactor.

In a new development, Iran installed 2,088 empty IR-1 centrifuge outer casings as well as all the associated feed and withdrawal piping at the Fordow facility. It is unclear whether and when Iran will install the rotor assemblies necessary to create operational IR-1 centrifuges. Fully outfitting the Fordow facility with centrifuges ready to enrich would have been a significant development. As in the case of the newly installed casings at the FEP, it is unknown if Iran has enough raw materials to actually install this number of centrifuge rotor assemblies into the outer casings at the Fordow site. However, given the international sensitivity about the deeply buried Fordow site, by installing the outer casings for over 2,000 machines and the associated piping, Iran is in effect sending a warning to

the international community that it intends to fully outfit the Fordow site. If it cannot do so with advanced centrifuges, it appears to be willing to do so with IR-1 centrifuges. Only time will tell if Iran can actually install the critical centrifuge rotors and operate the machines..

Iran also submitted to the IAEA a new Design Information Questionaire (DIQ), revising yet again the stated purpose of the Fordow enrichment facility. Iran originally stated that Fordow would be used to make 3.5 percent enriched uranium, and later said that Fordow would also be used for R&D purposes. Then Iran submitted a new DIQ declaring that Fordow would be used to make 19.75 percent enriched as well. In the latest DIQ, Fordow will be used for only 19.75 and 3.5 percent enriched uranium production but Iran left open how many of the centrifuges will be dedicated to making 19.75 percent LEU. That Iran has changed the stated purpose of the Fordow facility so many times over such a short period of time raises significant questions regarding the original purpose of the facility. Iran's decision to build a relatively small enrichment facility without informing the IAEA suggested that Fordow was intended to be used to quickly and securely make highly enriched uranium for nuclear weapons.

In summary, Iran is being ambiguous over the number of its centrifuges at Fordow that will make 19.75 percent LEU. It is signaling that it intends to fully outfit the plant with centrifuges, despite having no credible civilian need for the LEU that these machines would produce.

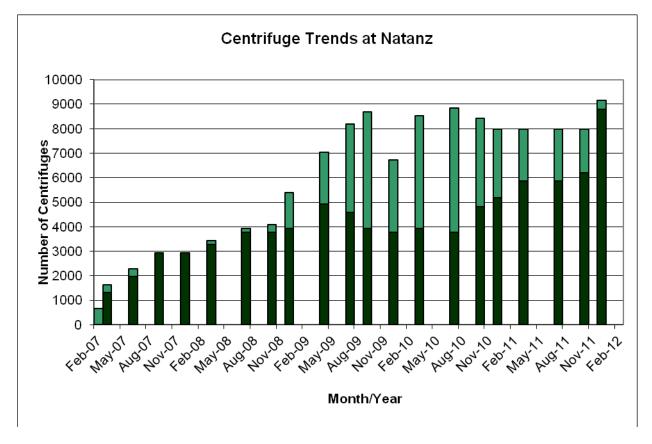
Taking Stock

Between the two enrichment sites, Iran has produced 109.2 kilograms of 19.75 percent LEU hexafluoride. Of that total, Iran has sent an unknown amount of 19.75 percent LEU to the Uranium Conversion Facility at Esfahan. Typically, transport containers would contain about 25 kilograms of such LEU. As of February 19, 2012, Iran had converted about 8 kilograms into U₃O₈ for use in Tehran Research Reactor fuel, which it is making at the nearby Fuel Manufacturing Plant. So, about 101.2 kilograms of 19.75 percent LEU remains in the form of hexafluoride as of that date.

Iran has produced a total of 5,451 kilograms of 3.5 percent LEU hexafluoride. About 985 kilograms has been used to make the 19.75 percent LEU hexafluoride. Table 2 represents Iran's overall production of 3.5 and 19.75 percent enriched uranium.

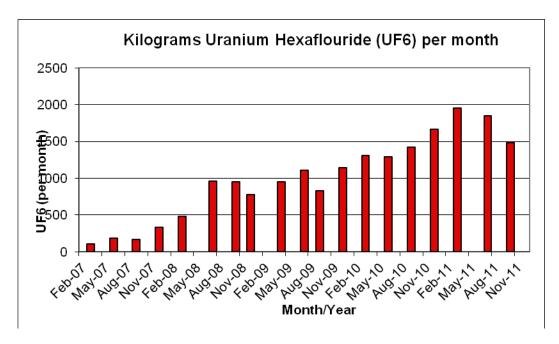
Iran has achieved varying rates of separative work in the IR-1 centrifuge in its enrichment plants. Although it continues to install and enrich in additional centrifuges at the FEP, the swu/centrifugeyear at this plant has varied wildly and declined overall. The separative work achieved at both the PFEP and FFEP indicates that Iran has been using tandem cascades to enrich to 19.75 percent comparably effectively. However, it is unknown whether Iran could maintain this level of output if it deployed these centrifuges on a broader scale. Table 3 compares the SWU/year-centrifuge at the FEP, PFEP, and FFEP.

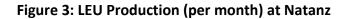
Figure 1: Centrifuge Trends at Natanz**

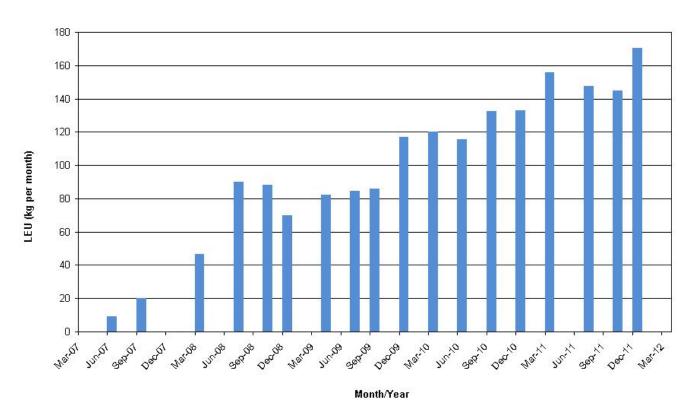


** The dark green bar represents the number of centrifuges enriching, while the light green represents the number of centrifuges installed but not enriching. The sum of the two represent the total number of centrifuges installed at the FEP.

Figure 2: Uranium Hexaflouride Feed at Natanz (data no longer reported quarterly by the IAEA)

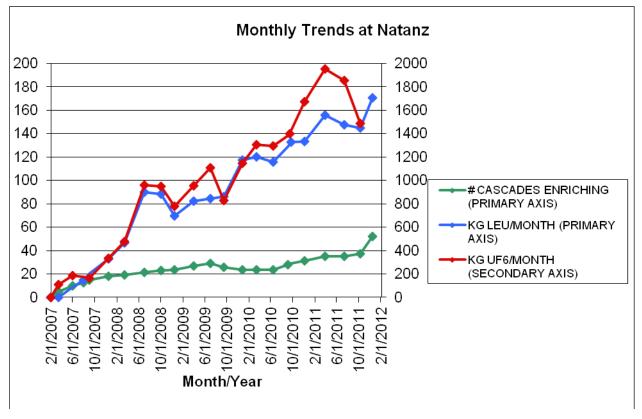






Kilograms Low Enriched Uranium (LEU) per Month

Figure 4: Overall Trends at Natanz



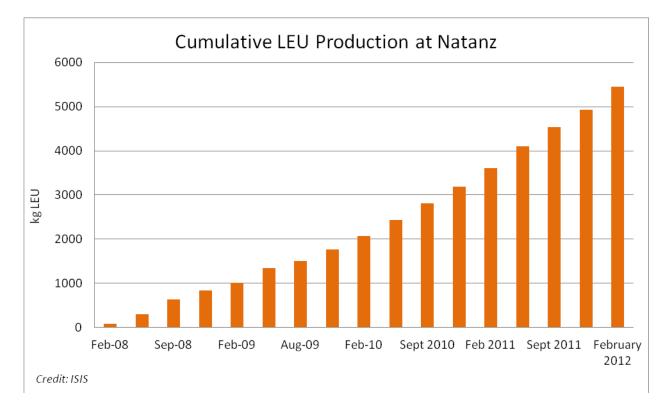
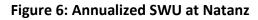


Figure 5: Cumulative LEU Production at the Natanz Fuel Enrichment Plant



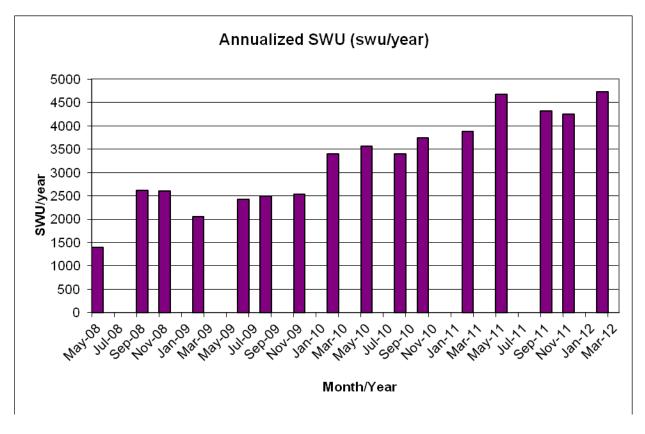


Table 1: Minimal Average Separative Capacity of an IR-1 Centrifuge at FEP

(kg U swu/year-centrifuge)

<i>Period</i> 12/13/2007 – 05/06/2008	<i>Start of Period</i> 0.47	<i>End of Period</i> 0.43
05/07/2008 - 08/30/2008	0.80	0.69
08/31/2008 - 11/07/2008	0.69	0.69
11/08/2008 - 11/31/2009	0.55	0.52
02/01/2009 - 05/31/2009	0.62	0.49
06/01/2009 - 07/31/2009	0.51	0.54
08/01/2009 - 10/30/2009	0.55	0.64
11/23/2009 - 01/29/2010	0.88	0.92
01/30/2010 - 05/01/2010	0.92	0.90
05/02/2010 - 08/06/2010	0.90	0.92
08/07/2010 - 10/31/2010	0.99	0.78
10/18/2010 – 02/05/2011	0.75	0.81 (1.0 if 1,000 questionable centrifuges ignored)
02/06/2011 - 05/13/2011	0.90	0.80
05/14/2011 - 08/13/2011	0.74	0.74
08/14/2011 - 11/01/2011	0.73	0.68
11/02/2011 – 02/04/2011	0.76 0.53 (Note: Iran began enriching in approximately 2,600 additional centrifuges during this period. Therefore, these data are likely skewed.)	

Table 2: CUMULATIVE TOTALS OF NATURAL AND ENRICHED URANIUM FEED AND 3.5AND 19.75 PERCENT PRODUCT IN IRAN

LOCATION	0.711 percent	3.5 percent	3.5 percent	19.75 percent
	feed	LEU product	LEU feed	LEU product
FEP	Unreported	5,451 kg	N/A	N/A
PFEP	N/A	N/A	885.7 kg	95.4 kg
FFEP	N/A	N/A	99.3 kg	13.8 kg
GROSS TOTAL	N/A	5,451 kg	985 kg	109.2 kg
NET TOTAL	Unavailable	4,466 kg*	985 kg	101.2 kg**

*Number is less 3.5 percent enriched uranium used as feedstock at the PFEP and FFEP as well as 3.5 percent uranium converted to uranium oxide.

**Number is less 8 kg of 19.75 percent enriched uranium converted to U_3O_8 .

Table 2: COMPARATIVE SWU* IN IR-1 CENTRIFUGES ATIRAN'S ENRICHMENT FACILITIES

LOCATION	IR-1 centrifuges producing 3.5 percent enriched uranium	IR-1 centrifuges producing 19.75 percent enriched uranium
FEP	0.65 swu/cent-year	N/A
PFEP	N/A	0.91 swu/cent-year
FFEP	N/A	Not enough information to estimate

*SWU represents an average of the SWU/centrifuge-year calculated using the number of centrifuges at both the beginning and the end of the reporting period.