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ISIS Analysis of IAEA Iran Safeguards Report

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The International Atomic Energy Agency (IAEA) released on February 21, 2013 its latest report on the implementation of NPT safeguards in Iran and the status of Iran's compliance with Security Council resolutions.

Key Findings:

1) Number of installed centrifuges at Natanz Fuel Enrichment Plant (FEP) increases substantially;

2) IR-1 centrifuge installation is occurring at a faster than expected rate at Natanz FEP;

3) New IR-2m advanced centrifuges are being installed at Natanz, although when they will start enriching or how well they will operate remains unknown;

4) Number of cascades producing near 20 percent low enriched uranium (LEU) is constant;

5) Iran has less than enough 20 percent low enriched uranium hexafluoride for one nuclear weapon, if further enriched to weapon-grade;

6) Almost all of the cascades at Fordow are now vacuum tested and likely ready for enrichment;

7) Iran resumes converting near 20 percent LEU hexafluoride to oxide form;

8) Iran will use the Tehran Research Reactor (TRR) to test IR-40 Arak reactor fuel; continued construction of the IR-40 reactor is in violation of UNSC resolutions; and,

9) No progress on "structured approach" to resolve outstanding questions about military dimensions and no access to Parchin, which Iran continues to sanitize.

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

Iran's total 3.5 percent low enriched uranium (LEU) production at the FEP through February 3, 2013 is reported to be 8,271 kilograms (kg), including 660 kg estimated by Iran to have been produced since November 10, 2012. 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 (PFEP), where Iran is enriching uranium up to the 20 percent level, is discussed below.

The average production of 3.5 percent LEU at the FEP has remained consistent for the past few reporting periods at approximately 236 kg per month of LEU hexafluoride.

As of February 19, Iran had 74 centrifuge cascades fully installed and three additional cascades partially installed for a total of 12,699 IR-1 centrifuges. Iran has increased the number of centrifuges installed at the FEP by 2,255 centrifuges since the end of the last reporting period. However, Iran did decrease the number of cascades in which it was enriching by one cascade for a total of 53 cascades containing approximately 8,992 centrifuges. Iran fed 7,530 kg of natural uranium hexafluoride into the cascades at the FEP, which is consistent with the previous reporting period. Figures 1-5 illustrate these trends at Natanz.

Iran's centrifuge performance at the FEP can be evaluated 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 are used. Using standard idealized enrichment calculations, 660 kg of LEU translates to 1,623 kg of swu, or 19 kg swu/day. On an annualized basis, this is about 6,887 kg swu per year (see Figure 6). These numbers are consistent with the previous reporting period.

The average swu/centrifuge-year for this period remained at 0.76, which is consistent with performance at the FEP throughout 2012. However, 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). This consistently lower enrichment output likely indicates that Iran is continuing to have trouble with the IR-1 centrifuges installed at the FEP.

Installation of Advanced Centrifuges Starts at Natanz Fuel Enrichment Plant

In a letter dated January 23, 2013, Iran informed the IAEA that its advanced, carbon-fiber-based centrifuge, designated the IR-2m, "will be used" in one of the modules of Production Hall A. This statement is being widely interpreted as Iran announcing that it intends to install about 3,000 IR-2m centrifuges, which is the normal deployment in a module. On February 6, 2013, IAEA inspectors observed that Iran had started the installation of IR-2m centrifuges and empty centrifuge casings. As of February 19, 180 IR-2m centrifuges and empty centrifuge casings were installed in FEP. One could conclude that 180 IR-2m centrifuge casings have been installed, but the report does not make clear how many IR-2 rotor assemblies have been inserted into the casings. The piping and other associated cascade equipment is likely not fully installed, meaning the centrifuges are not under vacuum.

Advanced Centrifuges at Pilot Fuel Enrichment Plant (PFEP)

The Pilot Fuel Enrichment Plant has four out of six cascades dedicated to research and development (R&D), cascades 2, 3, 4 and 5. On 19 February 2013, there were 29 IR-4 centrifuges, six IR-6 centrifuges and two IR-6s centrifuges installed in cascade 2, nine IR-2m centrifuges and two IR-1 centrifuges installed in cascade 3, 164 IR-4 centrifuges installed in cascade 4 and 162 IR-2m centrifuges installed in cascade 5.

Since the last IAEA safeguards report, Iran has installed two new types of centrifuge, the IR-6 and IR-6s, although no information is in the report about the design or capabilities of these centrifuges. Iran has intermittently fed each with natural uranium hexafluoride. Iran has also fed intermittently natural uranium hexafluoride into IR-2m and IR-4 centrifuges, into single machines and sometimes into cascades of various sizes.

In a new development, Iran informed the IAEA that it planned to start producing enriched uranium in cascades 4 and 5, rather than recombining the product and tails at the end of the process as it had done previously. This process will start only after the IAEA and Iran implement modified safeguards measures to account for the new production of enriched uranium. The level of enrichment, whether 3.5 or near 20 percent, is not given in the report.

19.75 percent LEU production at the Natanz pilot plant

Iran has designated two, tandem cascades at the smaller, above-ground Pilot Fuel Enrichment Plant for the production of LEU enriched to nearly 20 percent uranium-235, ostensibly 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 and outputs roughly 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 November 11, 2012 and February 12, 2013, 88.1 kg of 3.5 percent low enriched uranium in the form of uranium hexafluoride was introduced into the two, interconnected cascades. Iran withdrew from the tandem cascades a total of 12.6 kg of nearly 20 percent LEU hexafluoride during this reporting period. This rate, approximately 4 kg per month, is slightly lower than rate of 5 kg per month Iran has achieved in the past. However, because these data represent so little LEU and so few centrifuges, the change cannot be considered precipitous. **In total, Iran has fed 1,265 kg of 3.5% LEU to produce 150 kg of 19.75% uranium since the beginning of operations in February 2010.**

Fordow Fuel Enrichment Plant (FFEP)

The Fordow site has two enrichment halls, Units 1 and 2, which are currently each designed to hold 8 cascades of 174 IR-1 centrifuges. Iran is continuing to operate the four cascades of 174 IR-1 centrifuges each in two, tandem sets to produce 19.75 percent LEU in a total of 696 enriching centrifuges, the same number of centrifuges enriching as was reported in the November, August, and May 2012 safeguards reports. **Thus, Iran has not increased the number of centrifuge cascades producing 20 percent LEU at either Fordow or Natanz.**

As of the last reporting period, Iran had fully installed centrifuges in the facility, although it had not connected much of the piping or deployed electronics and other critical materials. As of the February 2013 report, Iran had fully vacuum tested 15 of the 16 cascades at the plant. However, it had not yet introduced material into the additional cascades. During this reporting period, Iran had 2,710

centrifuges, 74 centrifuges fewer than the previous reporting period. The reason for the removal of these 74 centrifuges is not given.

Though Iran has expanded the number of cascades subject to vacuum testing, it has not started to enrich in any of these newly installed centrifuges; in fact, Iran has not increased the number of centrifuges enriching in three reporting periods. Based on Iran's patterns of installation, it may be that it plans to orient all of the cascades at the Fordow facility as tandem cascades. Figure 9 displays the number of centrifuges enriching and installed at the FFEP graphically.

Between November 11, 2012 and February 10, 2013, the two sets of tandem cascades produced approximately 34.4 kg of 19.75 percent enriched uranium at a combined average rate of 11.5 kg of 19.75 percent LEU hexafluoride per month. This represents a slight increase in Iran's performance at the plant, which has achieved a consistent rate of 10 kilograms per month for the past two reporting periods.

Production of Uranium Oxide

Iran reported in the August 2012 report that it began feeding its 19.75 percent uranium hexafluoride into the Fuel Plate Fabrication Plant at Esfahan. As of February 11, 2013, Iran had fed a total of 111 kg 19.75 percent enriched uranium hexafluoride into the process at Esfahan to produce U_3O_8 containing about 50 kg of enriched uranium. The 111 kg of near 20 percent LEU hexafluoride contains about 75 kg of enriched uranium. Thus, approximately 25 kg of enriched uranium remain held up in the process or in different forms. Therefore, Iran still seems to be experiencing problems in its conversion process.

The report does not make clear how much additional material has been sent to Esfahan for conversion.

Taking Stock

Iran has produced a total of 8,271 kilograms of 3.5 percent LEU hexafluoride. About 2,244 kilograms have been used to make the 19.75 percent LEU hexafluoride.

Combined, the PFEP at Natanz and the FFEP have produced 280 kg of 19.75 percent uranium. Figure 7 represents the cumulative production of 19.75 percent enriched uranium in Iran. The total average monthly production of 19.75 percent LEU hexafluoride during the most recent period tracks closely with the average in the last reporting period, 15.5 versus 15.1 kilograms per month of 19.75 percent LEU hexafluoride, respectively. If Iran begins enriching in the additional deployed cascades, this rate could triple.

Even the current rate of production of 20 percent LEU far exceeds Iran's need for enriched uranium for the Tehran Research Reactor.

Of the 280 kg of near 20 percent LEU, according to the IAEA's May 2012 report, Iran had down blended 1.6 kilograms of 19.75 percent LEU hexafluoride into LEU enriched to less than five percent. Between December 17, 2011 and February 11, 2013 the IAEA reported that Iran fed into the process line at the Fuel Plate Fabrication Plant at Esfahan 111 kilograms of uranium hexafluoride enriched up to 20 percent uranium-235, and it produced 50 kilograms of near 20 percent enriched uranium in the form of U_3O_8 powder. A small amount has been manufactured into TRR fuel assemblies or elements, a portion of which were sent to the TRR. **Table 2 summarizes these findings.**

Iran has achieved varying rates of separative work in the IR-1 centrifuge at its enrichment plants. Although Iran continues to install and enrich in additional centrifuges at the FEP, the enrichment output measured in swu/centrifuge-year at this plant has varied 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 and effectively. During this reporting period, the FFEP achieved 1.10 swu/centrifuge-year, an increase from the previous 0.97 swu/centrifuge-year, and the PFEP cascades achieved 0.82 swu/centrifuge-year, a decrease from their performance during the last reporting period. Table 3 compares the enrichment output at the FEP, PFEP, and FFEP.

Work Continues at IR-40 Nuclear Reactor, TRR to be Used to Irradiate Arak Reactor Fuel

On February 11, the IAEA carried out a DIV at the IR-40 heavy water research reactor at Arak and observed that the previously reported installation of cooling and moderator circuit piping was almost complete. Iran stated previously that operation of the reactor was expected to commence in the first quarter of 2014.

The IAEA reports that Iran will use the Tehran Research Reactor (TRR) to test fuel for the IR-40 reactor, a reactor that the United Nations Security Council has demanded that Iran stop building because it could be used to produce plutonium for nuclear weapons. The TRR is now more than a medical isotope production reactor (Iran's stated use for the reactor) and is necessary for the operation of the IR-40 reactor. The IAEA report states, "On 26 November 2012, the Agency verified a prototype IR-40 natural uranium fuel assembly before its transfer to TRR for irradiation testing."

Nuclear Accident at Uranium Conversion Facility almost cleaned up

The report states that Iran informed the Agency it had recovered the majority of nuclear material (natural uranium scrap material) that spilled onto the floor of the facility when a storage tank ruptured last year. The Agency is assessing this declaration. The radiological implications are not discussed.

No Progress on "Structured Approach" after nine rounds of talks

The IAEA reports that "Contrary to the Board resolutions of November 2011 and September 2012 and despite the intensified dialogue between the Agency and Iran since January 2012 in nine rounds of talks, it has not been possible to agree on the structured approach. The Director General is unable to report any progress on the clarification of outstanding issues, including those relating to possible military dimensions to Iran's nuclear programme." Iran had agreed to finalize a structured approach document with the Agency to set out a path for resolving outstanding issues over the previously reported, possible military dimensions to its nuclear program.

Still No Access to Parchin, "Alterations" Ongoing

Regarding the Parchin site, where Iran is suspected to have constructed an explosive chamber that used for high explosive tests relevant to nuclear weapons development, the IAEA continues to stress the need for "access to this location without further delay." It admits that the due to extensive demolition, earth displacement, and construction activities that have taken place at the site since the

Agency's initial request for access in January 2012, "its ability to conduct effective verification will have been seriously undermined."

The report also lists recent alterations to the Parchin site that the Agency has observed in satellite imagery, including:

- Reinstatement of some of the chamber building's features (e.g. wall panels and exhaust piping);
- Alterations to the roofs of the chamber building and the other large building;
- Dismantlement and reconstruction of the annex to the other large building;
- Construction of one small building at the same place where a building of similar size had previously been demolished;
- Spreading, leveling and compacting of another layer of material over a large area; and
- Installation of a fence that divides the location into two areas.

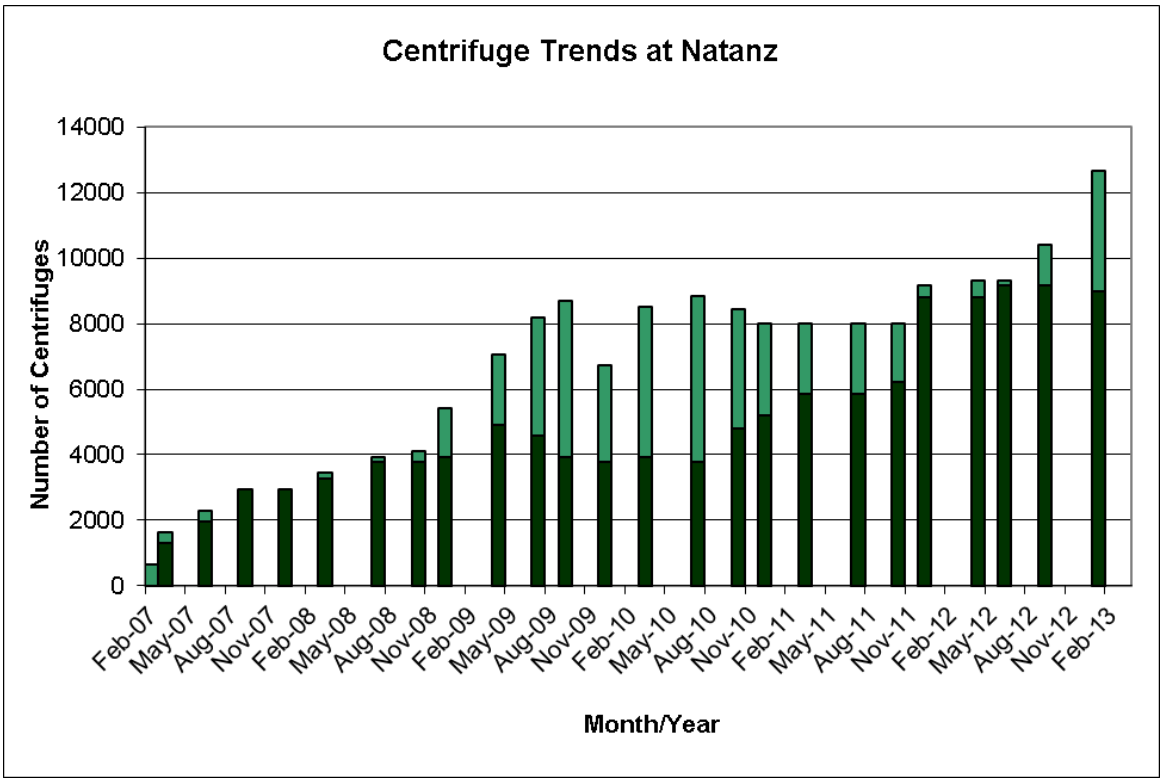
Most of these activities have also been documented by ISIS in satellite imagery reports, dated November 29, 2012, December 12, 2012 and January 25, 2013.

One of the main worries caused by Iran's alterations of the site is that the IAEA's ability to conduct an investigation to check for evidence left by potential nuclear weapons related explosive tests will have been degraded. As pointed out in ISIS's January 25, 2013 report, in order to increase the possibility of a visit and address the overall issue raised by Parchin, the IAEA should forward the entire case to the Board of Governors where it could be considered as grounds for a resolution.

Note on Legal Mandate and Completeness

The IAEA underlines that while it continues to verify the non-diversion of declared nuclear material in Iran, "it is unable to provide credible assurance about the absence of undeclared nuclear material and activities," a point which the IAEA Board has confirmed "on numerous occasions" since as early as 1992 that the IAEA has a mandate to do under comprehensive safeguards agreements. The IAEA writes in footnote 56 of the report that the Board has "authorize[d] and require[d] the Agency to seek to verify both the non-diversion of nuclear material from declared activities (i.e. correctness) and the absence of undeclared nuclear activities in the State (i.e. completeness). It is imperative that Iran not delay further in answering the IAEA's questions about the alleged past and possibly on-going military dimensions of its nuclear programs, especially given the current state of heightened international tensions over this issue.

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 Hexafluoride Feed at Natanz

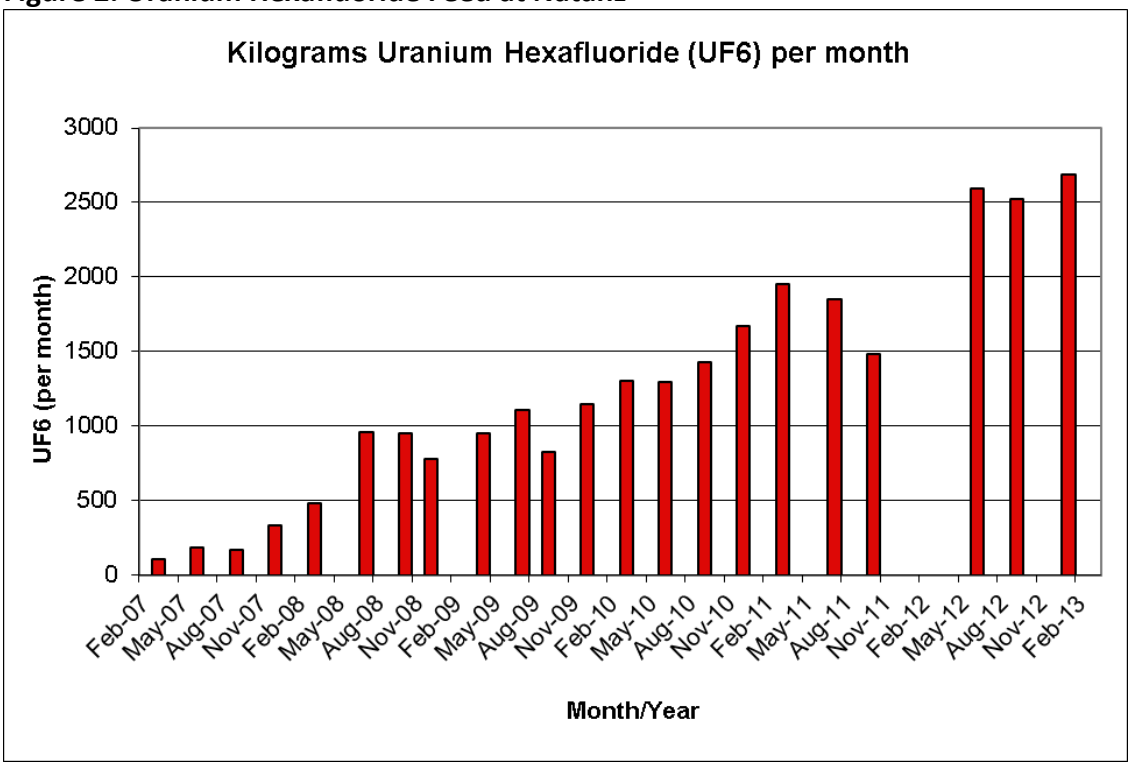


Figure 3: LEU Production (per month) at Natanz

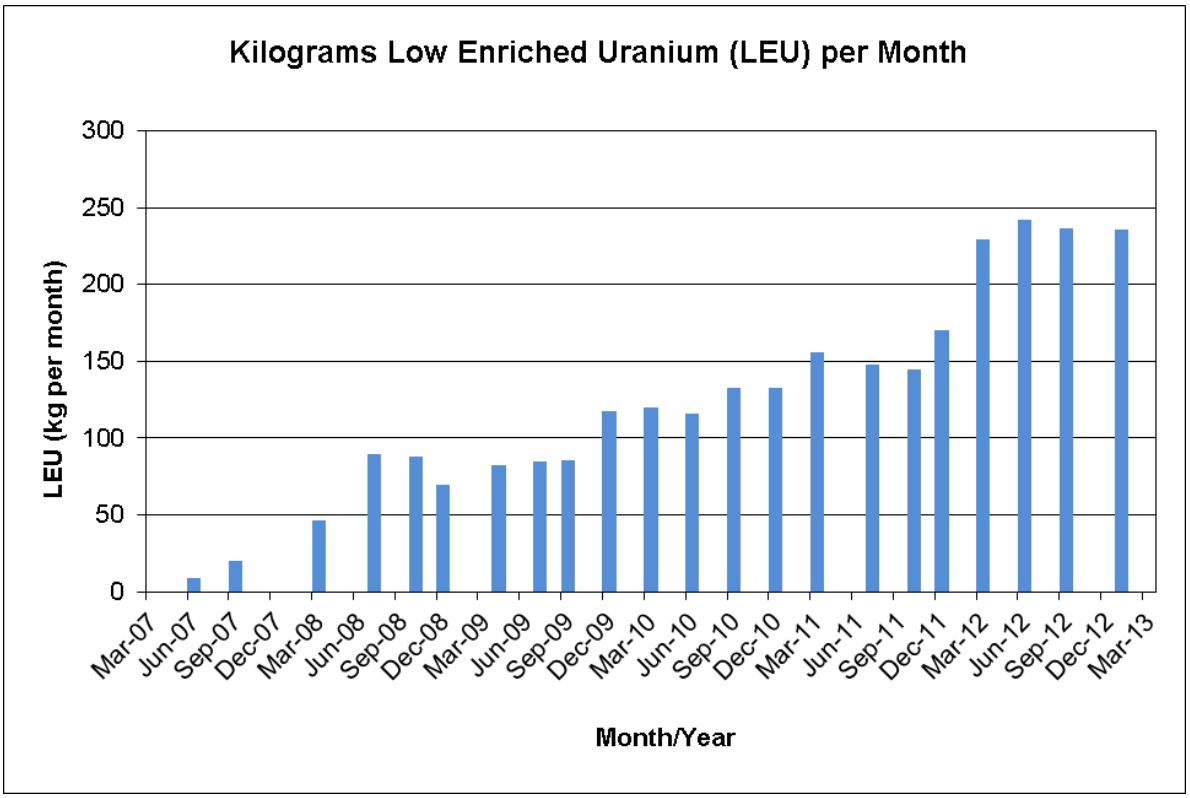


Figure 4: Overall Trends at Natanz

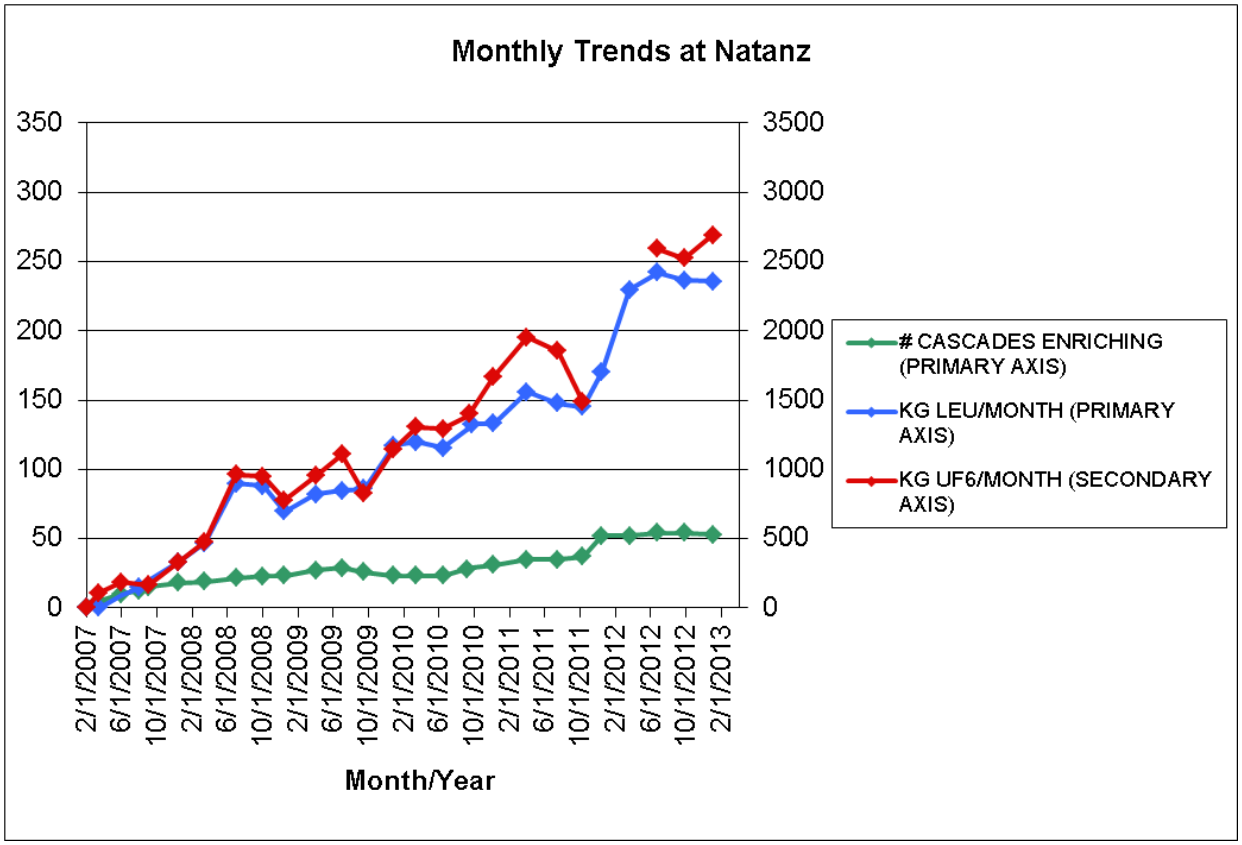


Figure 5: Cumulative LEU Production at the Natanz Fuel Enrichment Plant

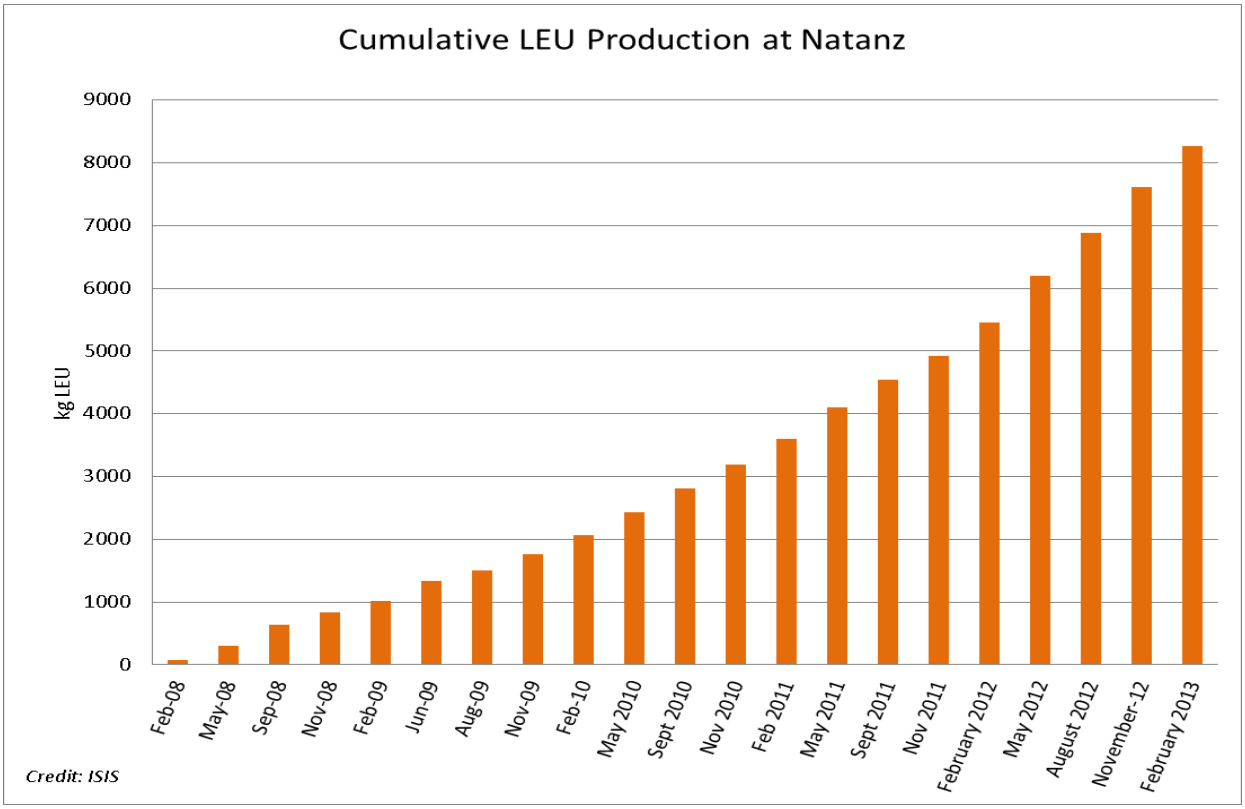


Figure 6: Annualized SWU at Natanz

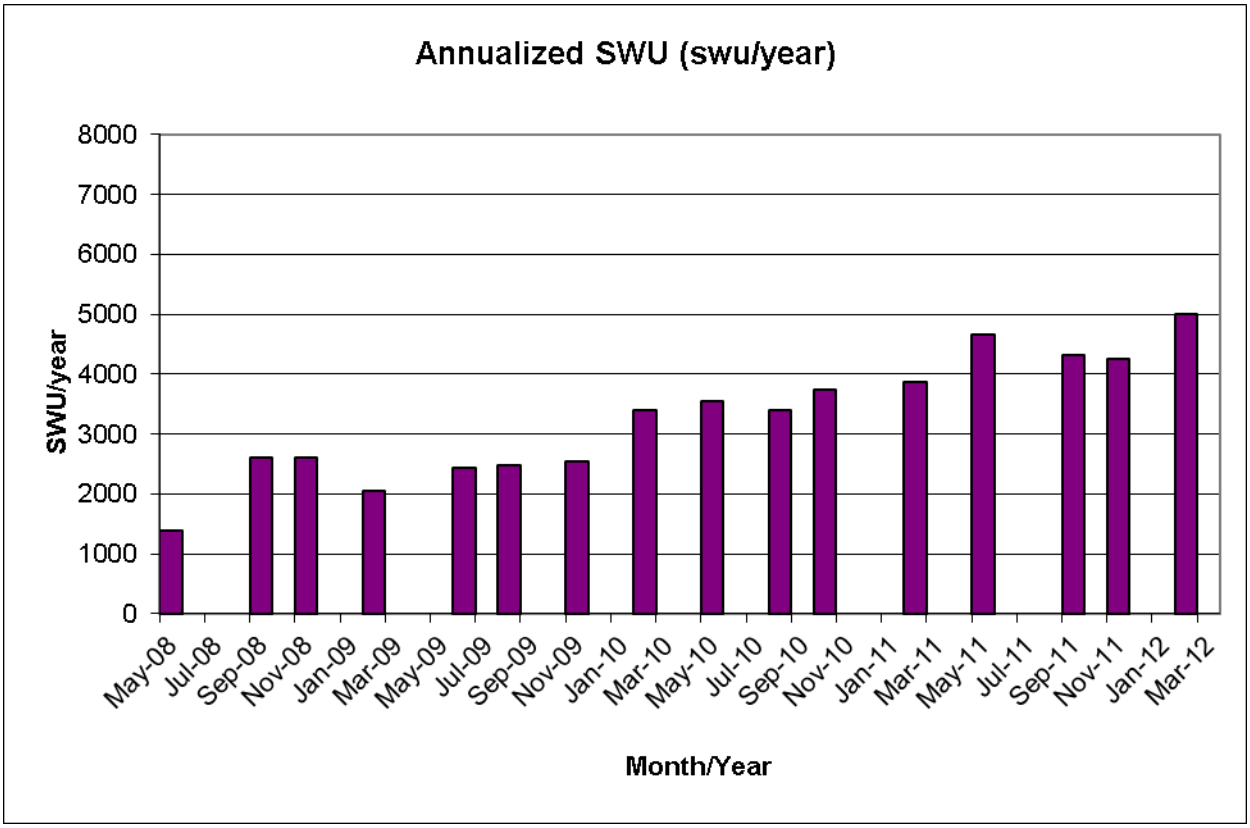


Figure 7: Cumulative 19.75 Percent Uranium Production in the PFEP and FFEP

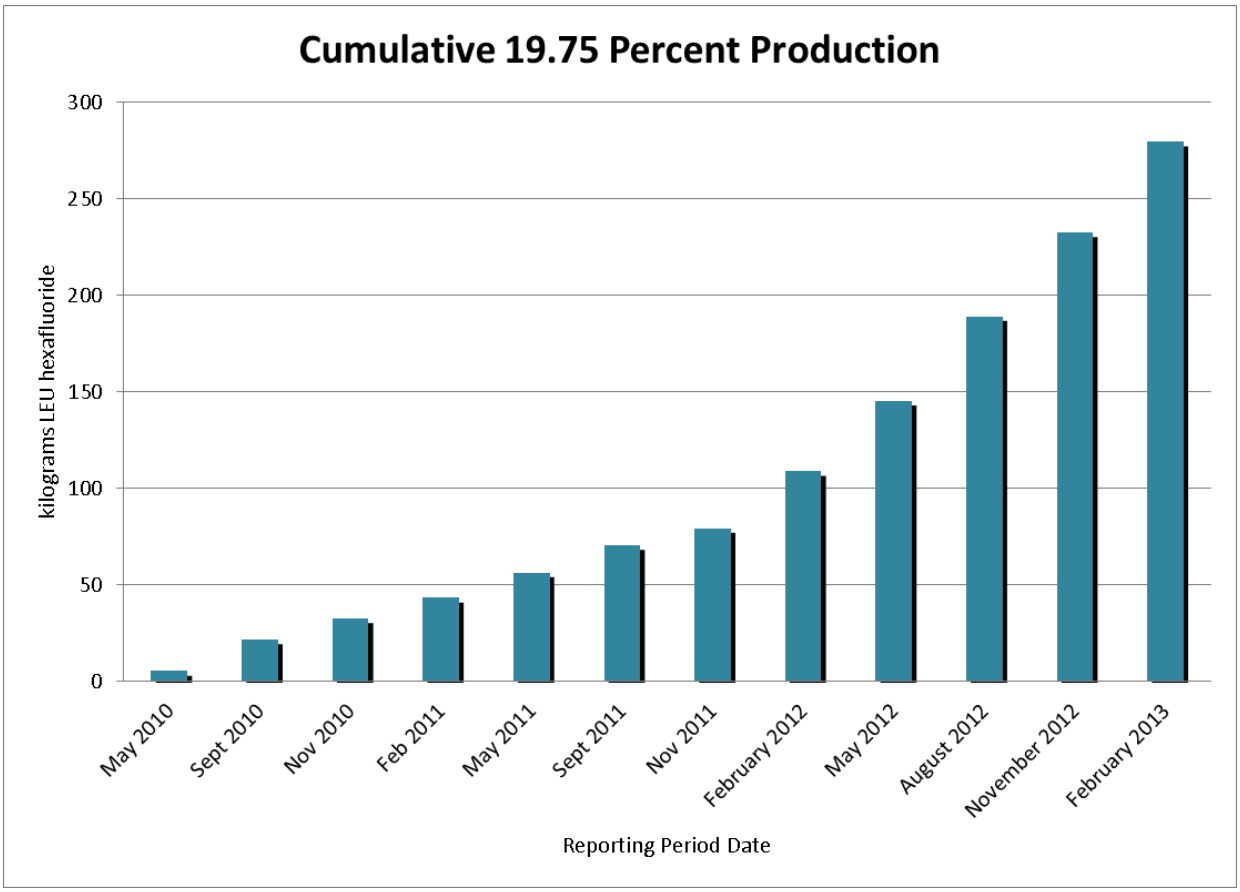


Figure 8: SWU/Centrifuge-year at the Fordow Fuel Enrichment Plant and Pilot Fuel Enrichment Plant

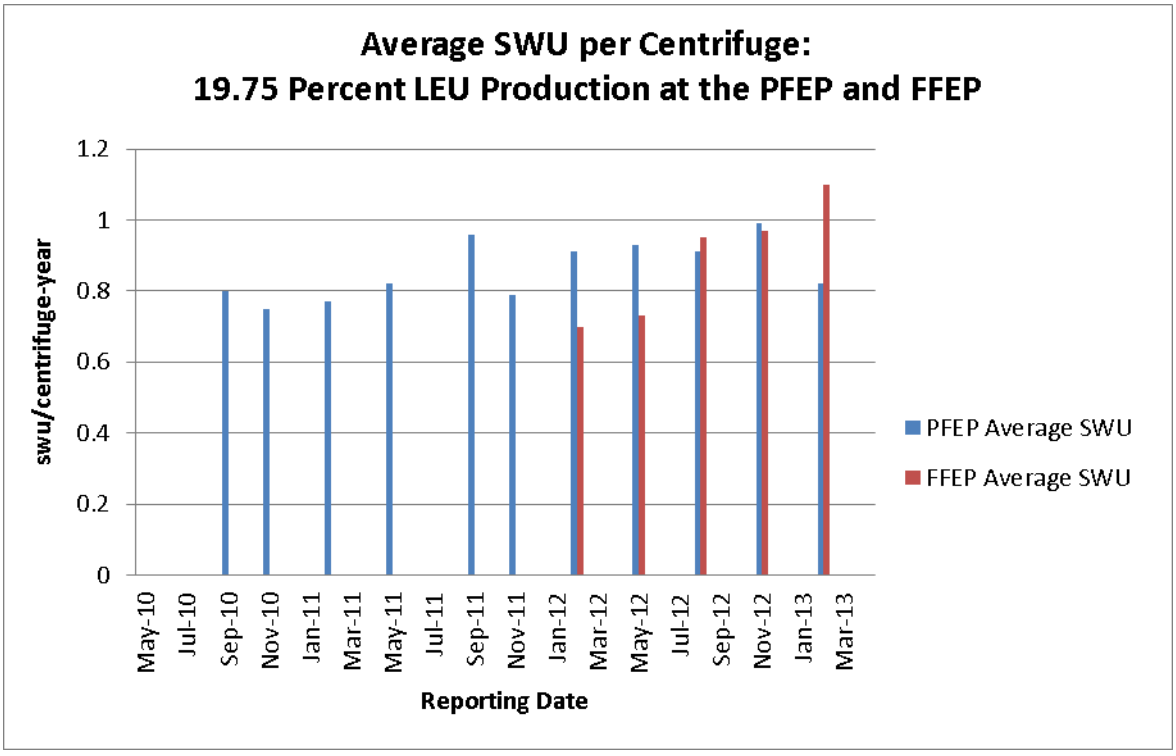


Figure 9: Centrifuges Enriching and Installed at the Fordow Fuel Enrichment Plant

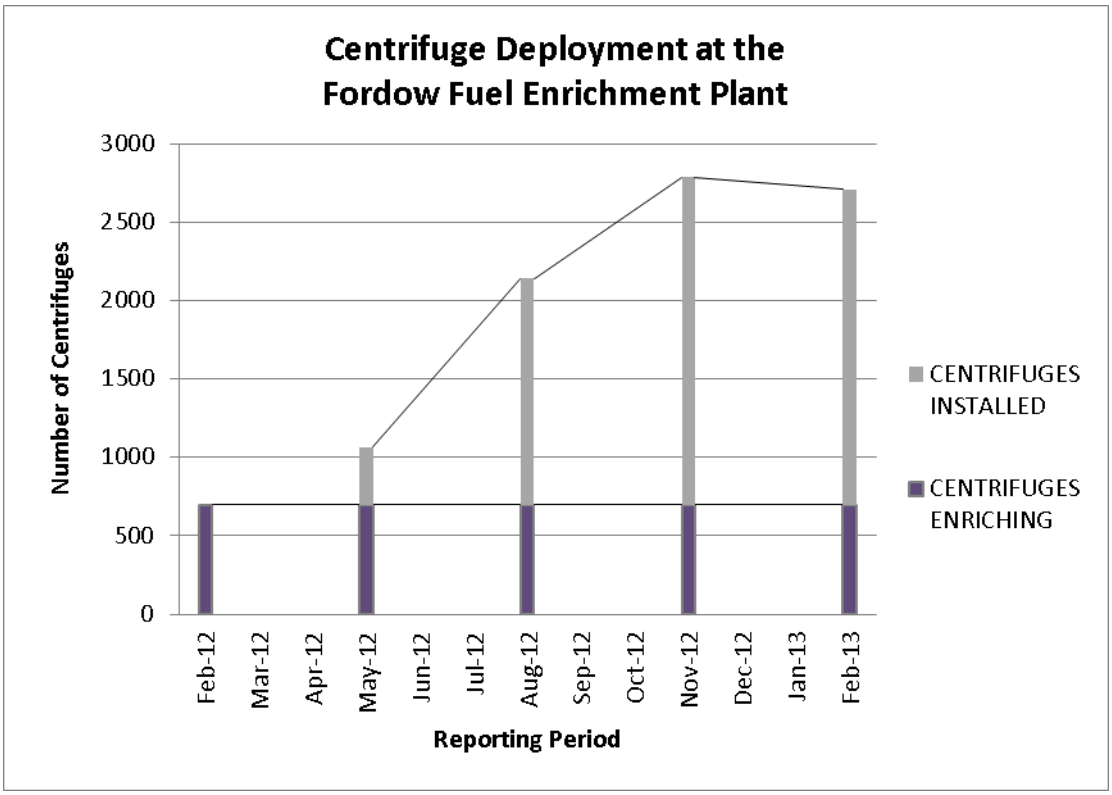


Table 1: Minimal Average Separative Capacity of an IR-1 Centrifuge at the FEP

(kg U swu/year-centrifuge)

Period	*Start of Period*	*End of Period*
12/13/2007 – 05/06/2008	0.47	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 – 02/04/2012	0.76 (Note: Iran began enriching in approximately 2,600 additional centrifuges during this period. Therefore, these data are likely skewed.)	0.53
02/05/2012 – 05/11/2012	0.77	0.77
05/12/2012 – 08/06/2012	0.77	0.77
08/07/2012 – 11/9/2012	0.77	0.76
11/10/2012 – 02/03/2013	0.75	0.76

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

LOCATION	0.711 percent feed	3.5 percent LEU product	3.5 percent LEU feed	19.75 percent LEU product
FEP	94,750 kg	8,271 kg	N/A	N/A
PFEP	N/A	N/A	1,265 kg	150 kg
FFEP	N/A	N/A	979 kg	130 kg
GROSS TOTAL	94,750 kg	8,271 kg	2,244 kg	280 kg
NET TOTAL	94,750 kg	5,974 kg*	2,244 kg	167 kg**

*Number is less 3.5 percent enriched uranium hexafluoride used as feedstock at the PFEP and FFEP as well as 53 kg 3.5 percent LEU hexafluoride converted to uranium oxide.

**Number is less 111 kg of 19.75 percent LEU hexafluoride fed into the process at the Fuel Plate Fabrication Plant near Esfahan and 1.6 kg 19.75 percent LEU hexafluoride down blended. As of the February 21 report, the IAEA did not report how much 19.75 percent material remained in uranium hexafluoride form at Esfahan and had not yet been feed into the process.

Table 3: COMPARATIVE SWU Rate* IN IR-1 CENTRIFUGES AT IRAN'S ENRICHMENT FACILITIES

LOCATION	IR-1 centrifuges producing 3.5 percent enriched uranium	IR-1 centrifuges producing 19.75 percent enriched uranium
FEP	**0.76 swu/cent-year**	**N/A**
PFEP	**N/A**	**0.82 swu/cent-year**
FFEP	**N/A**	**1.10 swu/cent-year**

***SWU rate 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.