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ISIS Analysis of IAEA Iran Safeguards Report

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The International Atomic Energy Agency (IAEA) released on February 20, 2014 its [report](#) on the implementation of NPT safeguards in Iran and the status of Iran's compliance with Security Council resolutions.

Key Findings:

- 1.) Iran begins taking measures agreed upon in the Joint Plan of Action, including ceasing enrichment to 19.75 percent and beginning to down blend or convert at an accelerated rate its stockpile of 19.75 percent hexafluoride;
- 2.) No new centrifuges of any type installed at Natanz or Fordow fuel enrichment plants;
- 3.) Iran continues R&D work at the Natanz Pilot Fuel Enrichment Plant; has installed casing for new "IR-8" centrifuge, which Iran says is far more powerful than the IR-1 centrifuge;
- 4.) The IAEA reports that Iran has implemented the six initial measures agreed upon with the Agency in November 2013 under the Framework for Cooperation within the three-month period; it is analyzing the information and requesting additional clarification;
- 5.) The Enriched Uranium Oxide Powder Plant (EUPP), which can convert newly produced 3.5 percent low enriched uranium hexafluoride into oxide form, is not yet operational;
- 6.) IAEA has observed new activity at Parchin; no new progress on addressing past military dimensions.

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 9, 2014 is reported to be 11,091 kilograms (kg), including 734 kg estimated by Iran to have been produced since November 6, 2013. 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 has enriched uranium up to the 20 percent level until January 20, 2014, is discussed below.

The average production of 3.5 percent LEU at the FEP rose slightly from the past reporting period to approximately 235 kg per month from approximately 230 kg per month of LEU hexafluoride. However, this rate is consistent with Iran’s production during the majority of 2013.

Since November 10, 2013, Iran has had 90 IR-1 centrifuge cascades fully installed for a total of 15,420 IR-1 centrifuges, the same as the last reporting period. Iran increased the number of cascades enriching by two cascades since the previous reporting period for a total of 54 cascades of approximately 9,166 centrifuge enriching. Iran fed 8,345 kg of natural uranium hexafluoride into the cascades at the FEP, which is consistent with Iran’s feed rate throughout much of 2013. Iran’s centrifuge performance at the FEP can also 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 is taken as on average as being 3.5 percent enriched, and the waste is assumed to have on average a tails assay of 0.4 percent. The IAEA did not provide updated concentrations in this report, but these older numbers are used, based on interviews with knowledgeable senior officials close to the IAEA. Using standard idealized enrichment calculations, 734 kg of LEU translates to 1,805 kg of swu, or 19 kg swu/day. On an annualized basis, this is about 6,863 kg swu per year (see Figure 6). These numbers are consistent overall with the FEP’s operation throughout 2013.

The average swu/centrifuge-year for this period remained consistent with performance at the FEP throughout 2012 at 0.76 swu/centrifuge-year. 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 6, 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. Although reports are that fewer IR-1 centrifuges are breaking at the FEP.

Installation of Advanced Centrifuges 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 intended to install about 3,000 IR-2m centrifuges, which is the normal deployment in a module. Under the Joint Plan of Action, Iran agreed to halt installation of any additional centrifuges and to not begin enriching in new any new machines.

On February 10, 2014, IAEA inspectors observed that Iran had made no changes since the previous reporting period, and that there were six cascades fully installed and placed under vacuum and Iran had partially installed one cascade, for a total of 1,008 IR-2m centrifuges. The IAEA also reports that Iran completed “preparatory installation work” for an additional 12 cascades of IR-2m centrifuges. Iran had not begun enriching in any of these cascades. Figure 7 tracks the IR-2m installation at the FEP.

Advanced Centrifuges at Natanz Pilot Fuel Enrichment Plant (PFEP): New “IR-8” Centrifuge Casing Installed; Iran Downblending 20 Percent LEU

Iran is not precluded from continuing its centrifuge R&D activities under the Joint Plan of Action, although it cannot feed uranium hexafluoride into any centrifuges that had not been fed with UF₆ as of November 2013. Four out of six cascades at the pilot plant are dedicated to this on-going research and development (R&D).

They are cascades 2, 3, 4 and 5. As of February 15, 2014, there were:

In Cascade 2: 11 IR-4 centrifuges (down from 14 on November 3, 2013, 17 on August 12, 2013, 19 on May 14, 2013, and 29 on February 19, 2013); 7 IR-6 centrifuges (down from 13 on November 3, 2013, which was up from 12 on August 12, 2013, down from 14 on May 14 2013, and up from six on February 19, 2013); 1 IR-6s centrifuge (same as November 3, 2013, down from 8 on August 12, 2013, 3 on May 14, 2013 and two on February 19, 2013); and one IR-5 centrifuge (same as previous report);

In Cascade 3: 14 IR-1 (2 IR-2m centrifuges removed since November 2013 report);

In Cascade 4: 164 IR-4 centrifuges, same as in the past year;

In Cascade 5: 162 IR-2m centrifuges, same as in the past year.

Since the previous report, Iran has fed intermittently natural uranium hexafluoride into IR-1, IR-2m, IR-4, and IR-6 centrifuges, into the single machines and sometimes into cascades of various sizes and types of centrifuges. It has not yet fed the single installed IR-5 centrifuge with UF₆, and under the interim arrangement, cannot do so during the JPA period. On December 4, 2013, Iran provided the IAEA with an updated Design Inventory Questionnaire (DIQ) which informed it of its intention to install a single “new centrifuge” called the IR-8. Since then, Iran has installed a new casing that is not connected. Iran has committed not to feed this centrifuge with uranium hexafluoride.

Between October 26, 2013 and February 9, 2014, Iran had fed a total of 430.1 kg of natural UF₆ into the centrifuges in the R&D area, but continued to recombine the enriched product and depleted tails.

19.75 percent LEU production at the Natanz pilot plant: Halted on January 20; Iran downblending its 19.75 percent stock

From February 2010 to January 2014, 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. 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. **Per its agreement with the P5+1, Iran ceased production of 19.75 percent enriched uranium in these cascades and began producing 3.5 percent enriched uranium as of January 20, 2014.**

Between October 26, 2013 and January 20, 2014, 90 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 13 kg of nearly 20 percent LEU hexafluoride during this reporting period. This rate, approximately 4.6 kg per month, represents a slight decrease of 0.35 kg per month from previous reporting periods. **In total, Iran has fed 1,631 kg of 3.5% LEU to produce 202 kg of 19.75% uranium since the beginning of operations in February 2010.**

As of January 21, 2014, the IAEA reports that Iran began enriching to 3.5 percent in the cascades previously designated for 19.75 percent enrichment. Between January 21 and February 9, Iran had fed 35 kg to produce 4.1 kg of LEU enriched up to 5 percent U-235.

On January 20, 2013, in line with its commitment in the JPA, Iran began down blending some of its inventory of UF₆ enriched to 20 percent U-235. As of February 9, 2014, it had down blended 22.9 kg of the material to produce UF₆, enriched to no more than 5 percent U-235. Assuming a target of 3.5 percent enriched uranium and a blend stock of natural uranium, Iran likely produced roughly 160 kg 3.5 percent enriched uranium from this material.

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 August, May, and February 2013 reports as well as the November, August, and May 2012 safeguards reports. In compliance with the Joint Plan of Action, Iran stopped enriching to 19.75 percent in these cascades and began enriching to no greater than 5 percent LEU hexafluoride.

The Fordow facility remains nearly fully outfitted with centrifuges, though Iran has not increased the number of centrifuges enriching in five reporting periods. Figure 11 displays the number of centrifuges enriching and installed at the FFEP graphically.

Between November 2, 2013 and January 20, 2014, the two sets of tandem cascades produced approximately 24.5 kg of 19.75 percent enriched uranium at a combined average rate of 9.4 kg of 19.75 percent LEU hexafluoride per month. This represents a slight decrease in the average rate since the previous reporting period.

As of January 21, 2014, the IAEA reports that Iran began enriching to 3.5 percent in the cascades previously designated for 19.75 percent enrichment. Between January 21 and February 9, Iran had fed 144 kg of natural uranium hexafluoride to produce approximately 16 kg of LEU enriched up to 5 percent U-235. The IAEA reports that Iran updated the facility's Design Information Questionnaire on February 8 as it "had taken measures due to change in level of enrichment and that the measures are temporarily taken during the first step implementation of the JPA."

Production of Near 20 Percent 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 16, 2014, Iran had fed a total of 262.7 kg of 19.75 percent enriched uranium hexafluoride into the process at Esfahan to produce U₃O₈ containing about 120.6 kg of enriched uranium (uranium mass). The 262.7 kg of near 20 percent LEU hexafluoride contains about 175 kg of enriched uranium (uranium mass). The IAEA verified 36.8 kilograms of uranium in liquid or solid scrap form. Thus, approximately 17.7 kg of enriched uranium remain held up in the process or in different forms.

The IAEA also reports that as of February 15, 2014, Iran had produced 28 test plates (including 4 natural uranium text plates), standard fuel elements, and test assemblies for the Tehran Research Reactor (TRR) plus seven control fuel elements (for simplicity, the following text refers to the fuel simply as “elements”). The IAEA resumed its publication of additional data in annexes to its report. From this data, the 31 fuel elements contain 33.1 kilograms of near 20 percent LEU (U-mass). Of the total amount of 175 kg of near 20 percent LEU (uranium mass) sent for conversion, about 20 percent has been made into fuel assemblies for the TRR.

Taking Stock

Iran has produced a total of 11,111 kilograms of 3.5 percent LEU hexafluoride. About 3,437 kilograms have been used to make the 19.75 percent LEU hexafluoride. Across its three centrifuge facilities, it has installed 18,458 IR-1 centrifuges and 1,008 IR-2m centrifuges. Figure 7 shows IR-2m trends in Iran, and Figure 8 shows historical cumulative IR-1 centrifuge trends in Iran.

Combined, the PFEP at Natanz and the FFEP have produced 448 kg of 19.75 percent uranium, though Iran ceased production of this material on January 20, 2014. Figure 9 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 fell slightly from approximately 15 kilograms per month to approximately 14 kilograms per month of 19.75 percent LEU hexafluoride.

Of the 448 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 16, 2014 the IAEA reported that Iran fed into the process line at the Fuel Plate Fabrication Plant at Esfahan 262.7 kilograms of uranium hexafluoride enriched up to 20 percent uranium-235, or 175 kilograms of uranium, and it produced 120.6 kilograms of near 20 percent enriched uranium in the form of U₃O₈ powder (U-mass). Using this material, Iran has manufactured 31 TRR fuel elements. In total, Iran had a stock of 161 kg of near 20 percent LEU hexafluoride, down approximately 35 kg from the last IAEA report. **Table 2 summarizes these findings. It should be noted that Iran retains a large total stock of near 20 percent LEU.**

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 used tandem cascades to enrich to 19.75 percent comparably and effectively. During this reporting period, the FFEP achieved 0.89 swu/centrifuge-year, a decrease from the previous reporting period’s 1 swu/centrifuge-year, and the PFEP cascades achieved 0.92 swu/centrifuge-year, another slight decrease. Table 3 compares the enrichment output at the FEP, PFEP, and FFEP.

Arak IR-40 Reactor and Heavy Water Production Plant

The IAEA reports that Iran has produced 100 tonnes of reactor-grade heavy water at the Heavy Water Production Plant (HWPP) since production began in 2006. As of the last report, Iran claimed it had produced 90 tonnes and needed 100 tonnes to have sufficient heavy water for the commissioning of the IR-40 reactor.

According to a February 12, 2014 DIV at the IR-40 reactor, Iran has not installed any major components at the IR-40 reactor since the previous report, which in line with its obligations under the Joint Plan of Action. **As of January 20, 2014, the date which the JPA took effect, Iran “had ceased production of nuclear fuel assemblies for the IR-40 Reactor.”**

Toward implementation of the Iran/IAEA Framework for Cooperation, or six initial steps toward resolving the Iran nuclear file, Iran provided the IAEA managed access and information about the IR-40 reactor on December 8, 2013 and it provided an updated Design Inventory Questionnaire (DIQ). In the next seven practical measures agreed with the Agency, to be carried out by May 15, 2014, Iran has pledged to take steps “to agree with the Agency on the conclusion of a Safeguards Approach for the IR-40 Reactor.”

Iran implementing the Joint Plan of Action as agreed with P5+1

Iran is carrying out the “voluntary measures” agreed in the P5+1/Iran Joint Plan of Action on November 24, 2013, which became effective on January 20, 2014 and lasts for a duration of six months. The IAEA is monitoring and verifying those implementation steps. The report’s Annex III lists the steps thus far carried out. Many of these measures’ implementation have been discussed above and ISIS will report in later assessments on any significant developments warranting further scrutiny. **Of note, Iran is providing “managed access to centrifuge assembly workshops, centrifuge rotor production workshops and storage facilities, and provided information thereon.”** In a February 12 letter, Iran also provided the Agency with **“an inventory of centrifuge rotor assemblies to be used to replace those centrifuges that fail.”**

Iran is continuing to construct the Enriched Uranium Oxide Powder Plant (EUPP) for the conversion of UF₆ enriched up to 5% U-235 into oxide and, therefore, has yet to begin converting to oxide UF₆ “newly enriched” up to 5% U-235. Iran committed to convert all such newly enriched uranium into oxide form by the end of the six-month JPA period. On February 10, 2014, the IAEA conducted a design information verification at the EUPP during which it confirmed that the facility had yet to commence operation. In a letter dated February 14, 2014, the IAEA requested that Iran provide an updated operational schedule for the commissioning of EUPP. Iran has yet to reply.

Iran has implemented Framework for Cooperation’s six initial measures as agreed with IAEA; will implement next seven practical measures by May 15, 2014

The IAEA reports that Iran has implemented the six initial measures agreed upon with the Agency in November 2013 under the Framework for Cooperation within the three-month period, is analyzing the information, and is requesting additional clarification. **Notably, Iran has sited five potential locations for additional enrichment facilities and provided information relevant to the IAEA’s concerns about uranium laser enrichment (a follow-on ISIS report will assess these statements).** Its actions include, in relation to each commitment:

1. *Providing mutually agreed relevant information and managed access to the Gchine mine in Bandar Abbas:* Iran has provided information and access to the Gchine uranium ore mine

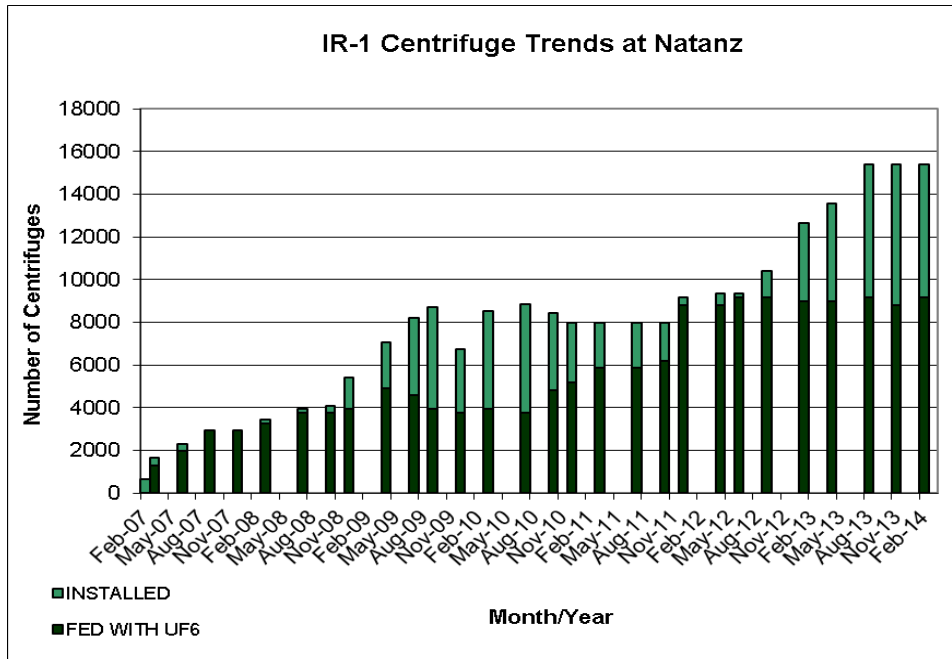
near Bandar Abbas and information on production and shipping of uranium ore concentrate (UOC);

2. *Providing mutually agreed relevant information and managed access to the Heavy Water Production Plant:* Iran has provided information and access to the Heavy Water Production Plant at Arak and an updated DIQ;
3. *Providing information on all new research reactors:* Iran informed the IAEA that a “10-MW (megawatt) light pool type research reactor with 20% enriched uranium oxide fuel, is planned to be constructed in order to fulfill the national demand...” and the site “selection process is still in its preliminary stages;”
4. *Providing information with regard to the identification of 16 sites designated for the construction of nuclear power plants:* Iran informed the IAEA it had begun to identify “candidate areas” for new nuclear power plants and provided a list of the 16 preferred candidate areas;
5. *Clarification of the announcement made by Iran regarding plans to build ten additional enrichment facilities:* **Iran notified the IAEA that it had made preliminary site selections for five new enrichment facilities but had not finalized them**, and that “successful development of new type of gas centrifuge machines” had “provided the timing flexibility before conducting next steps.” **It also stated it would not build additional enrichment sites during the six-month JPA time period;** and
6. *Further clarification of the announcement made by Iran with respect to laser enrichment technology:* **Iran stated that its announcement was related to past R&D experiences in the field of laser enrichment which ended in 2003 and since then “there had not been any especially designed or prepared systems, equipment and components for use in laser-based enrichment plants in Iran.”**

No Additional Progress on Possible Military Dimensions; Activity Observed at Parchin

The IAEA reports no additional progress on Iran addressing allegations of past military nuclear work. The IAEA underlines Iran’s agreement under the next seven practical measures under the Framework for Cooperation to provide “information and explanations for the Agency to assess Iran’s stated need or application for the development of Exploding Bridge Wire detonators.” It notes that Iran has pledged to cooperate further on addressing the past and present issues over its alleged military nuclear programs, including providing information about the foreign expert alleged to have assisted Iran on high explosives related to the development of nuclear weapons and provide access to a “location of interest” (the former site of the containment vessel for the experiments) at the Parchin site where these alleged experiments may have been carried out. Iran has taken steps to sanitize the site, observed in [ISIS satellite imagery reports](#), which “seriously undermine[s]” the IAEA’s ability to verify activities at the site. **The IAEA has observed in satellite imagery since the previous report “what appears to be possible building material and debris at the location of interest.”**

Figure 1: IR-1 Centrifuge Trends at Natanz**



** The dark green bar represents the number of IR-1 centrifuges enriching, while the light green represents the number of IR-1 centrifuges installed but not enriching. The sum of the two represent the total number of IR-1 centrifuges installed at the FEP.

Figure 2: Uranium Hexafluoride Feed at the Natanz FEP

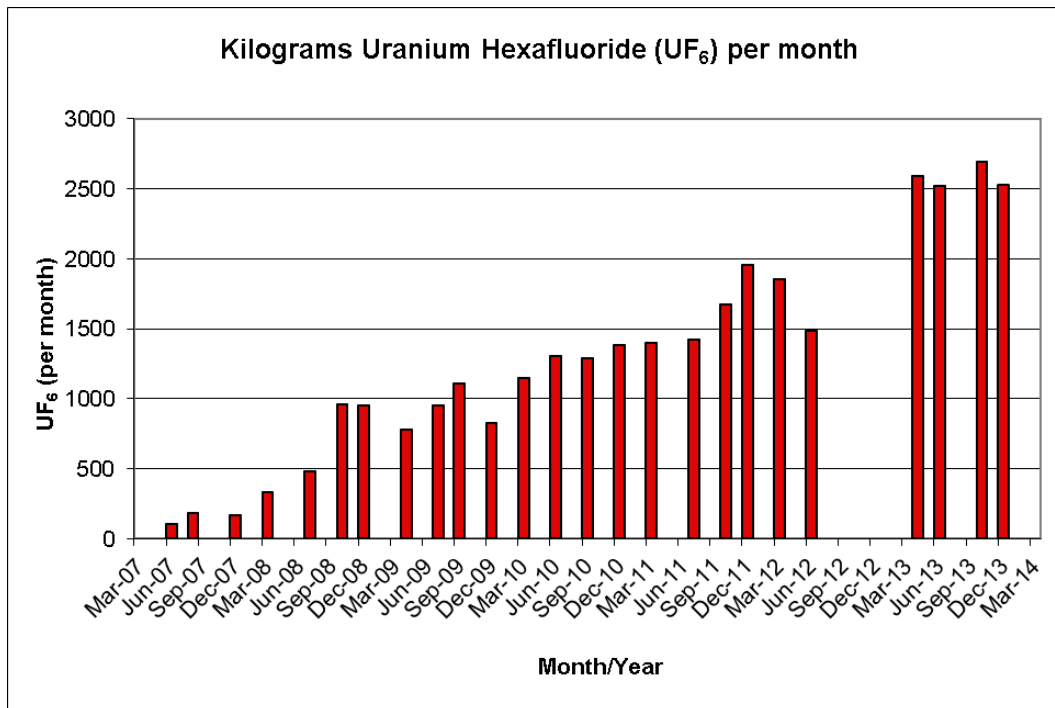


Figure 3: LEU Production (kilograms uranium hexafluoride per month) at Natanz

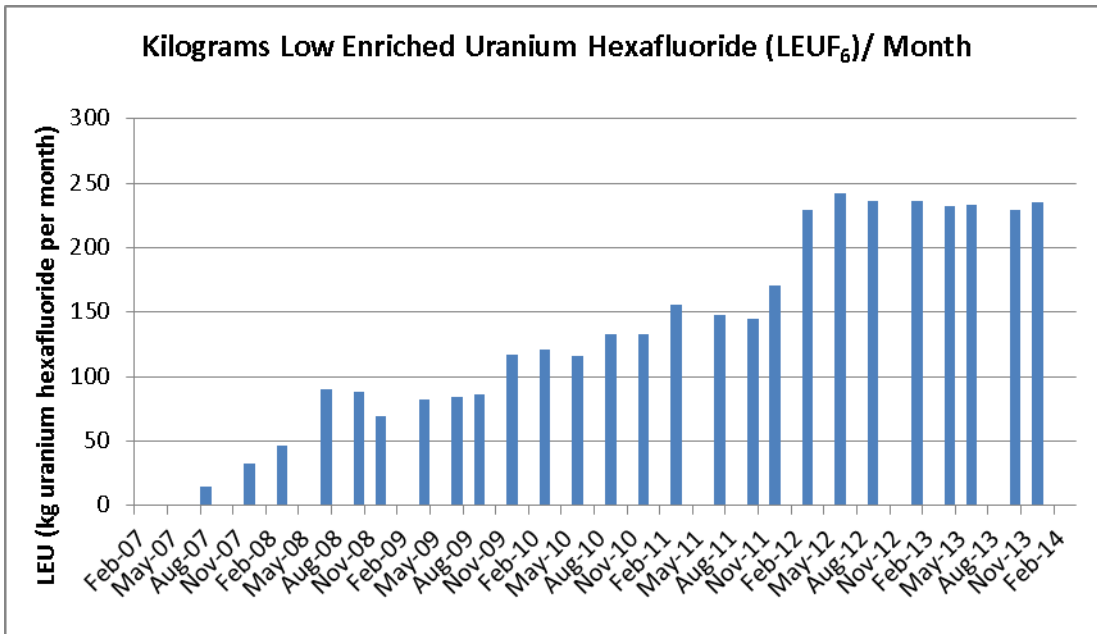


Figure 4: Overall Trends at Natanz

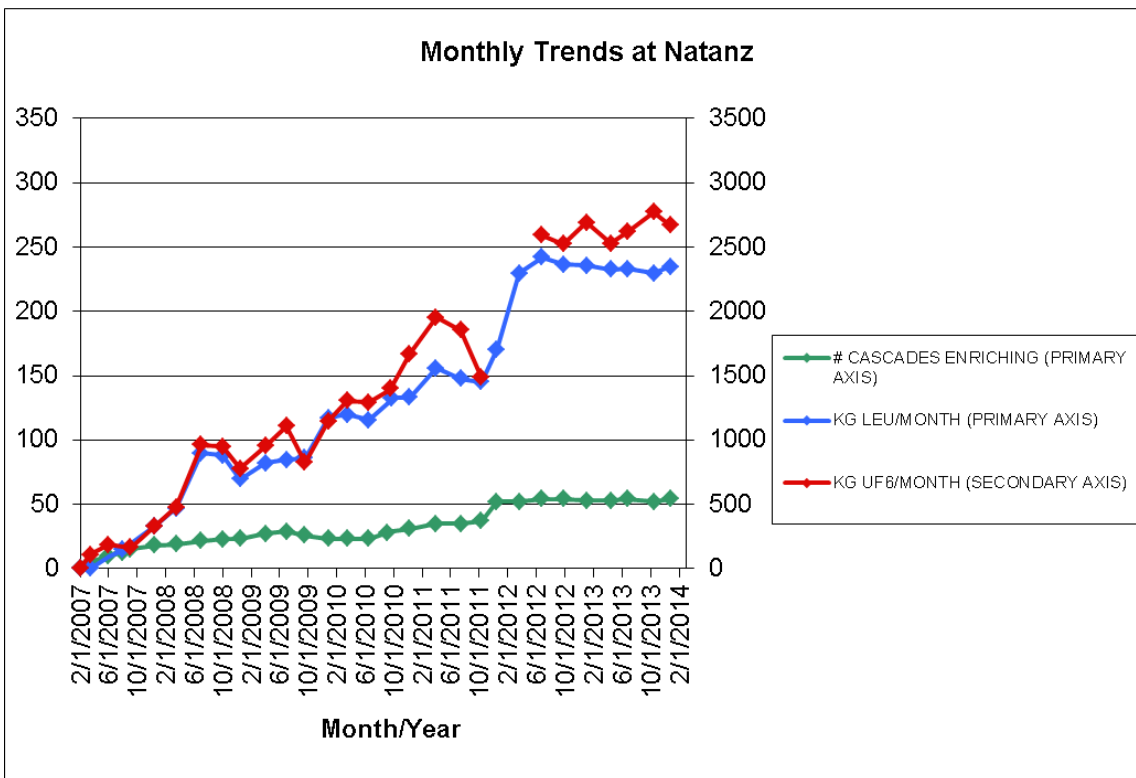


Figure 5: Cumulative LEU Production at the Natanz Fuel Enrichment Plant

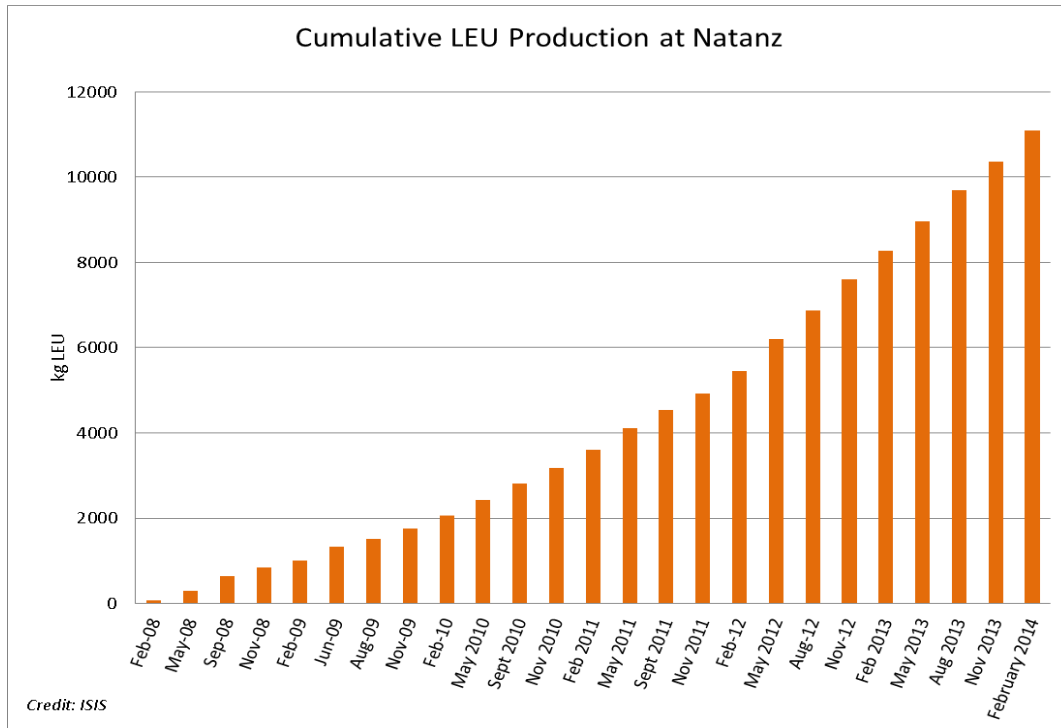


Figure 6: Annualized SWU at Natanz

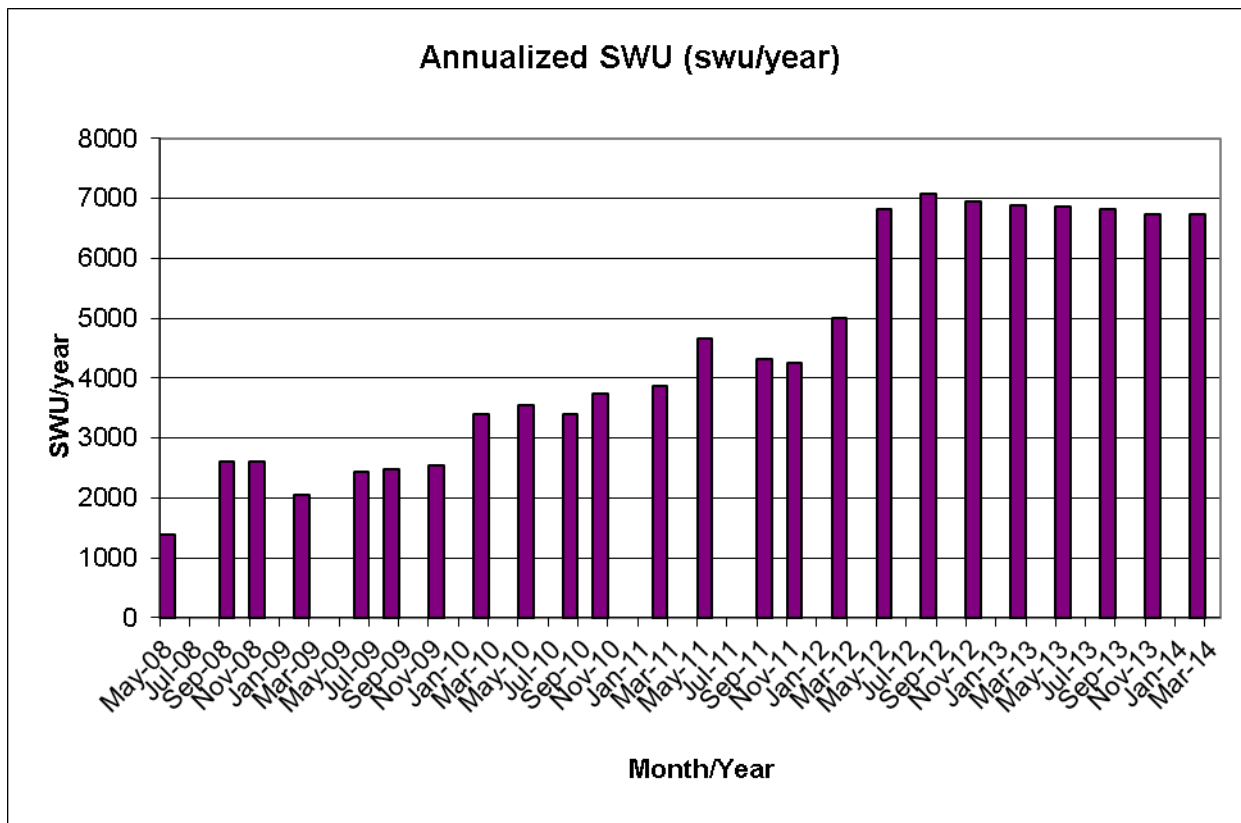


Figure 7: IR-2m Progress at the FEP

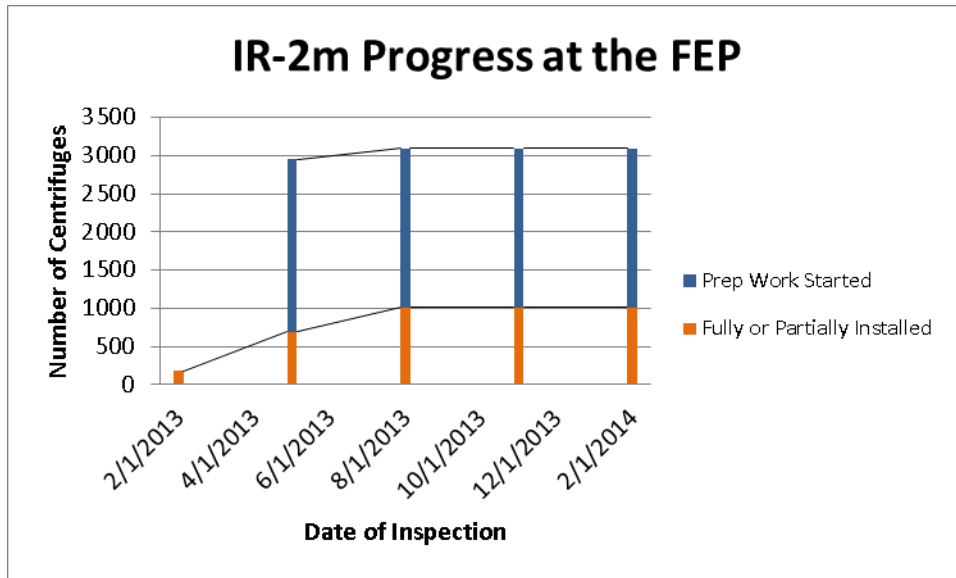


Figure 8: Total Number of Deployed IR-1 Centrifuges in Iran

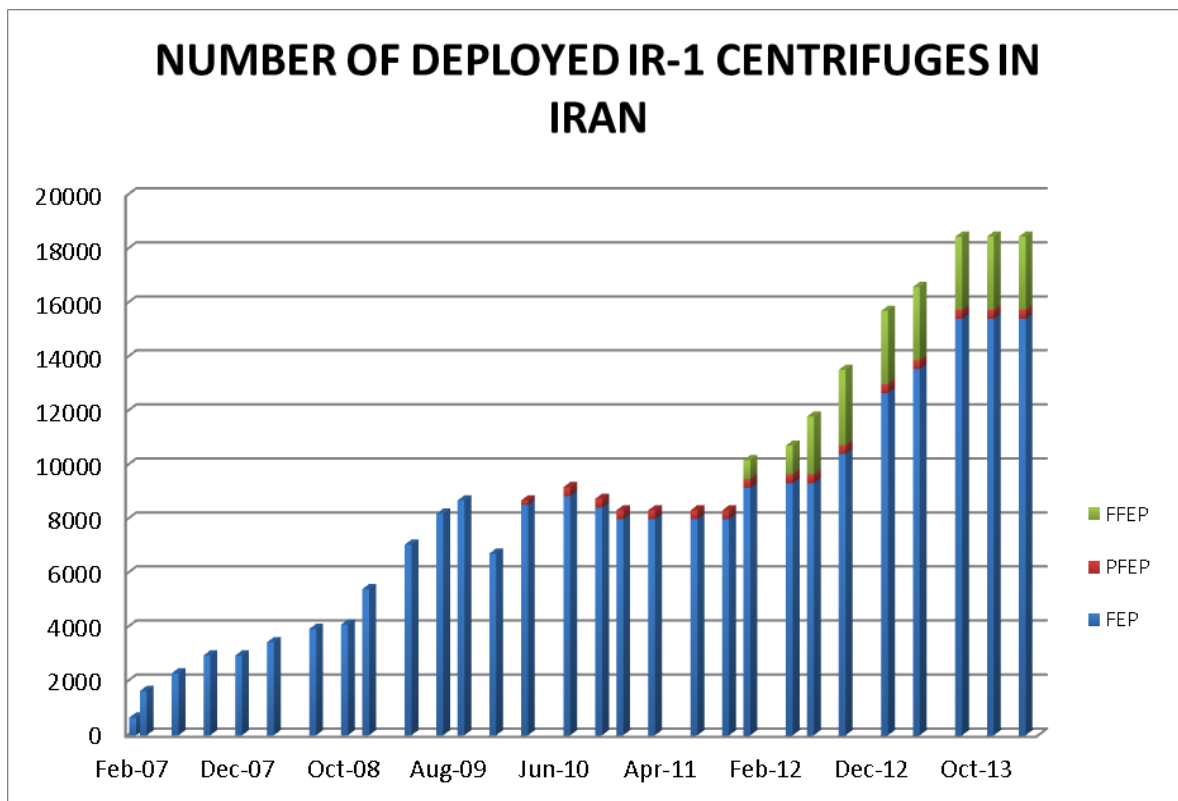


Figure 9: Cumulative 19.75 Percent Uranium Production in the PFEP and FFEP

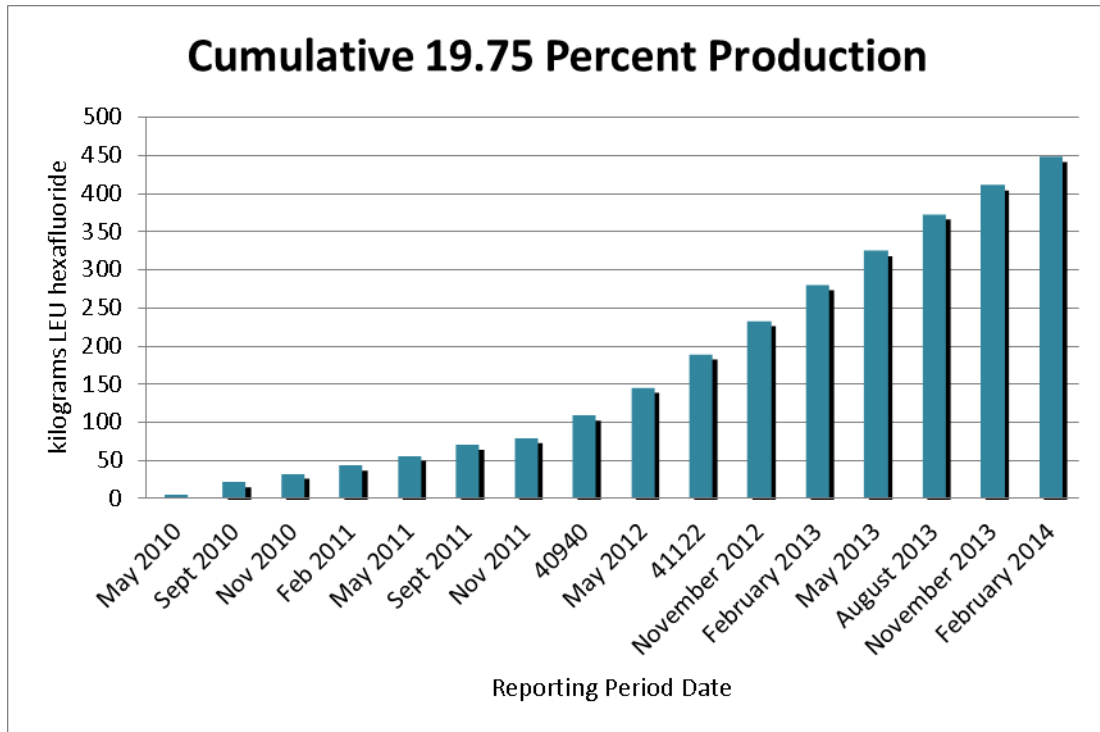


Figure 10: SWU/Centrifuge-year at the Fordow Fuel Enrichment Plant and Pilot Fuel Enrichment Plant

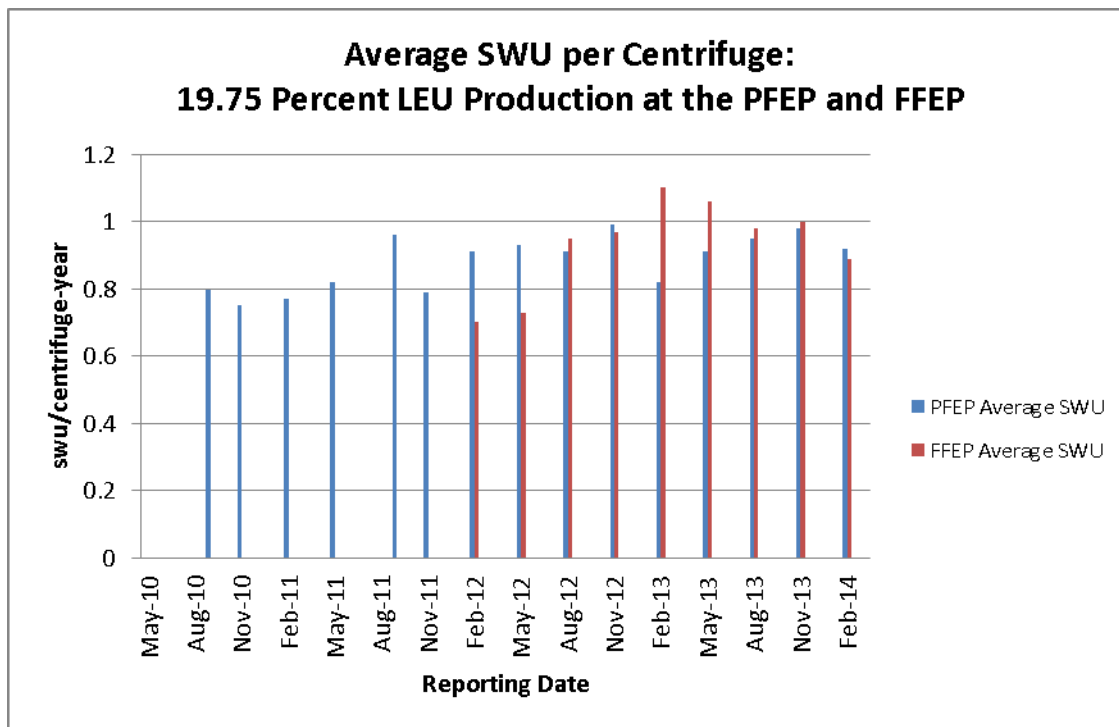


Figure 11: IR-1 Centrifuges Enriching and Installed at the Fordow Fuel Enrichment Plant

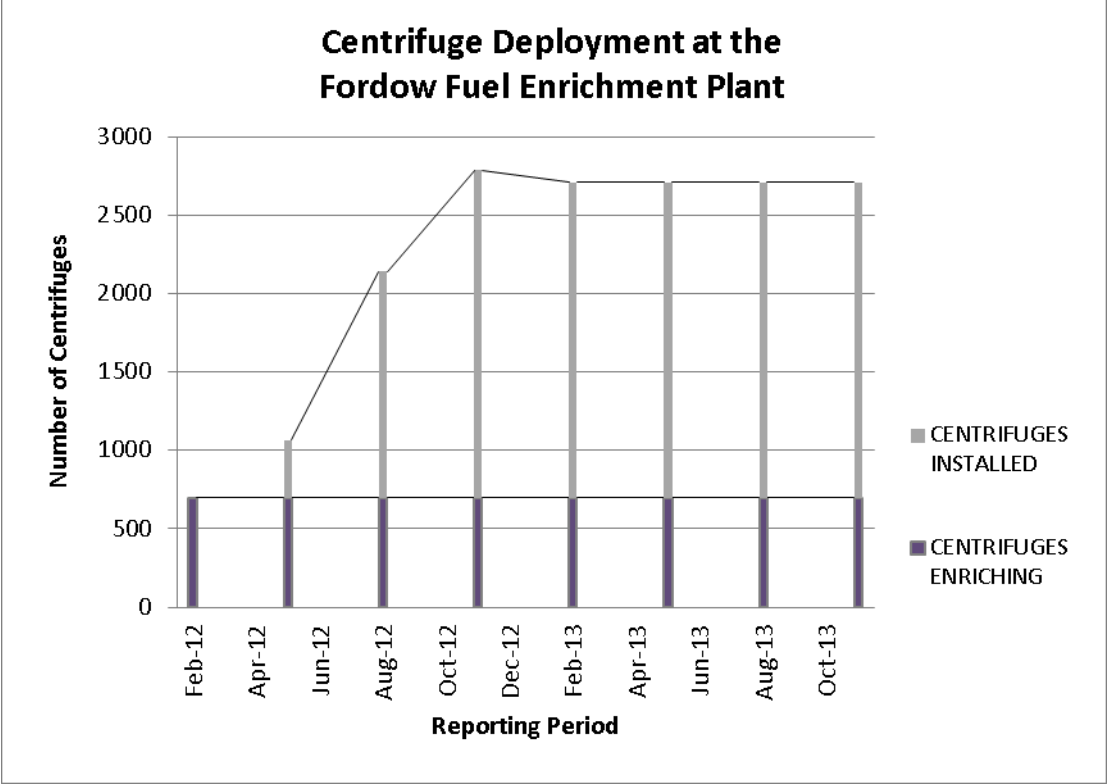


Table 1: Minimal Average Separative Capacity of an IR-1 Centrifuge at the FEP**(kg U swu/year-centrifuge)**

<i>Period</i>	<i>Start of Period</i>	<i>End of Period</i>
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	0.53 (Note: Iran began enriching in approximately 2,600 additional centrifuges during this period. Therefore, these data are likely skewed.)
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
02/04/2013 – 05/04/2013	0.76	0.76
05/05/2013 – 08/16/2013	0.76	0.74
08/17/2013 – 11/05/2013	0.74	0.76
11/06/2013 – 02/09/2014	0.78	0.75

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	126,815 kg	11,091 kg	N/A	N/A
PFEP	35	4	1,631 kg	202 kg
FFEP	144	16	1,806 kg	246 kg
GROSS TOTAL	126,994 kg	11,111 kg	3,437 kg	448 kg
NET TOTAL	126,994 kg	7,834 kg*	3,437 kg	161 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 includes approximately 160 kg resulting from downblending 19.75 percent enriched uranium with natural uranium blendstock.

**Number is less 262.7 kg of 19.75 percent LEU hexafluoride fed into the process at the Fuel Plate Fabrication Plant near Esfahan and 24.5 kg 19.75 percent LEU hexafluoride down blended.

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	0.92 swu/cent-year
FFEP	N/A	0.89 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.