**November 16, 2012**

# ISIS Analysis of IAEA Iran Safeguards Report, Rev. 1

**by David Albright, Christina Walrond, and Andrea Stricker**

The International Atomic Energy Agency (IAEA) released on November 16, 2012 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 both at Fordow and Natanz Increased;
2. No Additional 19.75 Percent Enriched Uranium Hexafluoride Sent to the Uranium Fuel Fabrication Plant at Esfahan;
3. Number of Cascades Producing Near 20 percent LEU Remains Constant;
4. All Centrifuges Installed at Fordow;
5. Advanced Centrifuge Program Making Progress;
6. Nuclear Spill Occurred at Uranium Conversion Facility;
7. Little Hope for Structured Agreement to Resolve Issues on Iran's Past and Possibly On-Going Military Nuclear Activities;
8. Iran Continues Sanitizing Parchin Site;
9. IAEA Reiterates its Current Inability to Verify Completeness of Iran's Declaration, Underlines its Mandate to do so.

## 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 November 9, 2012 is reported to be 7,611 kilograms (kg), including 735 kg estimated by Iran to have been produced since August 7, 2012**. **This total amount of 3.5 percent low enriched uranium hexafluoride, if further enriched to weapon grade, is enough to make, in theory, six or seven 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 (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 was approximately 237 kg per month of LEU hexafluoride, a rate that has stayed about the same as the last reporting period, when Iran produced on average 242 kg per month.**

As of November 10, 2012, Iran had 61 centrifuge cascades fully installed and a 62$^{nd}$ cascade partially installed for a total of 10,414 IR-1 centrifuges. Iran has increased the number of centrifuges installed at the FEP by 1,084 centrifuges since the end of the last reporting period. However, Iran did not

increase the number of cascades in which it was enriching. A total of 54 cascades containing 9,156 centrifuges enriched for the duration of the most recent reporting period. Iran fed 7,839 kg of natural uranium hexafluoride into the cascades at the FEP. This appears to be consistent with the previous reporting period, although the IAEA has reported feed numbers sporadically and precise estimates of the feed rate at the FEP are very difficult to ascertain from the available data. 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, 735 kg of LEU translates to 1,807 kg of swu, or 19 kg swu/day. On an annualized basis, this is about 6,943 kg swu per year (see Figure 6). These numbers are consistent with the previous reporting period.

The number of centrifuges declared as enriching was 9,156 at both the beginning and the end of the reporting period, corresponding with an average swu/centrifuge-year of 0.76, nearly the same as the last reporting period. 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.

## Deployment of Advanced Centrifuges at Pilot Fuel Enrichment Plant (PFEP) Moving Ahead

As of the latest IAEA report, Iran has been testing advanced centrifuges in production scale cascades at the Pilot Fuel Enrichment Plant (PFEP) at Natanz. Since the last reporting period, Iran has slightly increased the number of advanced centrifuges at the PFEP. As of August 18, 2012, 162 out of 164 IR-2m centrifuges were installed and apparently enriching in cascade 5. As of November 6, cascade 5 contained its full complement of 164 IR-2m centrifuges, and cascade 3 had 14 IR-2m centrifuges, where in the previous reporting period this cascade was empty.

Iran has also increased the number of IR-4 centrifuges in the pilot plant. As of August 18, 2012, it had 123 IR-4 centrifuges in cascade 4 and 10 IR-4 centrifuges in cascade 2. Both were being fed intermittently. As of November 6, cascade 4 had 144 IR-4 centrifuges and cascade 2 had 32 IR-4 centrifuges. Iran continues to feed these cascades intermittently.

Iran has yet to install three new types of centrifuges (IR-5, IR-6, and IR-6s) although it has indicated it intends to do. On November 6, 2012, inspectors observed the presence of two empty casings for IR-6 centrifuges at the PFEP. According to Iran, complete IR-6 centrifuges had been delivered to the pilot plant, but the rotors had subsequently been removed for testing somewhere other than the PFEP.

The IAEA report does not provide any indication of how well the advanced centrifuges are operating. The IR-4 involves a carbon fiber bellows, which is not a common way to make a bellows, and many governments expect that Iran has encountered difficulties in developing this centrifuge. However, Iran should have less trouble with the IR-2m centrifuge, which uses a maraging steel bellows, like the IR-1 centrifuge, albeit considerably more difficult to make. Iran has an incentive to succeed with the advanced centrifuges, because their enrichment capacity could be four times that of the IR-1.

A troubling possibility is that Iran could deploy the IR-2m in a third, possibly secret, enrichment facility. Iran claims it does not have to inform the IAEA about a new nuclear facility until it is nearly complete, and Iran has been ambiguous about whether it is building one. However, the IAEA rejects Iran's attempt to exempt itself from the requirement to report a new nuclear facility when construction is approved and views Iran as not in conformity with its comprehensive safeguards agreement. Iran was discovered secretly building the Fordow enrichment plant in early 2009; many increasingly worry that Iran is in the process of building another secret gas centrifuge plant. It is unlikely that it would be operational but a question is whether the IR-2m may be the centrifuge of choice for such a facility.

## 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 August 22, 2012 and November 11, 2012, 92.2 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 13.2 kg of nearly 20 percent LEU hexafluoride during this reporting period. Iran appears to be operating this set of cascades fairly consistently, and has achieved the same level of performance over the past year. **Thus, Iran is producing 19.75 percent enriched uranium at a rate of 5 kg per month in this tandem set. In total, Iran has fed 1,177[1] kg of 3.5% LEU to produce 137 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

[1] The IAEA reports two different numbers for the feed at the PFEP. For the purposes of this report, this number, slightly lower than what the IAEA reports initially, is derived from the date-specific reporting about the feed at the PFEP in paragraph 18.

centrifuges, the same number of centrifuges enriching as was reported in both the 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.**

At the beginning of this reporting period, Units 1 and 2 had a total of 2,140 IR-1 centrifuges installed. During this reporting period, Iran continued to place IR-1 rotor assemblies into outer casings. As of the November 16, 2012 report, it had fully installed all the rotor assemblies in this facility, bringing the total to 2,784 IR-1 rotor assemblies installed. **However, of the 12 cascades installed at the Fordow facility but not enriching, only four cascades are fully outfitted with pipes, electronics, and other critical materials. These four have been subjected to vacuum testing and are ready for feeding with uranium hexafluoride. The eight additional cascades have centrifuges with rotors and casings, but lack critical equipment that would allow Iran to enrich uranium in these last eight cascades.**

**Iran has not started to enrich in any of these newly installed centrifuges; in fact, Iran has not increased the number of centrifuges enriching in two 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.

Between August 13, 2012 and November 10, 2012, the two sets of tandem cascades produced approximately 30.2 kg of 19.75 percent enriched uranium at a combined average rate of 10.25 kg of 19.75 percent LEU hexafluoride per month. This tracks closely with Iran's rate of production during the last reporting period, where it produced 29.8 kg of 19.75 percent enriched uranium at a rate of 10.04 kg per month.

**The Fordow plant appears to have received higher priority than the Natanz FEP in terms of the installation of the IR-1 centrifuges.** Moreover, Iran seems to have deliberately focused on placing centrifuges in this facility rather than bringing centrifuges into enrichment operations. Figure 9 displays the number of centrifuges enriching and installed at the FFEP graphically.

Although we can only speculate on Iran's motivations, it may be signaling that it is choosing to limit its production rate of 19.75 percent LEU because it fears a more negative reaction from the international community, understanding that increasing that rate could stimulate greater sanctions and even military strikes. It may also be doing its own signaling, in essence using the Fordow facility as a bunker for IR-1 centrifuges, a facility Israel states it cannot destroy. Thus, if Israel attacks, Iran may calculate that the centrifuges at Fordow would survive, even if all centrifuge capabilities on the surface, including at Natanz, were destroyed. After the strike, Iran could use the centrifuges at Fordow or elsewhere in a reconstituted program, perhaps without any IAEA inspectors and with the intention to make weapon-grade uranium.

**Iran may choose to pipe these cascades into tandem sets and produce near 20 percent LEU, and it bears watching whether it can operate these cascades as well as it operates its current sets of tandem cascades.** Iran seems to have achieved a greater level of efficiency by using a tandem

cascade orientation, with the tandem cascades achieving about 0.9 swu/centrifuge-year. The individual cascades in the Natanz FEP only achieve about 0.76 swu/centrifuge-year. However, it is possible that Iran simply has trouble operating its IR-1 on a wide scale; the Natanz facility enriches to 3.5 percent in about 9,000 centrifuges, while Iran has only dedicated approximately 1,000 centrifuges between the FFEP and the PFEP to enrichment to 19.75 percent.

## 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. A total of 96.3 kg of 19.75 percent LEU hexafluoride was sent to the conversion plant by this date. Of this amount, 25.05 kg was in the form of uranium hexafluoride in a cylinder connected to the plant. The other 71.25 kg had been fed into the process lines, resulting in 31.1 of good $U_3O_8$ product. The remainder, or 40.15 kg, was held up in the process or in the waste flow.

According to this most recent report, between the start of conversion activities on December 17, 2011 and September 26, 2012, 82.7 kg of the near 20 percent enriched uranium hexafluoride had been fed into the conversion process and 38 kg of uranium had been produced in the form of $U_3O_8$ powder and fuel items. Iran stated that between September 27, 2012 and November 10, 2012, it did not convert any more of the near 20% LEU hexafluoride contained in the cylinder attached to the process line. **Thus, about 13.6 kg of near 20 percent LEU remains in the form of hexafluoride at the plant.**

The relatively small amount of good, near 20 percent $U_3O_8$ raises questions about whether the Fuel Plate Fabrication Plant is performing well. It is known that Iran has recycled some of material that has not met required specifications.

The report does not make clear if Iran has sent additional near 20 percent LEU hexafluoride to the Esfahan conversion site after August 2012. However, it if did, the near 20 percent LEU remains in the form of hexafluoride.

## Taking Stock

Iran has produced a total of 7,611 kilograms of 3.5 percent LEU hexafluoride. About 1,870 kilograms have been used to make the 19.75 percent LEU hexafluoride.

**Combined, the PFEP at Natanz and the FFEP have produced 232.8 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, 15.1 versus 14.4 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% LEU far exceeds Iran's need for enriched uranium for the Tehran Research Reactor.

Of the 232.8 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 November 10, 2012 the IAEA reported that Iran fed into the process line at the Fuel Plate Fabrication Plant at Esfahan 82.7 kilograms of uranium hexafluoride enriched up to 20 percent uranium-235, and it produced 38 kilograms of uranium enriched up to 20 percent 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. Since the beginning of operations, the IAEA has stated that 96.3 kilograms of 19.75 percent LEU has been sent or fed to the uranium conversion facilities. **In summary, about 134.9 kilograms of 19.75 percent LEU hexafluoride remained as of November 10, 2012 at the enrichment plants. Another 13.6 kg of 19.75 percent LEU hexafluoride was at the Fuel Plate Fabrication Plant and slated for conversion to oxide. Table 2 summarizes these findings.**

Iran has achieved varying rates of separative work in the IR-1 centrifuge at its enrichment plants. Although it 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 0.97 swu/centrifuge-year up marginally from 0.95 swu/centrifuge-year during the last reporting period, and the PFEP cascades achieved 0.99 swu/centrifuge-year, comparable to their performance during the last reporting period. Figure 8 shows these figures graphically. Table 3 compares the enrichment output at the FEP, PFEP, and FFEP.

## Work Continues at IR-40 Nuclear Reactor, but Start Date Delayed

The IAEA reports that construction on the IR-40 heavy water moderated research reactor at Arak continued, in particular that the installation of cooling and moderator circuit piping continues. However, Iran told the IAEA that the operation of the IR-40 Reactor was now expected to commence in the first quarter of 2014, not late 2013 as previously stated.

## Nuclear Accident at Uranium Conversion Facility

On November 6, 2012, Iran informed the IAEA that, due to the rupture of a storage tank, a large quantity of liquid containing natural uranium scrap material had spilled onto the floor of the facility. IAEA inspectors confirmed the spillage. The radiological implications are not discussed.

## No Results on Resolving Possible Military Dimensions

The IAEA reports that "since the November 2011 Board, **the Agency, through several rounds of formal talks and numerous informal contacts with Iran, has made intensive efforts to seek to resolve all of the outstanding issues related to Iran's nuclear programme, especially with respect to**

**possible military dimensions, but without concrete results.**" The Agency describes this safeguards report as providing a "comprehensive report on substantive implementation" of IAEA Board of Governors resolutions calling on Iran to address military related dimensions.

The IAEA describes in detail its long running effort to establish a process with Iran or otherwise make progress on resolving questions and concerns about the military dimensions of its nuclear program. Specific steps listed by the IAEA include: seeking agreement on a "structured approach" to clarify outstanding issues; requesting an initial declaration about evidence of the military related activities outlined in an annex in the IAEA's November 2011 safeguards report; identifying as part of a structured approach thirteen topics which need to be addressed; providing Iran with on-going clarifications about the IAEA's concerns, including its concerns about the Parchin site suspected of housing high explosive tests related to nuclear weapons development and the unnamed foreign expert alleged to have assisted Iran at Parchin (identified by ISIS and others as former Soviet scientist Vycheslav V. Danilenko); and finally, requesting access to the Parchin site for inspection.

The IAEA concludes that as a result of this lack of progress, "The Director General is, therefore, unable to report any progress on clarifying the issues relating to possible military dimensions to Iran's nuclear programme." It adds, "Given the nature and extent of credible information available, the Agency continues to consider it essential for Iran to engage with the Agency without further delay on the substance of [its] concerns." The IAEA reports that it will meet with officials in Tehran on December 13, 2012 in yet another attempt to establish a structured approach to resolve these outstanding issues, the result of a suggestion in a letter from the IAEA to Iran in late October.

## Continuing Activities at Parchin Site, No Grant of Access

Iran has continued to refuse IAEA requests for access to the Parchin military site, where the IAEA has evidence from member states "indicat[ing] that Iran constructed a large explosives containment vessel in which to conduct hydrodynamic experiments" relevant to nuclear weapons development. The IAEA reports that satellite imagery continues to show "significant developments" taking place at the Parchin military site leading to resultant changes that could be aimed at sanitizing or removing evidence of past activities from buildings and their environs. Among the developments observed by the IAEA since it first expressed interest in visiting this location in February 2012, as quoted from the IAEA report, are:

- Frequent presence of, and activities involving, equipment, trucks and personnel;
- Run off of large amounts of liquid from the containment building over a prolonged period;
- Removal of external pipework from the containment vessel building;
- Razing and removal of five other buildings or structures and the site perimeter fence;
- Reconfiguration of electrical and water supply infrastructure;
- Shrouding of the containment vessel building and another building; and

- Initial scraping and removal of considerable quantities of earth at the location and its surrounding area, covering over 25 hectares, followed by further removal of earth to a greater depth at the location and the depositing of new earth in its place.

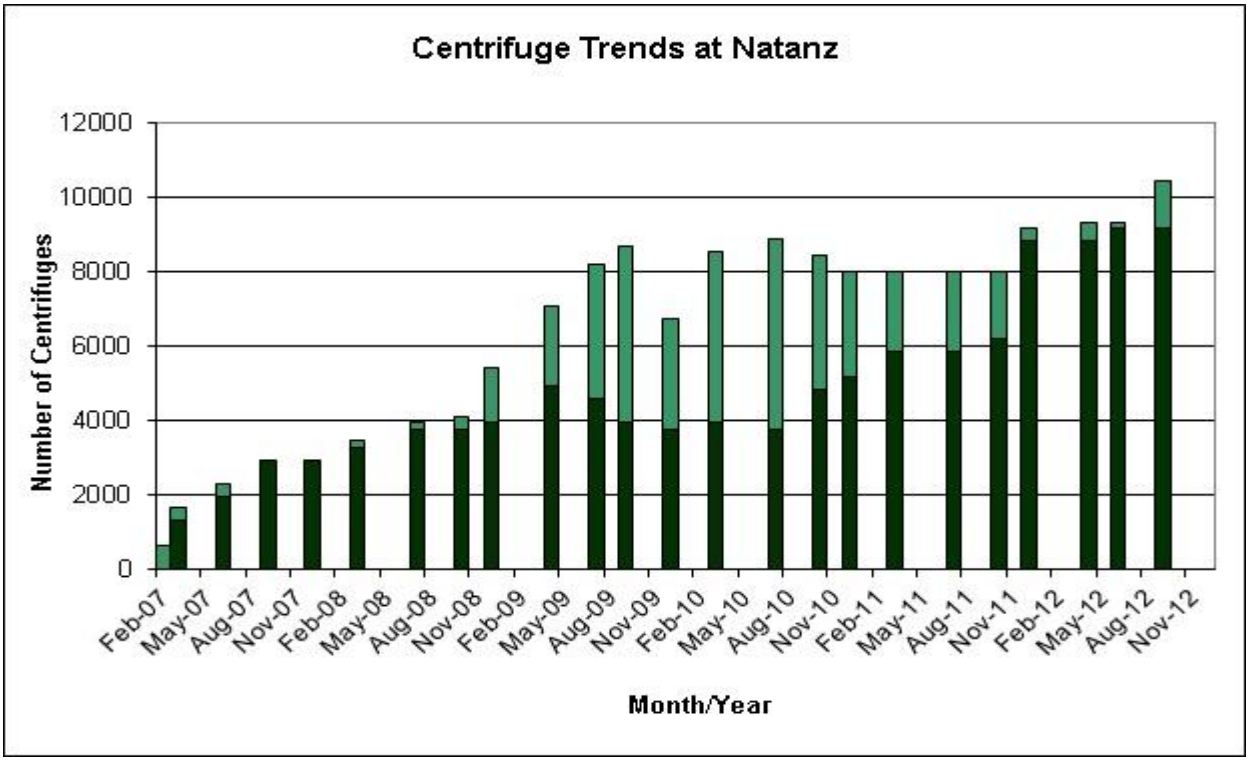
The third and final points about removal of external pipework from the containment vessel building and about a depositing of new earth where earth was removed are new observations and ones that were not previously reported by ISIS. (See previous ISIS imagery analysis on the apparent sanitization activities at Parchin here.) Iran undertook sanitization activities, including the removal of earth and deposit of new earth, at Lavisan-Shian in 2004. These activities are suspected to be related to Iran hiding evidence of efforts of the Physics Research Center, a military entity linked to parallel military nuclear activities that was sited there until the late 1990s.

The IAEA reiterates that in light of these continuing activities at Parchin, "When the Agency gains access to the location, its ability to conduct effective verification will have been seriously undermined." It nonetheless reiterates its "request that Iran, without further delay, provide both access to that location and substantive answers to the Agency's detailed questions regarding the Parchin site and the foreign expert (Danilenko)."

## 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 (data no longer reported quarterly by the IAEA)**

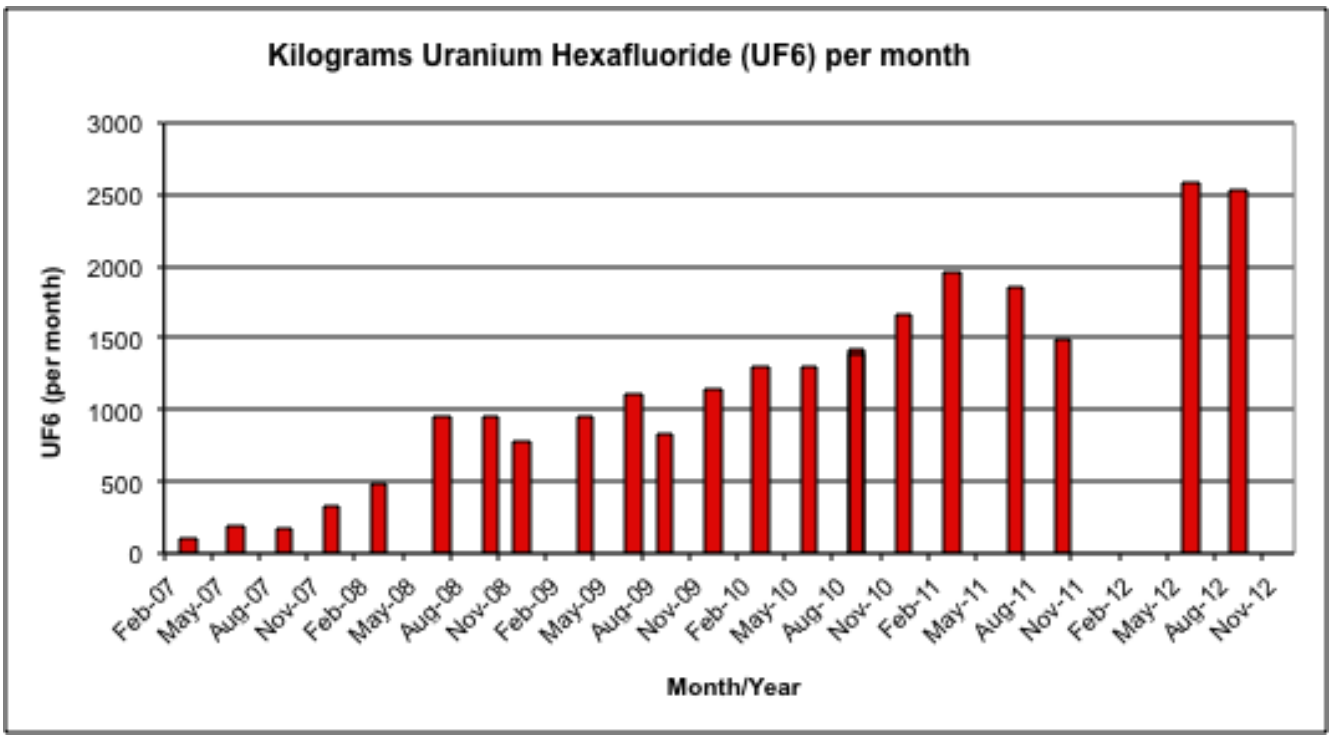


**Figure 3: LEU Production (per month) at Natanz**

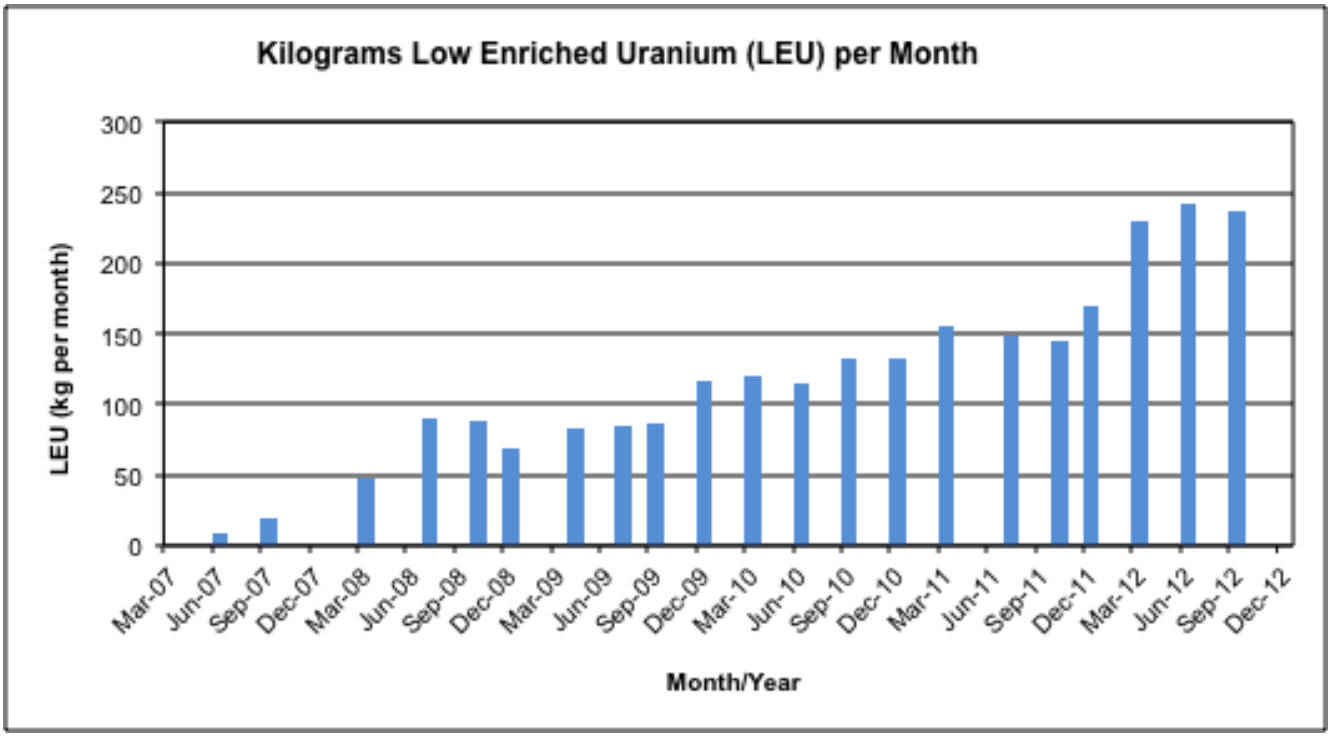



**Figure 4: Overall Trends at Natanz**

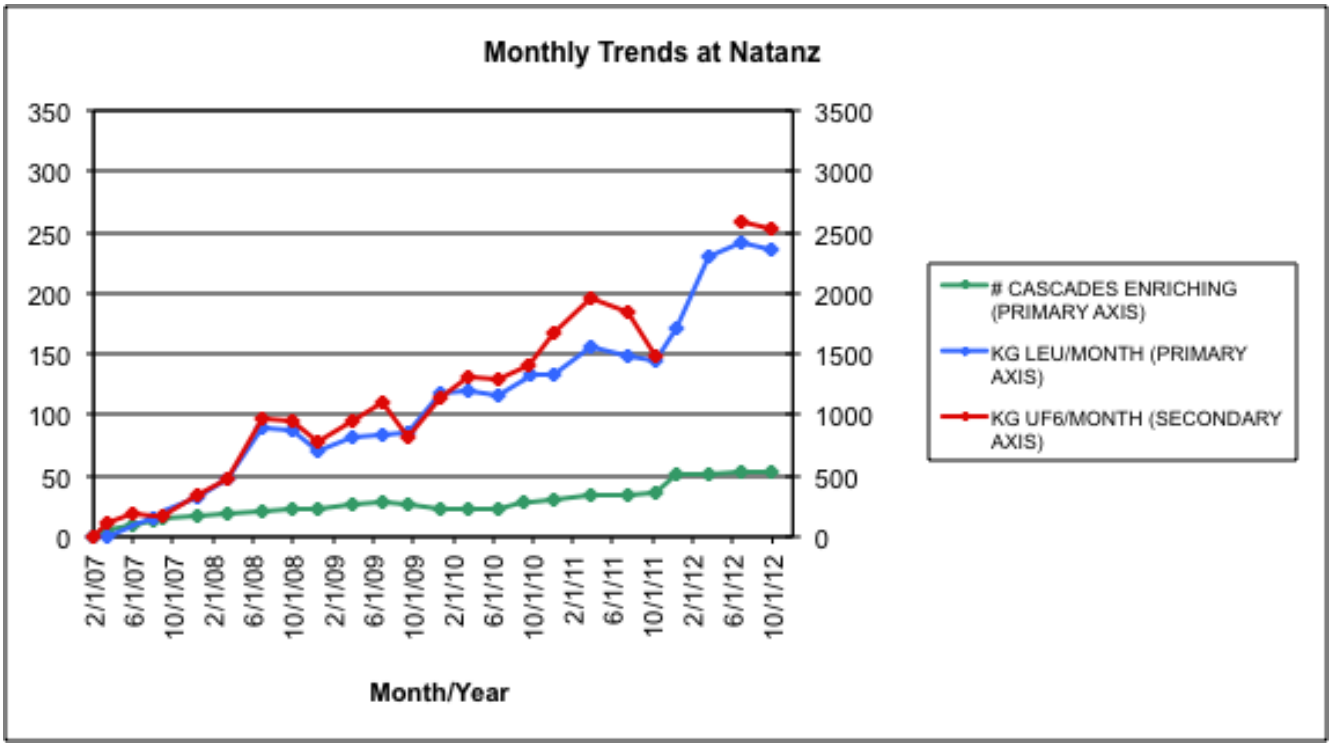


**Figure 5: Cumulative LEU Production at the Natanz Fuel Enrichment Plant**

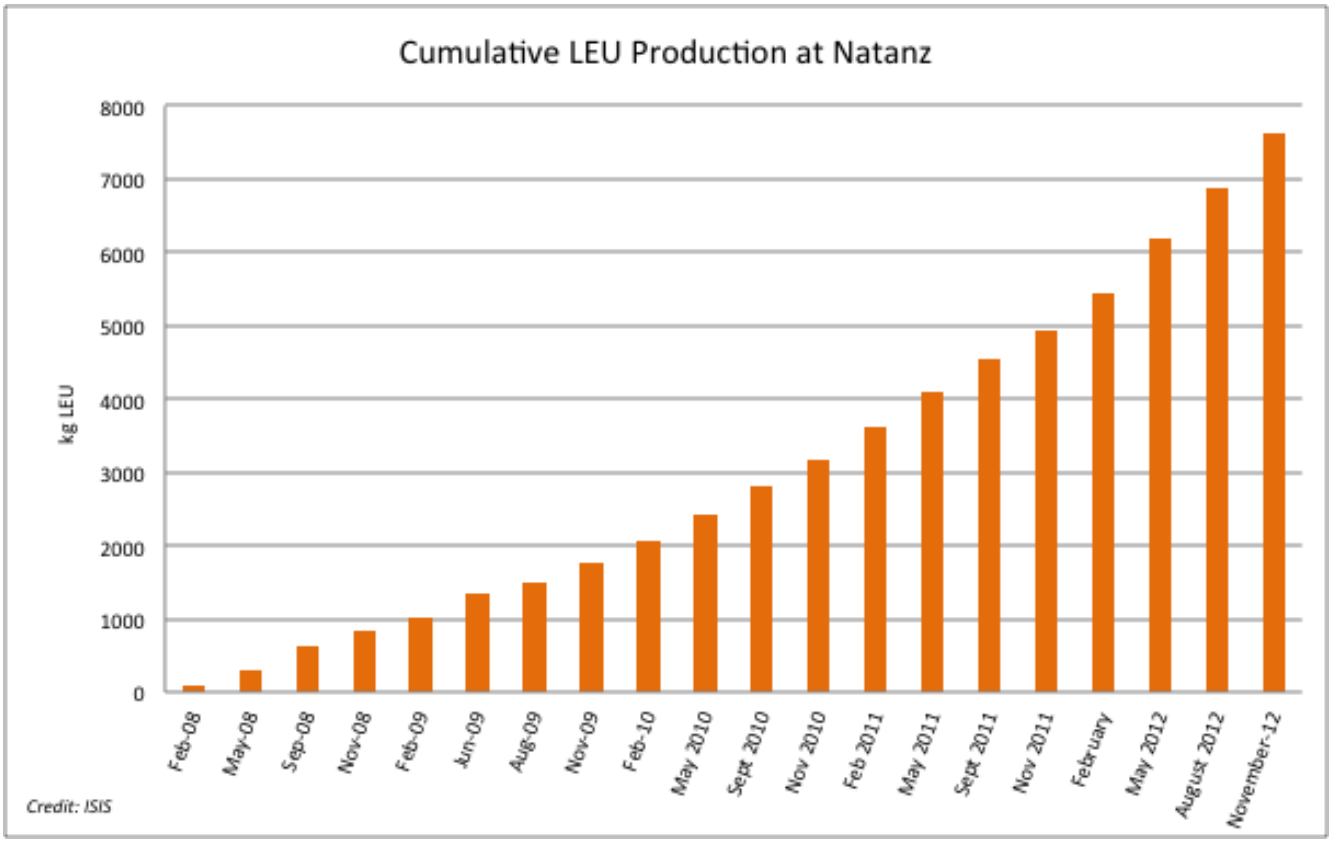



**Figure 6: Annualized SWU at Natanz**

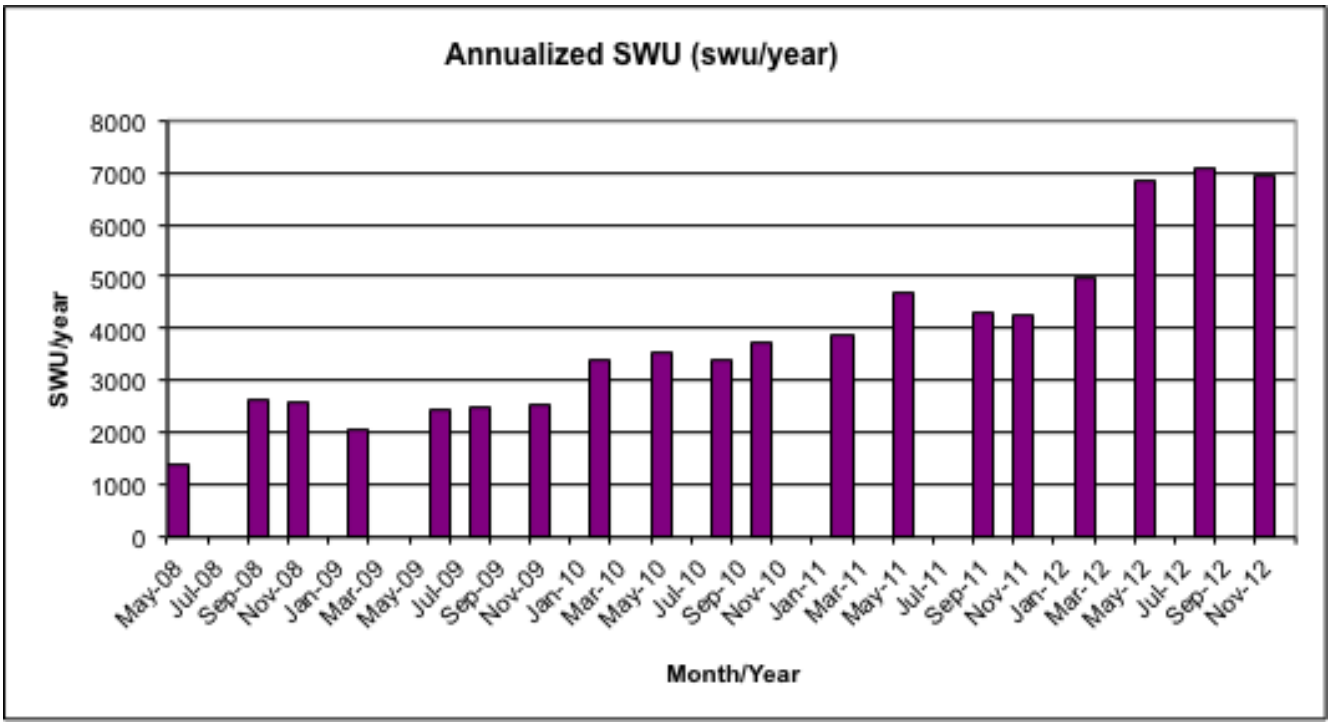


**Figure 7: Cumulative 19.75 Percent Uranium Production in the PFEP and FFEP**

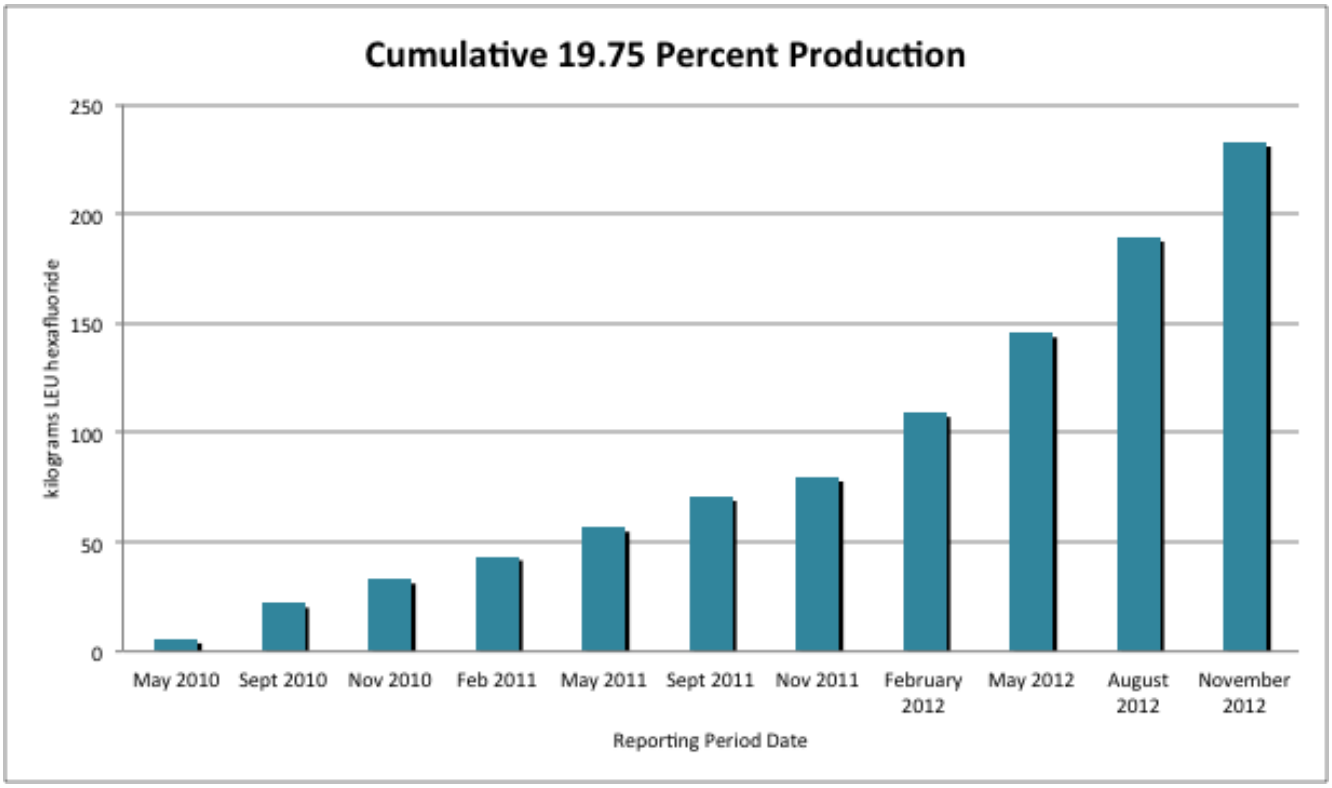



**Figure 8: SWU/Centrifuge-year at the Fordow Fuel Enrichment Plant and Pilot Fuel Enrichment Plant**

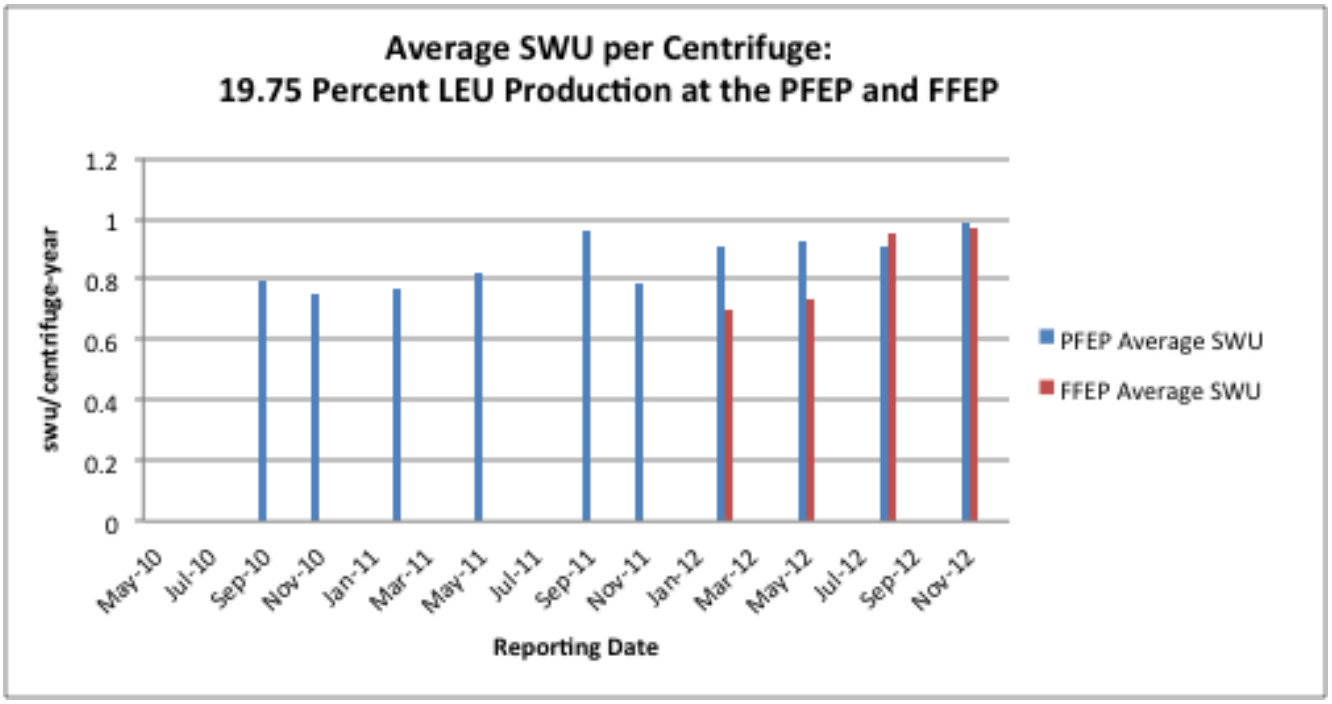


**Figure 9: Centrifuges Enriching and Installed at the Fordow Fuel Enrichment Plant**

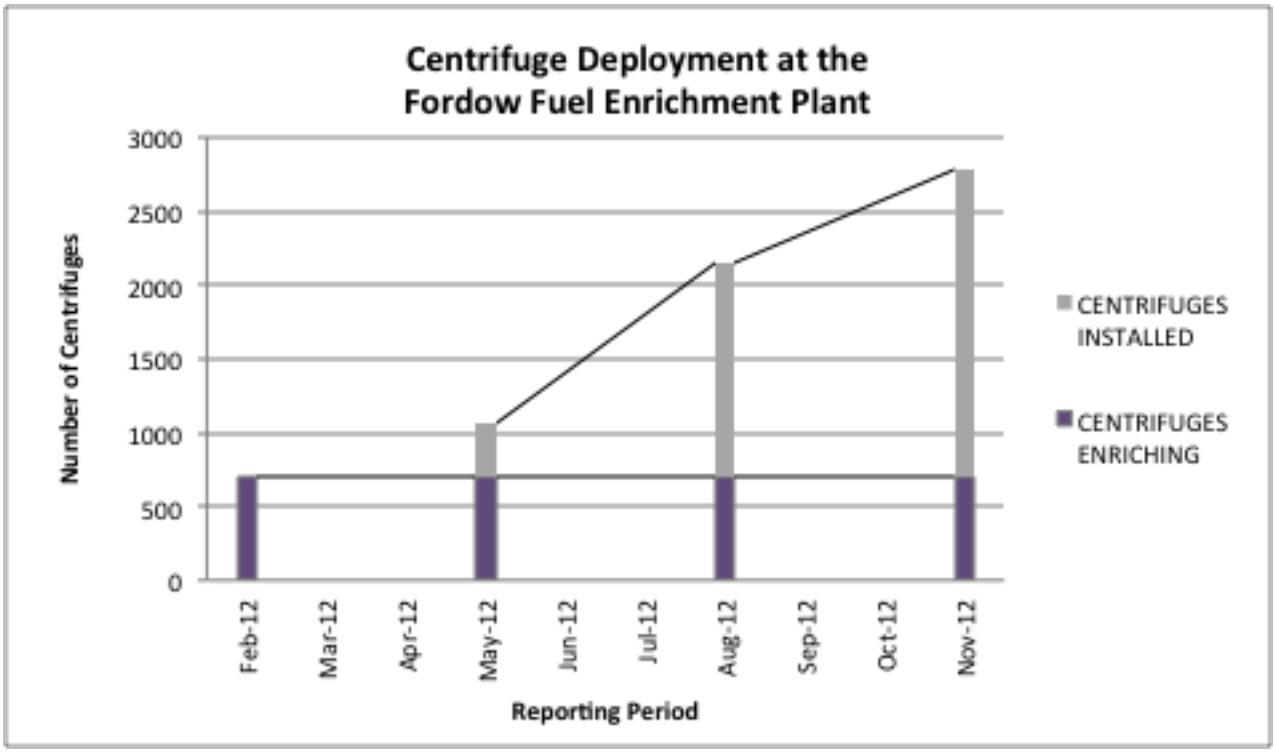


**Table 1: Minimal Average Separative Capacity of an IR-1 Centrifuge at the FEP**

**(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<br>(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<br>(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 |

## 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 | 87,220 kg | 7,611 kg | N/A | N/A |
| PFEP | N/A | N/A | 1,177 kg | 137.3 kg |
| FFEP | N/A | N/A | 693 kg ** | 95.5 kg |
| **GROSS TOTAL** | 87,220 kg | 7,611 kg | 1,870 kg | 232.8 kg |
| **NET TOTAL** | 87,220 kg | 5,688 kg* | 1,870 kg | 134.9 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.

**This number is the smaller of the two numbers given by the IAEA and is the one that appears in the Fordow section. It tracks more closely with previous reporting periods

***Number is less 96.3 kg of 19.75 percent LEU hexafluoride sent to the Fuel Plate Fabrication Plant near Esfahan and 1.6 kg 19.75 percent LEU hexafluoride downblended. As of November 10, 13.6 kg of this material at Esfahan remained in the form of uranium hexafluoride but is slated for conversion to oxide, which is the reason for not including it in the table.

## Table 3: COMPARATIVE SWU* 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** | **0.99 swu/cent-year** |
| **FFEP** | **N/A** | **0.97 swu/cent-year** |

*****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.