



February 25, 2011

## **IAEA Iran Safeguards Report:**

# **Expansion of Natanz Enrichment Plant Lags; LEU Production Not as High as Expected; Iran Ready to Deploy Advanced Centrifuges for Deployment?; Continued Non-Cooperation on Military Dimensions**

(Rev. 1)

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The International Atomic Energy Agency (IAEA) released on February 25, 2011 its latest report on the implementation of NPT safeguards in Iran and the status of Iran's compliance with Security Council Resolutions 1737, 1747, and 1803. The following analysis highlights the IAEA's key findings, including: 1) clearer statements about Iran not meeting its obligations under its safeguards agreement and United Nations Security Council resolutions; 2) Iran has stated that it intends to unload fuel assemblies at the Bushehr nuclear power plant,\* possibly confirming media reports of safety problems or equipment failures at the reactor, which could significantly delay its start; 3) the average monthly rate of low enriched uranium (LEU) production has remained steady, but the number of centrifuges declared as enriching has increased, which raises the possibility of ongoing problems in two of three of the modules at Natanz and some possible continuing after-effects of the Stuxnet malware; 4) monthly production rates of 20 percent enriched LEU remain steady; and 5) the IAEA has new evidence about Iran's weaponization activities.

\*ISIS has learned that the unloading may be motivated by concerns that fuel assemblies have been sabotaged or are defective.

**One special note: The IAEA is releasing less information about Fuel Enrichment Plant (FEP)'s operation, making it more difficult to evaluate the plant's performance. The IAEA should again release this information.**

### **LEU production and centrifuge levels at Natanz Fuel Enrichment Plant**

**Iran's total LEU production at the FEP through February 5, 2011 is reported to be 3,606 kg of low enriched uranium hexafluoride, including 471 kg estimated by Iran to have been produced since**

**October 18, 2010.**<sup>1</sup> 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 begun to enrich uranium up to the 20 percent level, is discussed below.

**The average monthly production of LEU at the FEP has stayed at about 133 kg per month of LEU hexafluoride (for the last reporting period we noted it was 133 kg of LEU hexafluoride and the one prior to that it was 116 kg of LEU hexafluoride).** As of February 20, 2011, Iran was enriching in 31 cascades, containing a total of 5,184 IR-1 centrifuges. The IAEA noted that some of these centrifuges "were possibly not being fed" with uranium hexafluoride. The number of cascades enriching increased slightly from 29 cascades, with 4,816 IR-1 centrifuges enriching, at the end of the last reporting period. Some 3,000 centrifuges are installed but not being fed with uranium hexafluoride, according to this report. The total number of centrifuges installed is given as about 8,000 centrifuges, which represents a decrease from the number installed at the end of the last reporting period. Figures 1-3 illustrate these trends at Natanz.

With up to an additional 1,000 centrifuges enriching at the end of this reporting period, the average monthly LEU production provides some insight into the FEP's performance. At the end of the previous reporting period, the average value was value was 0.028 kg of LEU hexafluoride per month per centrifuge, about ten percent lower than in the previous reporting period. At the end of the current reporting period, the average is about 0.026 kg LEU hexafluoride per month per centrifuge. This represents a slight decrease from the previous period. To describe the situation in another way, the number of centrifuges declared as enriching increased by 37 percent since last summer, but the level of LEU output has increased by only 15 percent. The IAEA does not discuss a reason for a less than expected output, but it could confirm the IAEA statement in this report that not all these centrifuges are likely fed with uranium hexafluoride. This in turn could imply continuing problems in these 1,000 centrifuges, which are likely to be in module A26, the one most likely affected earlier by Stuxnet. A [report by Deutsche Press Agentur](#) quotes a senior official "close to the Iran investigation" as saying that Iran replaced several hundred centrifuges and repair work is still ongoing. In any case, these values imply that Iran appears to be encountering problems in expanding the number of centrifuges enriching at the FEP. The reduced number of centrifuges installed in total could also reflect such a problem.

This situation can also be understood by using an equivalent method that is easier to compare to historical enrichment output at the FEP, namely the output measured in 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 these updated numbers in this report, but these numbers are consistent with data in earlier reports. Using standard enrichment calculators, 471 kg LEU translates to 1,158 kg of separative work units (swu), or 10.6 kg swu/day (see Figure 4). On an annualized basis, this is 3,878 swu per year. The number of centrifuges declared as enriching was 5,184 centrifuges at the end of this period and 4,816 centrifuges at the beginning. Thus the possible range of averaged values is 0.75 kg U swu per year per centrifuge at the beginning of the reporting period and 0.81 kg U swu per year per centrifuge at its end. For the 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

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<sup>1</sup> This reporting period is slightly different from the previous report. The last report went through October 31, 2010. The average values are not affected as best as can be determined.

since the FEP started operation). The average swu per centrifuge per year has decreased during the last reporting period by about fifteen percent from the earlier values in 2010. However, if only the most reliable centrifuges are considered, which number about 3,800 centrifuges in modules A24 and A26, then the average is about 1.0 kg swu per year per centrifuge, higher than expected but more in line with the expected performance of the better performing centrifuges. These numbers again imply that there is probably a problem affecting these additional 1,000 centrifuges. They may not be enriching or they may be enriching inefficiently or sporadically.

As reported earlier by ISIS and *The Washington Post*, the FEP appears to have recovered from the Stuxnet malware, at least in the sense that it has maintained the higher level of LEU output it achieved in the fall and continued to enrich in a greater number of cascades. This is consistent with the findings reported by ISIS last year and again recently that the damage caused by Stuxnet was likely in the non-enriching cascades, not the A24 module, which historically has been the most efficient module in enriching uranium. However, this IAEA report does imply continuing problems in the other modules, some of which could be after effects of Stuxnet. For more information on the possible effects of the Stuxnet malware on Iranian centrifuges, see [ISIS's resource page](#).

## **LEU Production at the Pilot Fuel Enrichment Plant**

Iran has designated two cascades at the smaller, above-ground 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 February 9, 2010 and February 11, 2011, 487.2 kg of 3.5 percent low enriched uranium in the form of uranium hexafluoride was introduced into the single cascade, and Iran withdrew a total of 43.6 kg of nearly 20 percent LEU hexafluoride. Over the last year, Iran has produced at a rate of 3.63 kg of near 20 percent LEU per month.

## **Production-Scale Advanced Centrifuges at the Pilot Fuel Enrichment Plant**

Iran told the IAEA that it would install two new cascades, each containing 164 advanced centrifuges. One would contain the IR-2m centrifuge and the other the IR-4 centrifuges. Although little information is publicly available about either type, they are both assessed as significantly more advanced than the IR-1 centrifuge. They should have a significantly higher enrichment output and a lower failure rate than the IR-1 centrifuge. These two cascades would be fed with natural uranium hexafluoride, not 3.5 percent LEU. The purpose of operating these cascades is likely to demonstrate performance prior to installation of such cascades at Natanz or other enrichment sites.

## **Unexpected Delay in Operation of Bushehr Nuclear Power Reactor**

Iran has informed the IAEA that it would have to unload fuel assemblies from the core of the Bushehr nuclear power reactor. The media has reported safety or equipment problems in the reactor; however, these problems are not believed to be related to the Stuxnet malware. Alternatively, ISIS

has learned that the unloading may be motivated by concerns about the possible sabotage of the fuel assemblies or defective fuel assemblies.

## **No Progress on Addressing Military Dimensions, New Questions about Iran's Weaponization Work**

The IAEA reports that Iran has still refused to clarify "outstanding issues which give rise to concerns about possible military dimensions to its nuclear programme," including Iran's work on "past or current undisclosed nuclear related activities involving military related organizations, [and] activities related to the development of a nuclear payload for a missile." Since the Agency first raised these concerns with Iran in August 2008, it has not provided access to locations, personnel, and information the Agency seeks in order to investigate these issues. The IAEA notes, moreover, that new information has come to its attention that it needs to clarify with Iran. An [Associated Press report](#) quotes a senior international official who says this new intelligence was received "within the last 3 months."

The IAEA lays out very clearly its lack of progress on investigating Iran's military related research and development in the attachment at the end of the report, including: "procurement of nuclear related items..., neutron generation and associated diagnostics, uranium conversion and metallurgy, high explosives manufacturing and testing, exploding bridgewire detonator studies, particularly involving applications necessitating high simultaneity, multipoint explosive initiation and hemispherical detonation studies involving highly instrumented experiments, high voltage firing equipment and instrumentation for explosives testing over long distances and possibly underground, missile re-entry vehicle redesign activities for a new payload assessed as being nuclear in nature."

The Agency notes that this information was gathered through the assistance of member states and its own efforts. Due to Iran's lack of cooperation on its investigation of these alleged activities and studies, the Agency cannot verify that Iran's nuclear activities are strictly peaceful in nature.

## **Work continues at the Fordow Enrichment Site**

**Iran has still not installed any centrifuges at the Fordow site near Qom. However, it told the IAEA that it planned to begin feeding nuclear material into cascades "by this summer."**

The available information continues to support assessments that after its discovery by Western intelligence, Iran downgraded the role of the Fordow plant as a centrifuge facility. Iran has declared that the plant will hold only twelve cascades of IR-1 centrifuges. The other part of the plant will be devoted to research and development of more advanced centrifuges.

The reduction in the planned number of IR-1 centrifuges at Fordow suggests that Iran could be de-emphasizing the site following its discovery and will concentrate on constructing new secret sites, at least one of which it has announced it will start building early this year. Although Iran says it will eventually declare those sites to the IAEA, doubts remain. In several cases, including with Natanz, Kalaye Electric, Lavizan Shian, and now the Fordow site, Iran only declared the formerly secret sites after their discovery by other nations and groups. The new developments at Fordow also contradict

speculation that Iran wants to build and operate many centrifuge plants at once, as opposed to what it now appears to be doing—building multiple facilities that will not be outfitted with large numbers of centrifuges unless they can remain secret sites that could be used in a breakout.

Figure 1: Centrifuge Trends at Natanz

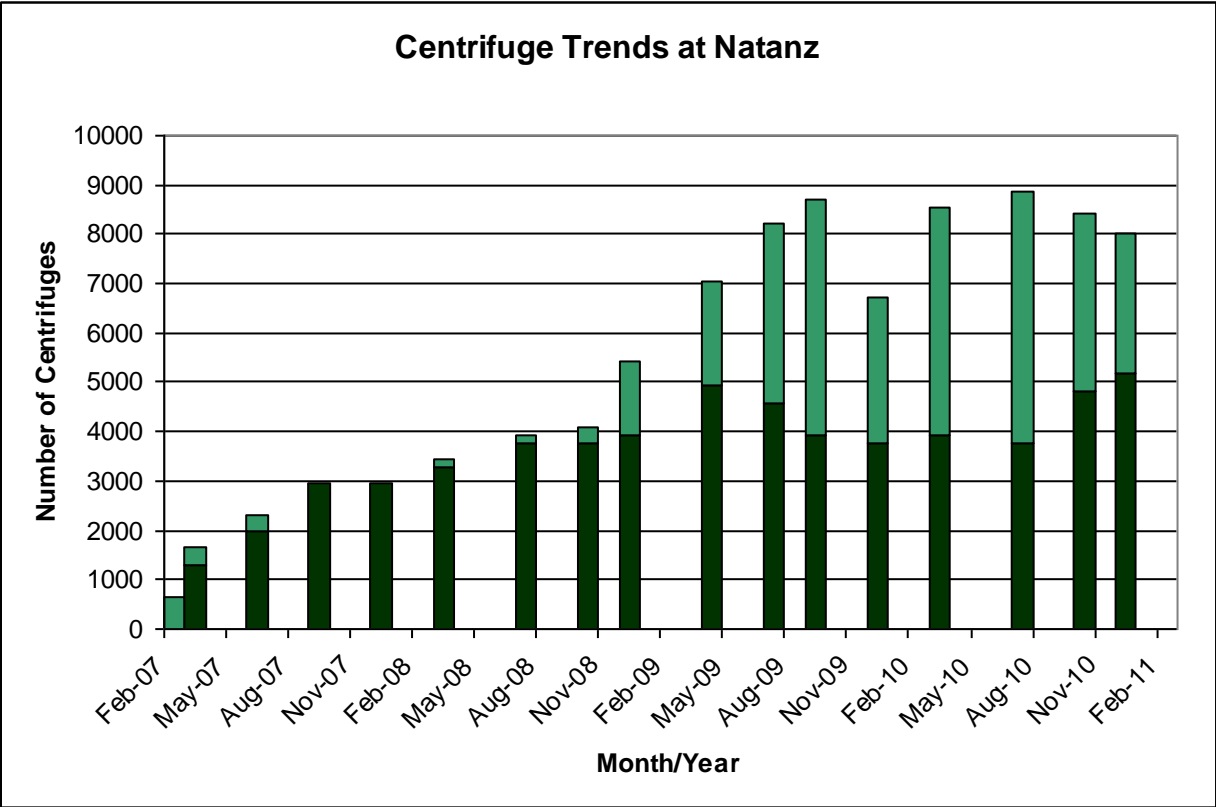


Figure 2: LEU Production (per month) at Natanz

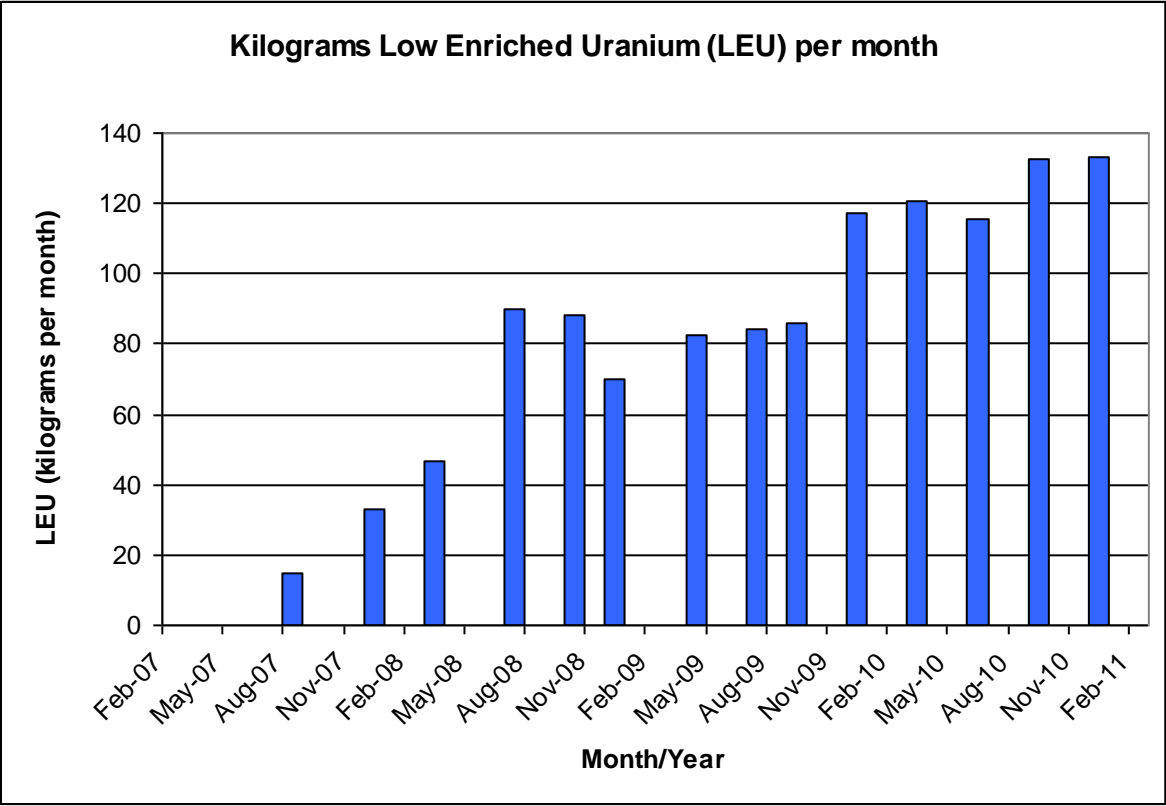


Figure 3: Overall Trends at Natanz

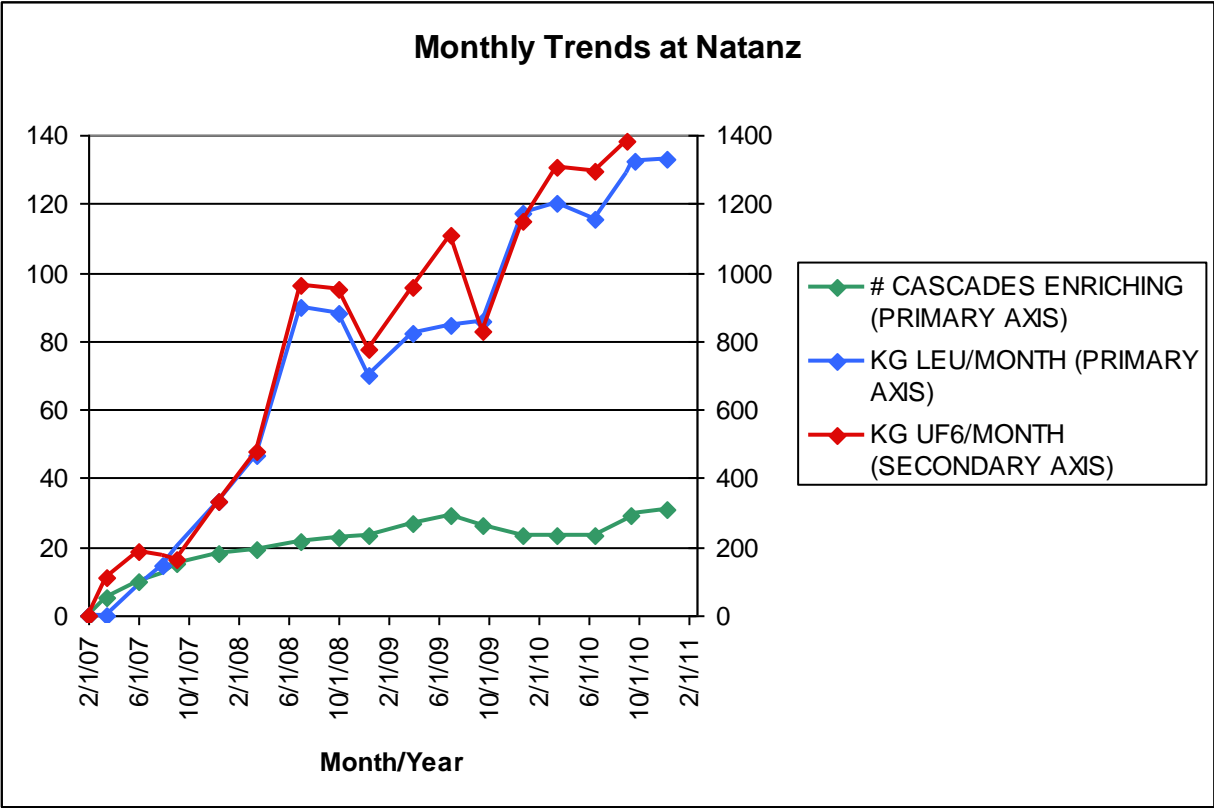
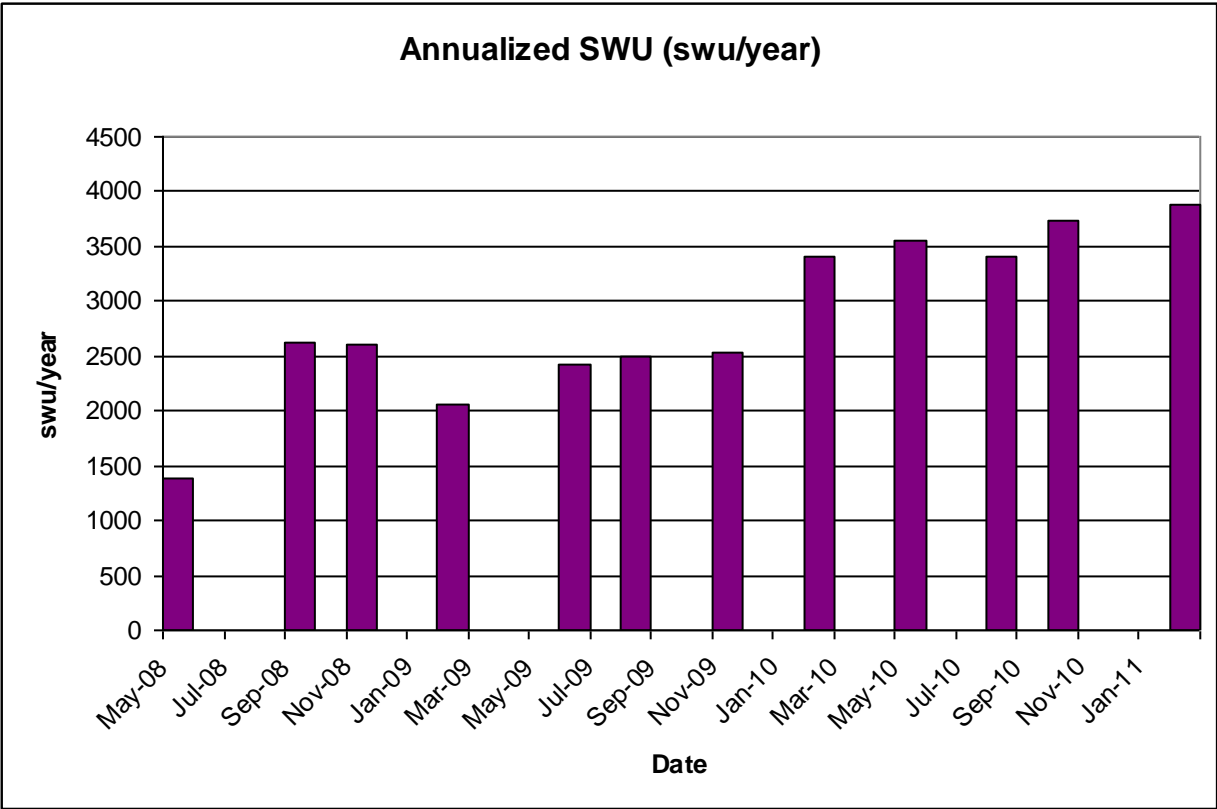




Figure 4: Annualized SWU at Natanz



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