

Iran's Centrifuges: How well are they working?

By Jacqueline Shire and David Albright

The Institute for Science and International Security (ISIS)

March 15, 2007

There is scant publicly available data to allow for detailed analysis of Iran's centrifuge enrichment program. At the same time, there appears to be at least some consensus among experts familiar with Iran's nuclear program that technical difficulties have stymied the program since Iran began operating its first cascade of 164 centrifuges in early 2006.¹

Drawing upon the limited data available in IAEA safeguards reports on Iran, we conclude that although Iran may be experiencing some technical difficulties, there is also evidence to suggest that it continues to make steady progress. This analysis is based primarily on information about Iran's consumption of uranium hexafluoride (UF₆), the gas that is introduced into a centrifuge for enrichment. We emphasize that there are many variables that determine a cascade's operating performance, and that the limited nature of the UF₆ data precludes firm conclusions one way or the other about Iran's overall success. Nonetheless, absent specific assessments from the IAEA or the intelligence community, this approach helps estimate Iran's overall progress toward enriching uranium in P-1 gas centrifuge cascades.

Iranian Centrifuge Operations in 2006: A Slow Start

Iran informed the IAEA in January 2006 that it planned to re-start uranium enrichment at its pilot enrichment plant at Natanz. By February 11, Iran began testing a single P-1 centrifuge with UF₆, moving to a 10-machine cascade on February 15, 2006 and a week later to a 20-machine cascade. Iran completed installation of the full 164-machine cascade in March and begun testing it with UF₆, while beginning construction of a second cascade.

Throughout the spring and summer, the second cascade remained under construction. While this may have been for technical reasons, this period also coincided with an intense phase of diplomatic activity, with the European Union in June offering Iran a package of incentives in exchange for Iran relinquishing its uranium enrichment program, among other things. Iran effectively rejected the package in late August, and brought a second cascade online by mid-October 2006, in the shadow of the North Korean nuclear test.

A Few Clues

We know little about how Iran's centrifuges are performing in practice. Drawing on two limited pieces of data however—the quantity of UF₆ that Iran introduced into 164-machine cascades at the pilot plant, and statements by a senior Iranian nuclear official about the maximum rate at which UF₆ can be fed into one such cascade, some limited conclusions are possible.

¹ David Ignatius, "Iran's Uranium Glitch: Technical Troubles Offer Time for Diplomacy" *Washington Post*, September 29, 2006, p. A21.

In an April 12, 2006 interview², Gholamreza Aqazadeh, head of Iran's Atomic Energy Organization said:

“...Let me explain, something. In the **164** chain [sic], the maximum amount of material that we can feed the system is **70 grams an hour**, with a 10 percent product of 7 grams. The product is 7 grams. When a series is operating 24 hours you have to multiply 24 by 70 grams. This is the total product of one series....”

Therefore, if a single cascade operates twenty-four hours per day, the UF₆ can be introduced at the following rates:

- Daily: 70 grams of UF₆ x 24 = 1,680 grams or **1.68 kg**
- Monthly: 1,680 x 30 = 50,400 g or **50.4 kg**
- Yearly: **613 kg**

From IAEA safeguards reports, we know that Iran has introduced the following quantities of UF₆ into its 164-machine cascades at the pilot plant:

- June 6 to 8 and June 23 to July 8: **6 kg**.
- August 13 to November 2: **34 kg**.³
- November 3 to February 17, 2007: **66 kg**

Conclusion

We calculate that over a three month period, operating at maximum capacity, each cascade could be fed approximately 150 kilograms of UF₆ or 300 kilograms over a six month period. We do not know from IAEA reports how the consumption of UF₆ was divided between the two cascades. Setting aside the six kilograms consumed in June and July and focusing only on the six-month period from August 13, 2006 to February 17, 2007, we can see that the two cascades consumed 100 kilograms, or approximately 22 percent of the UF₆ they might have consumed had a single cascade been operating continuously for six months and a second one been operating for three months.

Examined from a different perspective, the cascades appear to have operated with UF₆ for the equivalent of 5 hours per day on average. Although this is not the manner in which cascades typically operate, this estimate serves to illustrate our conclusion that Iran's centrifuges are functioning, perhaps with fewer technical impediments than previously understood.

² <http://www.armscontrolwonk.com/1035/more-fun-with-swu>.

³ On October 13, Iran brought the second cascade online and introduced UF₆.