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# May 26, 2008 IAEA Safeguards Report on Iran: Centrifuge Operation Improving and Cooperation Lacking on Weaponization Issues Rev. 2

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The International Atomic Energy Agency (IAEA) released on May 26, 2008 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 report, which shows continued non-compliance with these resolutions, includes two important findings. The first is that Iran is making significant progress on developing and operating its centrifuges. The second is Iran's lack of cooperation with inspectors in addressing its alleged nuclear weapons-related work, which the IAEA calls a "matter of serious concern."

## Significant increase in $UF_6$ consumption; cascade expansion continues:

The IAEA notes that between December 12, 2007 and May 6, 2008, Iran introduced 2,300 kg of uranium hexafluoride ($UF_6$) into the operating cascades at the Fuel Enrichment Plant. This compares to a total of 1,670 kg of UF6 introduced during the entire period from February to December 2007. At Iran's stated rates of feeding uranium hexafluoride into P-1 centrifuges, and assuming continuous operation, the centrifuges are running at about 50 percent of their capacity, a significant increase over previous rates.[1]

The IAEA does not provide information about the quantity of low-enriched uranium produced in the last five months. However, according to a senior official close to the

[1] Based on Iran's stated feed rates of 70 grams of $UF_6$ per hour per cascade, one would expect that a single cascade would consume 50 kg of $UF_6$ per month, with 18 cascades consuming 900 kg of $UF_6$. Over five months this would total approximately 4500 kg, making Iran's feed of 2300 kg approximately 50 percent of capacity.


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IAEA, Iran produced a little less than one kilogram of LEU per day, or approximately 150 kg of low enriched uranium (LEU) over the past five months. This is twice the 75 kg produced at the Fuel Enrichment Plant between February 2007 and December 2007.

In the past, Iran experienced significant problems in running its P-1 centrifuge cascades, encountering a high rate of centrifuge breakage and instability in their operation. These problems resulted in a lower than expected output of LEU. Under these conditions, a sizeable quantity of enriched uranium was "dumped" into the cascades' waste stream where it was mixed with depleted uranium and lost.

This latest report, however, shows that Iran is overcoming these problems. This is reflected in the increased feed rates. One official close to the Agency stated that Iran may now have reached a point where its cascades are operating in a stable manner. He added that fewer centrifuges are breaking.

In addition to the 18 cascades containing some 3,000 P-1 centrifuges, Iran is beginning to install a second module of 3,000 centrifuges, of which three cascades are either enriching or under vacuum. Installation of an additional 15 cascades is continuing, although a schedule of completion is unknown. Iran does not appear to be rushing to install the second module of centrifuges at this time.

## New advanced centrifuge designs in testing phase: IAEA sees only tip of the iceberg on centrifuge R&D

An equally important finding in the report is that Iran is now testing advanced centrifuges at the Natanz pilot fuel enrichment plant. It has installed two or three types of next-generation centrifuges: the IR-2, described in a previous ISIS report, the IR-3, and possibly a longer centrifuge. According to senior officials close to the IAEA, these centrifuge designs are modifications of the P-2 centrifuge obtained from A.Q. Khan in the 1990s. After testing, Iran is expected to decide which design to mass produce for deployment in the underground halls of the Natanz fuel enrichment plant. These centrifuges are expected to have greater enrichment output and perform better in operation.

According to the February 2007 IAEA safeguards report, inspectors visiting Kalaye Electric were given information on four different centrifuge designs, including two subcritical rotor designs, one or more supercritical rotor designs with bellows, and a more advanced centrifuge, which is undefined in the report. The IR-2 and IR-3 are the two subcritical centrifuges. The IR-2 is an experimental model that contains a single composite rotor made from carbon fibers. The other parts of the rotor assembly are modified P-2 components (see figure 1). The IR-3 is an experimental model that seeks to increase the enrichment output by increasing the centrifuge's length somewhat and by varying the cooling of the centrifuge rotor[2] (see figure 2).

[2] Centrifuge experts have speculated about the reason for the extra length. One suggests that the rotor length was extended to its maximum value. Beyond the maximum value, the rotor would experience its first flexural critical during run-up and run-down, likely breaking in the process. Another says that the extra length could accommodate a longer lower or upper bearing that was developed to allow the rotor to operate at a significantly greater speed.

According to the recent report, Iran has installed IR-2 centrifuges both as single machines and in a ten-machine cascade. It has installed a few single IR-3 centrifuges. Figure 3 shows the ten-machine IR-2 cascade and some single IR-3 centrifuges. Figure 4 is a close-up of a part of the ten-machine IR-2 cascade.

Although not mentioned in the report, there appears to be a third advanced centrifuge at the pilot plant. It appears to have the same diameter as the IR-2 and IR-3 but to have double or triple the length of the IR-2. Thus, it would hold two or three rotor tubes, connected by bellows (see figure 5). Prior to Iran's suspension of the Additional Protocol in 2006, Iranian officials told the IAEA they could not make P-2 bellows. Iran has apparently overcome this obstacle (see figure 6).

Iran is not required under its current safeguards agreement to share with the IAEA centrifuge research and development work or details about centrifuge manufacturing. If Iran were observing the Additional Protocol, the IAEA would have access to such information. Its lack of such information has created large uncertainties in assessing the scope and direction of Iran's enrichment program.

It is unknown how long Iran intends to test these new designs or when they could be deployed in large numbers in the underground halls.

**Failure to report centrifuge installation:** Paragraph 11 of the report notes that Iran recently provided revised design information for the fuel enrichment plant and the pilot fuel enrichment plant related to the installation of additional centrifuges. The Agency termed the changes "significant" and said that they should have been communicated days before the modifications were scheduled to be completed (in accordance with Code 3.1 of Iran's safeguards agreement). This is an example of Iran's lack of transparency and candor with the IAEA on issues that are essential to maintaining confidence in its safeguards compliance.

## Inadequate cooperation on alleged weaponization work

The IAEA states that Iran's alleged studies on the green salt project, high explosives testing and the missile re-entry vehicle project "remain a matter of serious concern." Despite Iran's recent agreement with the IAEA to address these issues, Iranian officials continue to insist that the documents are forged and "all the allegations are baseless." Where Iran acknowledges the factual basis of some of the information, it insists that the work had nothing to do with the development of nuclear weapons.

The report's annotated listing of 18 documents that the IAEA has shown to Iran, outlining its alleged work on green salt, high explosives testing and a missile re-entry vehicle, amounts to the most detailed compilation of evidence available on the public record regarding Iran's alleged nuclear weaponization work. Among these, according to senior officials close to the IAEA, high explosives studies and the re-entry vehicle work are the areas most in need of clarification and cooperation from Iran.

Together, these documents make a powerful case that Iran had an active weaponization effort prior to 2004. At the same time, it is important to note that they do not encompass the full scope of work required for a comprehensive nuclear weapons program. Missing from these documents is theoretical work on nuclear weapons, uranium metallurgy, and the development of a neutron initiator.

A senior official close to the IAEA said that the process is likely to take months to resolve. Iranian cooperation remains key to resolving these issues.

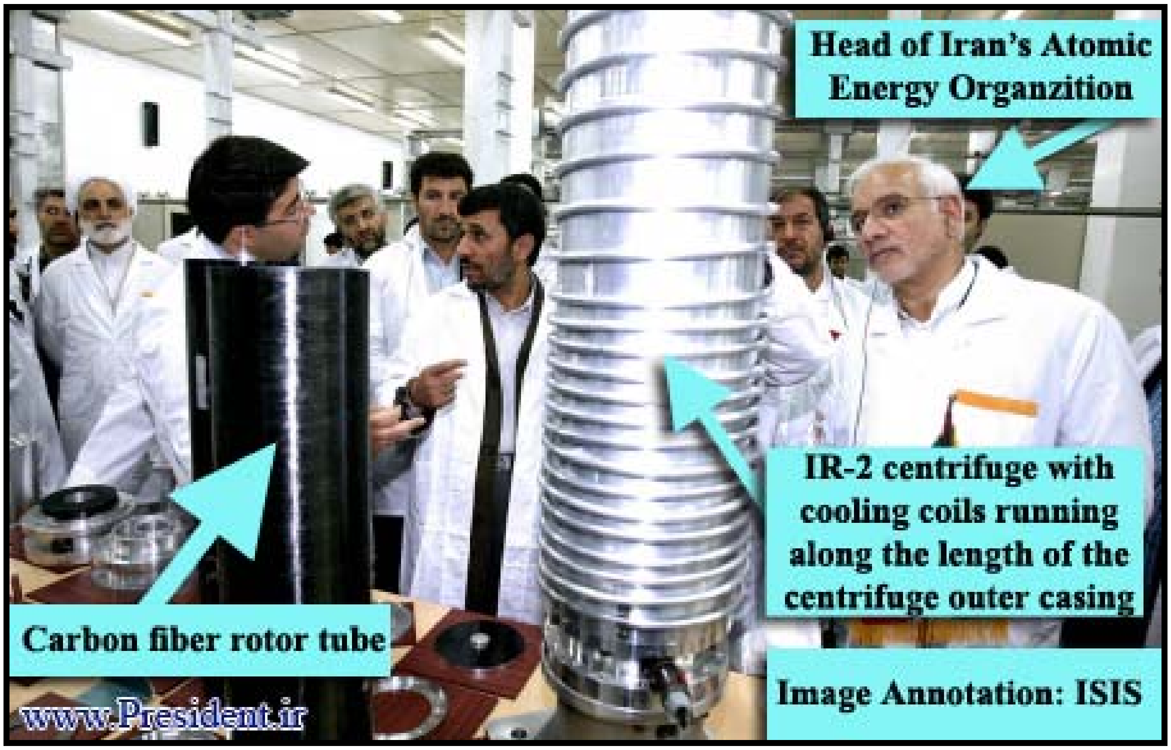


Figure 1.  The IR-2 centrifuge, which uses a carbon fiber, or composite, rotor tube, has water cooling coils running along the entire length of the centrifuge's outer casing, like in the P-1 centrifuge.  Off to the left are P-2 centrifuge components, some of which have been adapted for use with a carbon fiber rotor tube.  To the right of the IR-2 centrifuge is Gholamreza Aghazadeh, the head of Atomic Energy Organization of Iran (AEOI).


Figure 2. This is an image of the IR-3. The cooling coils are at the bottom of the centrifuge's outer casing. The P-2 centrifuge, on which the IR-2 and IR-3 centrifuges are based, uses a maraging steel rotor tube. Iran uses a carbon fiber rotor tube in the IR-2 and IR-3 and, in doing so, it has altered the way the temperature along the centrifuge rotor is created and maintained, which is key to the centrifuge's enrichment output. The two models, which are nearly identical, appear to be different ways of using cooling to understand and optimize the enrichment output. Another difference is that the IR-3 is somewhat longer than the IR-2, which also can increase the enrichment output.

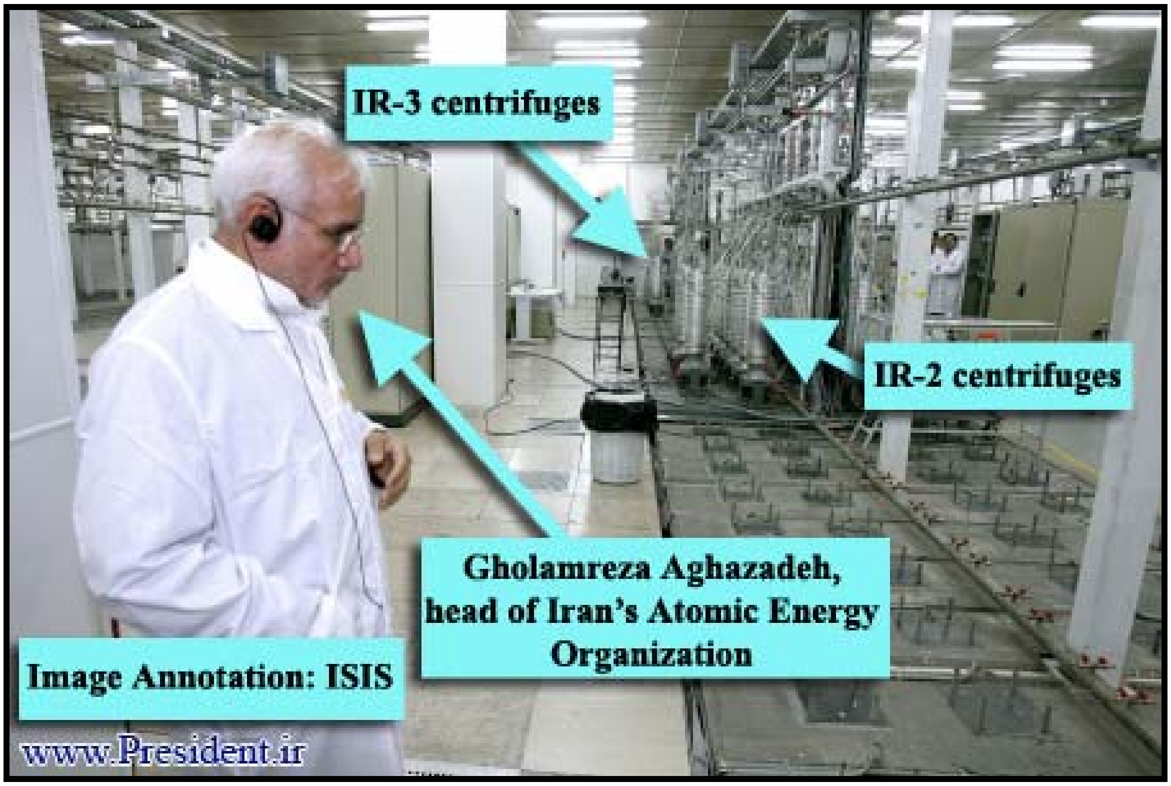


Figure 3. IR-2 centrifuges can be seen in the background. Further away are IR-3 centrifuges.


Figure 4. President Ahmadinejad walking past the small IR-2 centrifuge cascade.

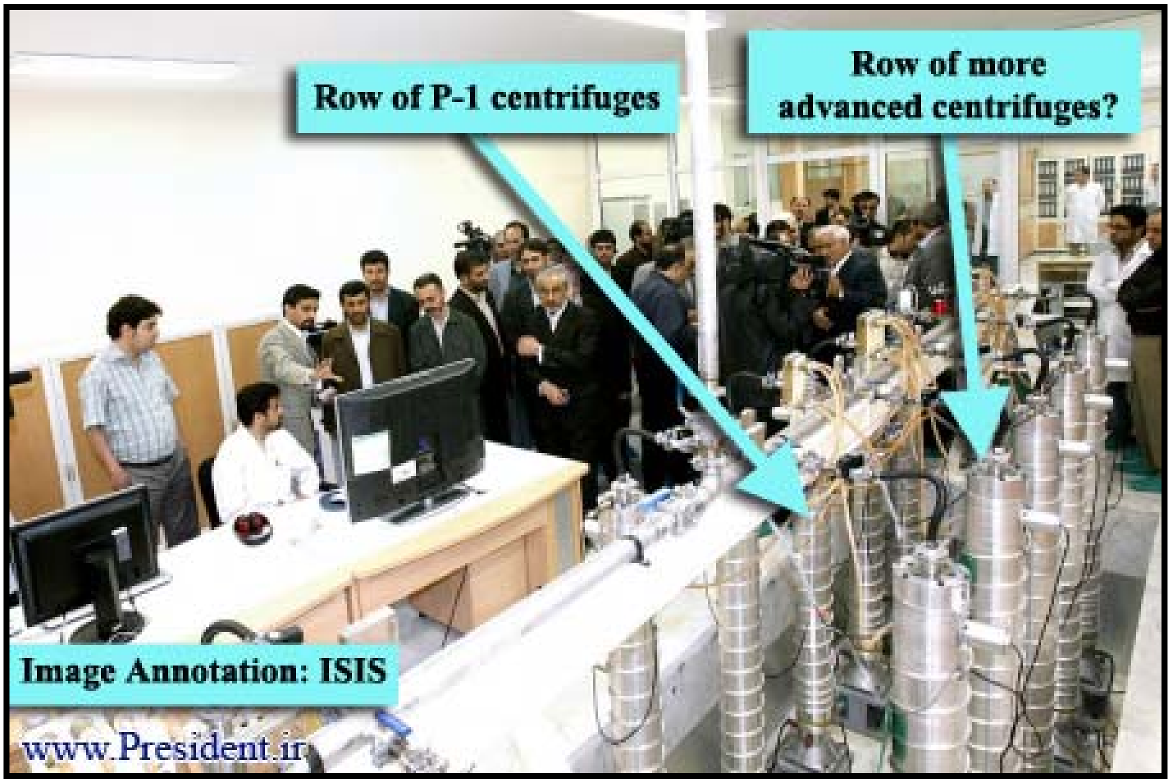


Figure 5. This image shows two rows of centrifuges inside a testing pit. Centrifuges in the left row appear to be P-1 centrifuges, or IR-1s. The row of centrifuges on the right may contain a new, more advanced centrifuge design. These centrifuges are wider than the P-1 centrifuges and longer than the IR-2 and IR-3 centrifuges. These centrifuges could have two rotor tubes with one bellows, or three rotor tubes with two bellows.

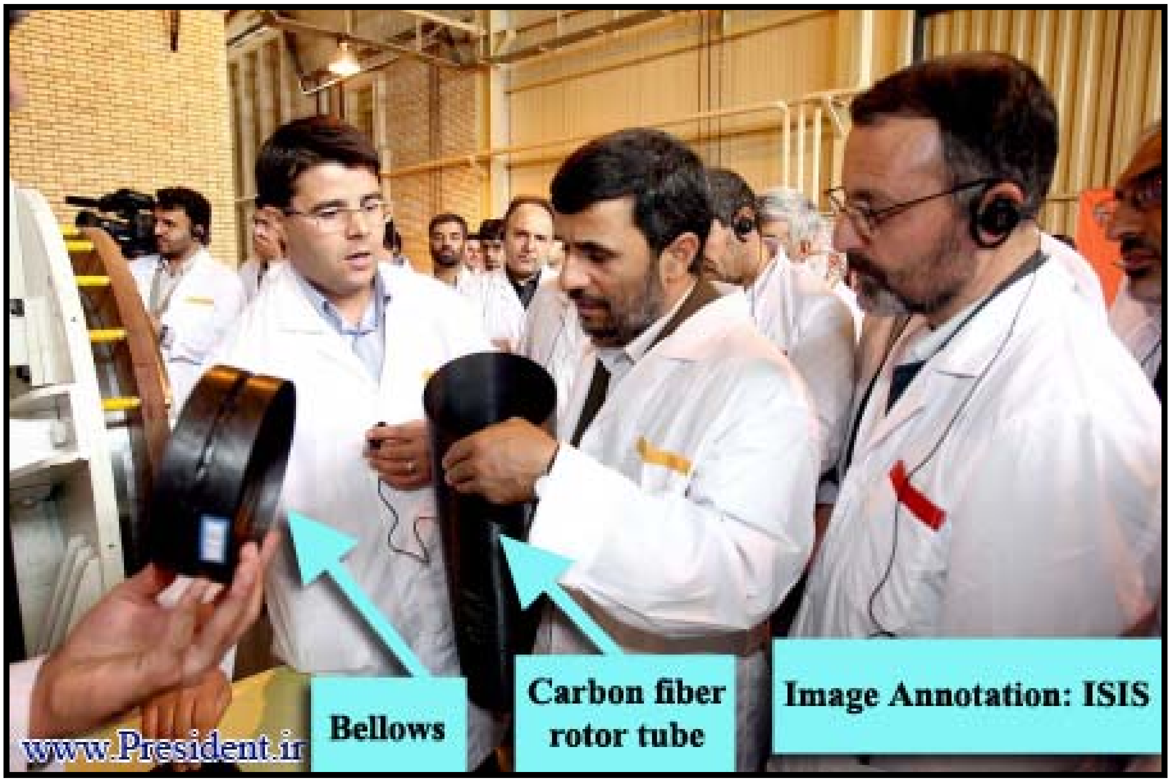


Figure 6. In the foreground is a bellows, which is probably oxidized or "blackened" maraging steel. Oxidation prevents corrosion by uranium hexafluoride. President Ahmadinejad is holding a carbon fiber rotor tube. Iran developed carbon-fiber rotors on its own; it is not believed to have obtained information on winding patterns from A.Q. Khan or other programs. Iran is likely to encounter problems in getting its carbon fiber centrifuges to work.