Iran's Nuclear Program: Production and Potential

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Iran is now on the verge of mastering a critical step in building and operating a gas centrifuge plant that would be able to produce significant quantities of enriched uranium for either peaceful or military purposes. However, Iran can be expected to face serious technical hurdles before it can produce significant quantities of enriched uranium.

In testimony before the Senate Intelligence Committee on February 2, 2006, John Negroponte, Director of National Intelligence, stated that Iran is judged as probably having neither a nuclear weapon nor the necessary fissile material for a weapon. He added that if Iran continues on its current path, it "will likely have the capability to produce a nuclear weapon within the next decade." The basis for this estimate remains classified, although press reports state that Iran's lack of knowledge and experience in building and running large numbers of centrifuges is an important consideration. Many interpret Negroponte's remark to mean that Iran will need 5-10 years before it possesses nuclear weapons.

Estimates of the amount of time Iran needs to get its first nuclear weapon are subject to a great deal of uncertainty. Many questions about Iran's technical nuclear capabilities and its plans to build nuclear weapons remain unanswered. In addition, the International Atomic Energy Agency (IAEA) is unable to verify that Iran has fully declared its nuclear activities. It still cannot state conclusively that Iran does not conduct secret uranium enrichment activities. Nonetheless, because of over three years of inspections, the IAEA has developed considerable knowledge about Iran's nuclear program and identified the main uncertainties in its knowledge about that program. The remaining uncertainties appear to exclude the existence of undeclared nuclear facilities large enough to significantly shift projections of the amount of time Iran would need to produce nuclear weapons. However, these uncertainties also suggest that Iran intends to develop a nuclear weapons capability, enabling it to build deliverable nuclear weapons once the regime's leaders make to a decision to do so.

To understand the assumptions, key information, calculations, and uncertainties driving estimates of the timelines, I present two "worst-case" estimates of the time Iran would need to build its first nuclear weapon. In both of these estimates, which involve the production of highly enriched uranium (HEU) and cover the more likely scenarios, Iran appears to need at least three years, or until 2009, before it could have enough HEU to make a nuclear weapon. Given the technical difficulty of the task, it could take Iran longer.

Before discussing these estimates, I will provide background information on Iran's nuclear program and discuss recent developments in Iran's gas centrifuge program. In particular, I will discuss several of Iran's recent progress and problems in its centrifuge program that affect these estimates.

Iran's Nuclear Program

Iran has invested heavily in nuclear industries in the last twenty years. It has sought a wide range of items overseas, including nuclear reactors, uranium conversion facilities, heavy water production plants, fuel fabrication plants, and uranium enrichment facilities. Many of its overseas purchases were thwarted, such as multiple efforts to buy research reactors and an attempt to purchase a turn-key gas centrifuge plant from Russia in 1995. However, in general, Iran found suppliers to provide the wherewithal to build nuclear facilities. A. Q. Khan and business associates in Europe and the Middle East provided Iran the ability to build and operate gas centrifuges. Without their assistance, Iran would have likely been unable to develop a gas centrifuge program.

Iran's current nuclear infrastructure is impressive. Although many key facilities are not finished, Iran is close to operating a large power reactor at Bushehr and has started or is close to operating several relatively large fuel cycle facilities. Following the end of the suspension embodied in its November 2004 agreement with the European Union, Iran resumed operating its uranium enrichment facilities at Natanz. Table 1 summarizes the main nuclear facilities in Iran.

Most of Iran's foreign procurement for its fuel cycle facilities occurred in secret, and several of the associated nuclear materials and facilities were not declared to the IAEA, as Iran was required to do under the Nuclear Non-Proliferation Treaty. Appendix 1 lists Iran's many violations of its safeguards agreement and important incidences of its lack of cooperation with the IAEA.

If Iran finishes its declared nuclear facilities, it would have a capability to produce HEU and plutonium for nuclear weapons. At that point, Iran could decide to change the purpose of its safeguarded nuclear facilities and rapidly dedicate them to nuclear weapons purposes.

Under current and expected developments, Iran's gas centrifuge program provides the quickest route to the indigenous production of nuclear explosive materials. As a result, the gas centrifuge program is the main focus of my testimony.

However, Iran is also progressing on developing an indigenous method to produce plutonium. It continues to build a heavy water reactor at Arak, despite repeated international requests that Iran discontinue this project. Iranian officials have stated that the reactor is scheduled to be completed in 2009, although this schedule may not be met due to problems in building and starting up such a reactor. When fully operational, the reactor is estimated to be able to produce about 9 kilograms of weapon-grade plutonium per year, enough for two nuclear weapons per year. Iran has told the IAEA that it does not intend to build reprocessing facilities to separate plutonium from this reactor. It did state that it was planning to build hot cells to separate "long-lived radioisotopes," but said that it was having problems obtaining the necessary manipulators and lead glass windows. IAEA investigations into Iran's past reprocessing activities continue.

Iran Breaks the Suspension on Enrichment Activities

Iran ended the suspension on enrichment and enrichment-related activities in January 2006. Its actions appear aimed at finishing the Pilot Fuel Enrichment Plant (PFEP) at Natanz this year and, soon afterward, starting to install centrifuges in the Fuel Enrichment Plant (FEP), the main underground enrichment facility at Natanz slated to hold eventually about 50,000 centrifuges.

In early January 2006, Iran removed 52 seals applied by the IAEA that verified the suspension of Iran's P-1 centrifuge uranium enrichment program. The seals were located at the Natanz, Pars Trash, and Farayand Technique sites, Iran's main centrifuge facilities. On February 11, Iran started to enrich uranium in a small number of centrifuges at Natanz, bringing to a halt Iran's suspension of uranium enrichment that had lasted since October 2003. A few days earlier, Iran moved to end its implementation of the Additional Protocol, an advanced safeguards agreement created in the 1990s to fix traditional safeguards' inability to provide adequate assurance that a country does not have undeclared nuclear facilities or materials.

After removing seals, Iran started to substantially renovate key portions of the PFEP. Iran began construction on the PFEP in secret in 2001, and it installed up to 200 centrifuges in 2002 and 2003. The PFEP is designed to hold up to six 164-machine cascades, groups of centrifuges connected together by pipes, in addition to smaller test cascades, for a total of about 1,000 centrifuges.

At Natanz and Farayand Technique, Iran quickly restarted testing centrifuge rotors and checking centrifuge components to determine if they are manufactured precisely enough to use in a centrifuge. By early March, Iran had restarted enriching uranium at the pilot plant in 10- and 20-centrifuge cascades.

On April 13, 2006, Iran announced that it had produced low enriched uranium in its 164 machine cascade, finished in the fall of 2003 but never operated with uranium hexafluoride prior to the suspension of enrichment that started in October 2003 as a result of an agreement between the European Union and Iran reached in Tehran. Soon afterward, it announced that it had enriched uranium up to a level of almost 5 percent.

Restarting the 164-machine cascade took several months. Iran had to repair damaged centrifuges. According to IAEA reports, many centrifuges crashed or broke when the cascade was shut down at the start of the suspension in 2003. Before introducing uranium hexafluoride, it had to reconnect all the pipes, establish a vacuum inside the cascade, and prepare the cascade for operation with uranium hexafluoride.

The initial performance of the P-1 centrifuges in this cascade has been less than expected. Based on statements on state-run television on April 12, 2006 by the Gholam-Reza Aqazadeh, head of the Atomic Energy Organization of Iran, the average annualized output of the centrifuges in this cascade is relatively low.[1] In the same interview, he implied that he expects that the average output of each P1 centrifuge will almost double in the main plant.

In addition, the Iranians have not yet run this cascade continuously to produce enriched uranium. One report stated that the cascade operated with uranium hexafluoride only about half of its first month of operation, although it continued to operate under vacuum the rest of the time. The Iranian centrifuge operators do not yet have sufficient understanding of cascade operation and must conduct a series of longer tests to develop a deeper understanding of the cascade.

The IAEA reported in April that Iran was building the second and third cascades at the PFEP. A senior diplomat in Vienna said in a recent interview that the second cascade could start in May and the third one could start in June. This schedule would allow Iran to test multiple cascades running in parallel, a necessary step prior to building a centrifuge plant composed of such cascades. The diplomat speculated that Iran could continue with this pattern, installing the fourth and fifth in July and August, respectively. He stated that the slot for the sixth cascade is currently being occupied by the 10 and 20-machine cascades.

Iran would likely want to run its cascades individually and in parallel for several months to ensure that no significant problems develop and to gain confidence that it can reliably enrich uranium in the cascades. Problems could include excessive vibration of the centrifuges, motor or power failures, pressure and temperature instabilities, or breakdown of the vacuum. Iran may also want to test any emergency systems designed to shut down the cascade without losing many centrifuges in the event of a major failure. Absent major problems, Iran is expected to need roughly six months or more to demonstrate successful operation of its cascades and their associated emergency and control systems.

[1] The annualized average output of each centrifuge was about 1.4 separative work units per machine per year, based on Aqazadeh's statement of a maximum feed rate of 70 grams per hour and the production of 7 grams per hour of 3.5 percent enriched uranium. The feed and product rate imply a tails assay of 0.4 percent. This relatively low output could mean that the aluminum centrifuge rotors are spinning at a lower speed than possible. For the main plant, he said that 48,000 centrifuges would produce 30 tonnes of low enriched uranium per year. Assuming a tails assay of 0.4 percent and a product of 3.5 percent enriched uranium, the estimated average output of each machine would be about 2.3 swu/yr. With an assumed tails assay of 0.3 percent, the estimated output rises to 2.7 swu/yr, high for a Pakistani P1 design, but theoretically possible if the centrifuge is further optimized.

Once Iran overcomes the technical hurdle of operating its demonstration cascades, it can duplicate them and create larger cascades. Iran would then be ready to build a centrifuge plant able to produce significant amounts of enriched uranium either for peaceful purposes or for nuclear weapons. However, Iran may encounter additional problems when it tries to build and operate a centrifuge plant.

As of late April, according to the IAEA, Iran was not moving aggressively to finish the FEP in preparation for installing the first module. Earlier, it moved process tanks and an autoclave, used to heat uranium hexafluoride into a gas prior to insertion into centrifuge cascades, into the FEP at Natanz. Iran told the IAEA that it intends to start the installation of the first 3,000 P1 centrifuges, called the first module, in the underground cascade halls at the FEP in the fourth quarter of 2006. Iran still needs to finish the basic infrastructure, including installing electrical cables. A key question is whether Iran has procured or manufactured all the equipment it needs to finish the first module. In addition, questions remain about the number of centrifuges Iran has in-hand and the quantity it would still need to manufacture indigenously to exacting specifications, a task that many countries have found challenging.

The Uranium Conversion Facility (UCF) at Isfahan has continued to operate since its restart in August 2005, following the breakdown in the suspension mandated by the November 2004 agreement between Iran and the European Union. By late February 2006, Iran had produced about 85 tonnes of uranium hexafluoride, where the quantity refers to uranium mass. This amount had increased to about 110 tonnes in April. With roughly 5 tonnes needed to make enough HEU for a nuclear weapon, this stock represents enough natural uranium hexafluoride for roughly 20 nuclear weapons. Although Iran's uranium hexafluoride reportedly contains impurities that can interfere with the operation of centrifuges and reduce their output, IAEA experts believe that Iran can overcome this problem. Iran is known to be working to improve the purity of the uranium hexafluoride produced at the UCF. Nonetheless, if necessary, Iran could use its existing stock of impure material, if it had no other material. It could take additional steps to purify this uranium hexafluoride, or it could use the material in its own centrifuges and experience reduced output and a higher centrifuge failure rate.

Worst-Case Estimates

Developing an answer to how soon Iran could produce enough HEU for a nuclear weapon is complicated and fraught with uncertainty. Beyond the technical uncertainties, several other important factors are unknown. Will Iran develop a nuclear weapons capability but produce only low enriched uranium for nuclear power reactors and not any highly enriched uranium? Will Iran withdraw from the NPT, expel inspectors, and concentrate on building secret nuclear facilities? How does Iran perceive the risks of particular actions, such as producing HEU in the pilot plant? What resources will Iran apply to finishing its uranium enrichment facilities? Will there be military strikes against Iranian nuclear sites?

Before developing a timeline, it is necessary to estimate how much HEU Iran would need to make a nuclear weapon. Many assessments cite 25 kilograms of weapon-grade uranium (HEU containing more than 90 percent uranium 235) as the minimum amount necessary for a crude, implosion-type fission weapon of the type Iran is expected to build. However, the experience of similar proliferant states such as Iraq leads to lower quantities. In 1990, Iraq initially planned to use 15 kilograms of weapon-grade uranium in its implosion design. An unclassified design using almost 20 kilograms was calculated in a study co-authored by Theodore Taylor and Albright in about 1990. Thus, an Iranian nuclear weapon could be expected to need about 15-20 kilograms of weapon-grade uranium. A larger quantity of HEU is needed than the exact amount placed into the weapon because of inevitable losses during processing, but such losses can be kept to less than 20 percent with care and the recovered material recycled into successive weapons. Thus, for the estimates presented here, a crude fission weapon is estimated to require 15-20 kilograms of weapon-grade uranium.

Scenario I--Clandestine Centrifuge Plant

Iran's most direct path to obtaining HEU for nuclear weapons is building a relatively small gas centrifuge plant that can make weapon-grade uranium directly from natural uranium.[2] If Iran built such a plant openly, it would be an acknowledgement that it seeks nuclear weapons. As a result, Iran is likely to pursue such a path in utmost secrecy, without declaring to the IAEA the facility and any associated uranium hexafluoride production facilities.

Without the Additional Protocol in effect, however, the IAEA faces a difficult challenge discovering such a clandestine facility, even as Iran installs centrifuges at Natanz to produce low enriched uranium. The IAEA has already reported that it can no longer monitor effectively centrifuge components, unless they are at Natanz and within areas subject to IAEA containment and surveillance. When Iran halted its adherence to the Additional Protocol, the IAEA lost access to centrifuge production and storage facilities. Alternatively, Iran may feel less assured about successfully deceiving the inspectors and proceed with such a plant only after withdrawing from the NPT and asking inspectors to leave. In either case, U.S., Israeli, and European intelligence agencies would be unlikely to locate precisely this facility.

The key to predicting a timeline is understanding the pace and scope of Iran's gas centrifuge program, for example the schedule for establishing a centrifuge plant large enough to make enough HEU for one nuclear weapon per year. Such a clandestine facility would require about 1,500-1,800 P1 centrifuges with an average capacity of about 2.5-3 swus per year. These values for separative work are at the high end of the possible output of Iran's P1 centrifuge; actual values may be less.

[2] Alternatively, Iran could secretly build a "topping plant" of about 500 centrifuges and use a stock of low enriched uranium produced in the pilot plant as feed to produce HEU. However, the estimated timeline for this alternative route is not significantly different from the one outlined in this scenario and is not considered further.

A capacity of 4,500 swus per year is sufficient to produce about 28 kilograms of weapon-grade uranium per year, assuming continuous operation and a tails assay of 0.5 percent, where tails assay is the fraction of uranium 235 in the waste stream. This is a relatively high tails assay, but such a tails assay is common in initial nuclear weapons programs. As a program matures and grows, it typically reduces the tails assay to about 0.4 percent and perhaps later to 0.3 percent to conserve uranium supplies.

Iran has enough components for up to 5,000 centrifuges, according to senior diplomats in Vienna. However, other senior diplomats said that Iran may not have 5,000 of all components, and many components are not expected to pass quality control. In total, Iran is estimated to have in-hand enough good components for at least an additional 1,000 to 2,000 centrifuges, beyond the roughly 800 centrifuges already slated for the pilot plant at Natanz. Iran could also build new centrifuge components, and in fact may have already started to do so.

If Iran had decided to build a clandestine plant in early 2006, it could assemble enough additional usable centrifuges for this plant of 1,500-1,800 centrifuges in about 15-18 months, or by about mid-2007. It would need to assemble at the upper limit of its past rate of about 70-100 centrifuges per month to accomplish this goal. If necessary, Iran could also increase the centrifuge assembly rate, for example by increasing the number of shifts from one to two per day, according to diplomats in Vienna.

In the meantime, Iran would need to identify a new facility where it could install centrifuge cascades, since it is unlikely to choose Natanz as the location of a secret plant. It would also need to install electrical, cooling, control and emergency equipment, feed and withdrawal systems, and other peripheral equipment. It would then need to integrate all these systems, test them, and commission the plant. Iran could start immediately to accomplish these steps, even before the final testing of the 164 machine cascades at Natanz, but final completion of the clandestine plant is highly unlikely before the end of 2007.

Given another year to make enough HEU for a nuclear weapon, where some inefficiency in the plant is expected, and a few more months to convert the uranium into weapon components, Iran could have its first nuclear weapon in 2009. By this time, Iran is assessed to have had sufficient time to prepare the other components of a nuclear weapon, although the weapon may not be small enough to be deliverable by a ballistic missile.

This result reflects a worst-case assessment, and Iran can be expected to take longer. Iran is likely to encounter technical difficulties that would delay bringing a centrifuge plant into operation. The output of its centrifuges may not achieve the higher value used in this assessment. Other factors causing delay include Iran having trouble in the manufacturing and installation of so many centrifuges and cascades in such a short time period, or Iran taking longer than expected to overcome difficulties in operating the cascades as a single production unit or in commissioning the secret centrifuge plant.

Scenario II—Break Out Using FEP

Iran has stated its intention to start installing centrifuges in late 2006 in its first module of 3,000 centrifuges in the underground halls of FEP at Natanz. This module would give Iran another way to produce HEU for nuclear weapons, even though the module is being designed to produce low enriched uranium. Once Iran has an adequate stock of LEU, the time to produce enough HEU for a nuclear weapon in this facility could be dramatically shortened.

At above rates of centrifuge assembly, and assuming that Iran has or can produce enough new P1 centrifuge components and associated equipment, Iran could finish producing 3,000 centrifuges for this module sometime in 2008. Although cascades would be expected to be built before all the centrifuges are assembled, Iran will probably need at least another year to finish this module, placing the completion date in 2009 or 2010. Unexpected complications could delay the commissioning date. On the other hand, Iran could accelerate the pace by manufacturing, assembling, and installing centrifuges more quickly. Given all the difficult tasks that must be accomplished, however, Iran is unlikely to commission this module much before the start of 2009.

If Iran decided to make HEU in this module, it would have several alternatives. Because of the small throughput and great operational flexibility of centrifuges, HEU for nuclear weapons could be produced by reconfiguring the cascades in the module or batch recycling where the cascade product is used as feed for subsequent cycles of enrichment in the same cascade.

Reconfiguration could be as straightforward as connecting separate cascades in series and selecting carefully the places where new pipes interconnect the cascades. The Iranian module is slated to be composed of 164-centrifuge cascades operating together under one control system. In such a case, reconfiguration would not require the disassembly of the individual cascades, and it could be accomplished within days. In this case, the loss of enrichment output can be less than ten percent, although the final enrichment level of the HEU may reach only 80 percent, sufficient for use in an existing implosion design albeit with a lower explosive yield. With a reconfigured plant, and starting with natural uranium, 20 kilograms of HEU uranium could be produced within four to six months. If Iran waited until it had produced a stock of LEU and used this stock as the initial feedstock, it could produce 20 kilograms in about one to two months.

Batch recycling would entail putting the cascade product back through the cascade several times, without the need to change the basic setup of the cascade. Cascades of the type expected at Natanz could produce weapon-grade uranium after roughly four or five recycles, starting with natural uranium. Twenty kilograms of weapon-grade uranium could be produced in about six to twelve months. If the batch operation started with an existing stock of LEU, the time to produce 20 kilograms of weapon-grade uranium would drop to about one to two months.

Whether using batch recycling or reconfiguration, Iran could produce in 3,000 centrifuges at Natanz enough HEU for its first nuclear weapon in less than a year. Iran could do so in considerably less than a year, if it used an existing stock of LEU as the initial feed. It is likely that Iran would operate the module to make LEU so that any production of HEU would be expected to happen quickly.

Using either break-out approach, Iran is not likely to have enough HEU for a nuclear weapon until 2009. This timeline is similar to that outlined in the clandestine plant scenario. In addition, technical obstacles may further delay the operation of the module in the FEP.

Conclusion

The international community needs to be committed to a diplomatic solution that results in an agreement whereby Iran voluntarily forswears having any deployed enrichment capability. Looking at a timeline of at least three years before Iran could have a nuclear weapons capability means that there is still time to pursue aggressive diplomatic options, and time for measures such as sanctions to have an effect, if they become necessary.

In the short-term, it is imperative for the international community to intensify its efforts to disrupt or slow Iran's overseas acquisition of dual-use items for its centrifuge program and other nuclear programs. Iran continues to seek centrifuge-related items aboard, but it has encountered greater difficulty acquiring these items because of the increased scrutiny by key supplier states. As Iran seeks these items in a larger number of countries, greater efforts will be required to thwart Iran from succeeding.

It is vital to understand what Iran has accomplished, what it still has to learn, and when it will reach a point when a plan to pursue nuclear weapons covertly or openly could succeed more quickly than the international community could react. Although these estimates include significant uncertainties, they reinforce the view that Iran must foreswear any deployed enrichment capability and accept adequate inspections. Otherwise, we risk a seismic shift in the balance of power in the region.

Table 1 Iran's Main Declared Nuclear Sites

Uranium Mining and Milling	**Saghand Mine and Mill** **Gchine Mine and Mill**
Nuclear Research & Development	**Jabr Ibn Havan Multipurpose Laboratories (JHL)** **Radiochemistry Laboratories of TNRC** **Tehran Research Reactor (TRR)** **Uranium Chemistry Laboratory (UCL)** **Research reactors at Esfahan** **Molybdenum, Iodine and Xenon Radioisotope Production Facility (MIX Facility)**
Uranium Conversion	**Uranium Conversion Facility (UCF)**
Centrifuge Research & Development and Manufacturing	**Kalaye Electric Company** **Farayand Technique** **Pars Trash** **Other centrifuge manufacturing sites**
Centrifuge Uranium Enrichment	**Pilot Fuel Enrichment Plant at Natanz** **Fuel Enrichment Plant at Natanz**
Laser Uranium Enrichment	**Lashkar Ab'ad** **Karaj Agricultural and Medical Center**
Fuel Fabrication	**Fuel Fabrication Laboratory (FFL)** **Zirconium Production Plant (ZPP)** **Fuel Manufacturing Plant**
Heavy Water-Related Facilities	**Heavy Water Production Plant** **IR-40 Heavy Water Reactor** **Hot Cells**
Nuclear Power Generation	**Bushehr Nuclear Power Plant (BNPP)**
Waste Disposal	**Anarak**
Suspect Sites	**Parchin, Lavisan-Shian**

Appendix 1 Iran's Safeguards Violations

The International Atomic Energy Agency (IAEA) has found that Iran violated the Nuclear Non-Proliferation Treaty (NPT) and its related safeguards agreement for many years. Iran's violations and eventual—though still incomplete—cooperation with the IAEA can be divided into four eras or stages.

First Stage: up to mid-2002

In the first stage, beginning in the mid-1980s to early 1990s and continuing until mid-2002, Iran violated its safeguards agreement by pursuing undeclared fuel cycle activities with little scrutiny by the IAEA or member states. Although the IAEA and member states were collecting information about Iranian violations, they were reluctant to act publicly.

Second Stage: 2002-2003

The second stage began in August 2002 when the National Council of Resistance of Iran (NCRI) made the first of many public revelations about secret Iranian nuclear facilities, revealing the Natanz and Arak nuclear sites and ended in late 2003. After pressure from the IAEA and further public revelations about the Natanz site by ISIS, Iran finally allowed the IAEA to visit Natanz in February 2003, and that month Iran began to reveal some of its violations. However, the Atomic Energy Organization of Iran denied many of the accusations, and blocked access by the IAEA to suspect sites. During this time, Iran's leadership seemed to be torn between acting cooperative and protecting their nuclear secrets at all costs. Despite many efforts by Iran to hide its past and current activities, however, the IAEA, with assistance from member states, NCRI, and ISIS, revealed several more secret nuclear activities and facilities.

In his November 2004 safeguards report to the IAEA Board of Governors, the Director General detailed Iran's failures to implement its safeguards agreement that had been uncovered through this period. The violations include Iran's failure to report activities related to nuclear material, the failure to declare the existence of relevant nuclear facilities, the failure to provide design data for a number of facilities, and the "failure on many occasions to cooperate to facilitate the implementation of safeguards, as evidenced by extensive concealment activities."[3]

According to the IAEA, Iran failed to declare six major activities related to nuclear material:

- Iran failed to report that it had imported natural uranium (1,000 kg of UF_6, 400 kg of UF_4, and 400 kg of UO_2) from China in 1991 and its transfer for processing. Iran acknowledged the import in February 2003.

[3] International Atomic Energy Agency, "Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran," GOV/2004/83, 15 November 2004.

- It failed to report that it had used the imported uranium to test parts of its uranium conversion process, such as uranium dissolution, purification using pulse columns, and the production of uranium metal, and the associated production and loss of nuclear material. Iran acknowledged this failure in February 2003.
- Iran failed to report that it had used 1.9 kg of the imported UF_6 to test P1 centrifuges at the Kalaye Electric Company centrifuge workshop in 1999 and 2002. In its October 2003 declaration, Iran said it first fed UF_6 into a centrifuge in 1999 and in 2002 fed UF_6 into as many as 19 centrifuges. Iran also failed to declare the associated production of enriched and depleted uranium.
- It failed to report that in 1993 it had imported 50 kg of natural uranium metal, and that it used 8 kg of this for atomic vapor laser isotope separation (AVLIS) experiments at Tehran Nuclear Research Center from 1999 to 2000 and 22 kg for AVLIS experiments at Lashkar Ab'ad from 2002 to 2003.[4] Iran acknowledged these activities in its October 2003 declaration.
- Iran failed to report that it had used imported depleted UO_2, depleted U_3O_8, and natural U_3O_8 to produce UO_2, UO_3, UF_4, UF_6, and ammonium uranyl carbonate (AUC) at the Esfahan Nuclear Technology Center and the Tehran Nuclear Research Center.
- It failed to report that it had produced UO_2 targets, irradiated them in the Tehran Research Reactor, and then separated the plutonium from the irradiated targets. Iran also failed to report the production and transfer of waste associated with these activities and that it had stored unprocessed irradiated targets at the Tehran Nuclear Research Center. In meetings with the IAEA following its October 2003 declaration, Iran said that it conducted the plutonium separation experiments between 1988 and 1993 using shielded glove boxes at the Tehran Nuclear Research Center.

According to the IAEA, Iran failed to declare the existence of key nuclear facilities and failed to provide design information, or updated design information, for a number of facilities. Iran failed to declare the existence of the pilot enrichment facility at the Kalaye Electric Company workshop, the laser enrichment facility at Tehran Nuclear Research Center, and the pilot laser enrichment plant at Lashkar Ab'ad.

Iran failed to provide design information for the facilities where the uranium imported in 1991 was received, stored, and processed, including at Jabr Ibn Hayan Multipurpose Laboratories, Tehran Research Reactor, Esfahan Nuclear Technology Center, and the waste storage facilities at Esfahan and Anarak. Iran also failed to provide design information for the facilities at the Esfahan Nuclear Technology Center and the Tehran Nuclear Research Center where Iran produced UO_2, UO_3, UF_4, UF_6 and AUC using imported depleted UO_2, depleted U_3O_8, and natural U_3O_8. Iran failed to provide design information for the waste storage facilities at Esfahan and Anarak in a timely manner. It failed to provide design information for locations where wastes resulting from undeclared activities were processed and stored, including the waste storage facility at Karaj. And it

[4] International Atomic Energy Agency, "Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran," GOV/2003/75, 10 November 2003, Annex 1, p. 2.

failed to provide design information for the Tehran Research Reactor, in relation to the irradiation of uranium targets, the facility at the Tehran Nuclear Research Center where Iran separated plutonium, and the center's waste handling facility.

Third Stage: End of 2003-2005

The third stage, from October 2003 to the end of 2005, could be called the "Rowhani era," because Hassan Rowhani, then head of Iran's National Security Council, took the lead from the Atomic Energy Organization of Iran in the fall of 2003 and attempted to convince the international community that Iran would now be transparent and cooperate fully with the IAEA. Facing a deadline set by the IAEA Board of Governors, on October 21, 2003 Iran made an extensive written declaration to the IAEA of its past nuclear activities, which revealed a number of additional safeguards violations, and Iran agreed to sign the Additional Protocol.

According to the IAEA Director General's November 15, 2004 report to the Board of Governors, "Since October 2003, Iran's cooperation has improved appreciably, although information has continued in some cases to be slow in coming and provided in reaction to Agency requests. Since December 2003, Iran has facilitated in a timely manner Agency access under its Safeguards Agreement and Additional Protocol to nuclear materials and facilities, as well as other locations in the country, and has permitted the Agency to take environmental samples as requested by the Agency."

However, despite better cooperation, a number of new questions have been raised. For example, Iran's work on developing P2 centrifuges, which Iran had failed to declare in its declaration in October 2003, is not fully understood by the Agency. In addition, Iran has not allowed the IAEA sufficient visits to suspect sites at Parchin that are involved in research and development of high explosives. In proceeding with construction of tunnels at the Esfahan Nuclear Technology Centre before it had told the IAEA, Iran failed to honor its commitment to tell the IAEA about plans to construct new facilities.

Iran has not permitted the IAEA adequate information about and access to dual-use equipment and materials procured by the Physics Research Center for its Lavisan-Shian site that could be used in a gas centrifuge program. Except in one case, Iran has also refused repeated IAEA requests to interview individuals involved in the acquisition of these items. In the one case where the IAEA recently interviewed a former head of the Physics Research Center and took environmental samples of some of the equipment he presented to the inspectors, it detected traces of HEU on some vacuum equipment. This result links this equipment to the gas centrifuge program and contradicts Iranian denials about its relationship to the centrifuge program.

In addition, the IAEA has questions about a range of studies and documents that could have a military nuclear dimension. The documents include a 15-page document that describes the production of uranium metal from uranium hexafluoride and the casting of enriched and depleted uranium into hemispheres, activities typically associated with a nuclear weapons program. Iran declared that it received the document unsolicited from agents of the Khan network and that it has never used the document. Because this document was part of a package of detailed documents available from the Khan network related to the production of nuclear weapon components made from depleted uranium and HEU, the IAEA remains concerned that Iran may have received more documents in the package and conducted undeclared activities associated with these documents.

Another set of documents were located on a laptop computer that was brought out of Iran and provided to the United States, which in turn shared part of the information with the IAEA. The studies relate to a "Green Salt Project," high explosives testing, and the design of a missile re-entry vehicle that appears able to carry a nuclear warhead. Although this information is not a smoking gun, it suggests the existence of a military-run nuclear weapons program. Iran has refused to answer questions about the last two areas and offered inadequate answers about the Green Salt Project.

A number of questions from before October 2003 also remain unanswered, pending new information or further analysis, such as the source of low enriched uranium and some HEU contamination on Iran's P1 centrifuges and the timeline of Iran's plutonium separation activities.

Fourth Stage: 2006-Present

In the fourth stage, starting in early 2006 and continuing until today, Iran has broken the suspension and halted its adherence to the Additional Protocol. The IAEA is making minimal progress in answering its outstanding questions and concerns or in confirming the absence of undeclared nuclear material and activities. It has also lost access to key centrifuge production and storage facilities, which would enable inspectors to determine the rate and status of Iran's production of centrifuges. This knowledge is especially relevant to concerns of a possible covert enrichment program.