An Arms Control Association Briefing Book

Solving the Iranian Nuclear Puzzle

Toward a Realistic and Effective Comprehensive Nuclear Agreement

3rd Edition, June 2014

ACA Research Staff

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Cover Photo

Negotiators representing the P5+1 and Iran meet in in Vienna, on April 8, 2014, for a third round of nuclear talks aimed at reaching a comprehensive agreement on Iran's nuclear program. Credit: Dieter Nagl/AFP/Getty Images

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Preface

For well more than a decade, the sensitive nuclear fuel-cycle activities of the Islamic Republic of Iran have been at the center of international concern about the further spread of nuclear weapons.

In November 2013, after years of on-and-off negotiations, the Obama administration and its P5+1 partners (China, France, Germany, Russia, and the United Kingdom) secured an agreement with the Iranian government, led by newly elected, more moderate President Hassan Rouhani's Foreign Minister Mohammad Javad Zarif.

The six-month-long interim agreement pauses some of the most proliferation-sensitive activities and opens the way for further talks on what the two sides called "a mutually-agreed long-term comprehensive solution that would ensure Iran's nuclear programme will be exclusively peaceful."

The negotiators' immediate and more difficult challenge is to hammer out a comprehensive, final-phase agreement, possibly by July 20 or by the end of 2014 if the two sides agree to extend the interim agreement and the negotiations on a final deal.

This is the third edition of the Arms Control Association briefing book "Solving the Iranian Nuclear Puzzle" and is a substantial revision from the second edition. It is the first update since the conclusion of the interim agreement in November 2013.

This volume provides an overview of Iran's nuclear history and an up-to-date summary of the status and capabilities of Iran's nuclear program. It includes a new section analyzing the major issues and policy options now before the P5+1 and Iranian negotiators.

In our considered judgment, a comprehensive agreement that sets practical, lower limits on Iranian enrichment capacity, maintains Iranian nuclear material stockpiles at very low levels, and significantly reduces the proliferation potential of Iran's other nuclear projects, combined with more-extensive International Atomic Energy Agency safeguards and a resolution to concerns about possible weapons-related experiments, in exchange for phased sanctions relief, could sufficiently guard against a nuclear-armed Iran for many years to come.

Concluding and implementing such an agreement will be difficult, but it is clearly the best option on the table.

—Daryl G. Kimball, Executive Director,
Arms Control Association, June 2014

EXECUTIVE SUMMARY

Toward a Realistic and Effective Comprehensive Nuclear Agreement

Negotiators from the United States and its P5+1 partners (China, France, Germany, Russia, and the United Kingdom) and their Iranian counterparts aim to negotiate a "comprehensive solution that would ensure Iran's nuclear programme will be exclusively peaceful" and to settle the long-running international dispute over Iran's nuclear capabilities and compliance with its nuclear Nonproliferation Treaty (NPT) safeguards obligations not to pursue nuclear weapons.

For the United States and its negotiating partners, an effective agreement should

- establish verifiable limits on Iran's program that, taken together, increase the time it would take for Iran to break out of the NPT and build nuclear weapons,
- increase the ability of the international community to promptly detect and effectively disrupt any breakout attempt, and
- decrease Iran's incentives to pursue nuclear weapons in the future.

The framework and timetable for reaching a comprehensive deal was spelled out in their interim accord known as the Joint Plan of Action, which was concluded by the two sides in November 2013 and went into effect January 20, 2014.

This six-month-long agreement essentially freezes the growth of Iran's nuclear capacity and increases international oversight of Iran's nuclear activities, which has helped provide the time and trust necessary for negotiations on a comprehensive agreement.

Elements of a Comprehensive Deal

The two sides agreed in November that a comprehensive agreement would include several key elements.

- Agreed limits on the size and scope of Iran's uranium-enrichment program commensurate with its "practical needs" for a civil nuclear program.
- Steps to reduce the proliferation potential of Iran's Arak heavy-water reactor project.
- More-extensive international monitoring and verification mechanisms, particularly at undeclared nuclear sites, to improve detection and deterrence of possible nuclear weapons-related activity in the future.
- A resolution of the multiyear investigation by the International Atomic Energy Agency (IAEA) of past Iranian experiments with possible military dimensions.
- Additional steps to address other issues cited in past UN Security Council resolutions relating to Iran's nuclear program, which include Iranian ballistic missiles capable of delivering nuclear weapons.
- Civilian nuclear energy assistance and cooperation for Iran.

Dieter Nagl/AFP/Getty Images

Catherine Ashton, lead negotiator for the P5+1, and Iranian Foreign Minister Mohammad Javad Zarif talk to press on March 19, 2014, in Vienna after the second round of negotiations between Iran and the P5+1 on a comprehensive nuclear agreement.

- The removal of sanctions imposed on Iran by the UN Security Council, the United States, and the European Union relating to its nuclear program.

Like the interim agreement, a comprehensive agreement would likely require that each side undertake reciprocal, step-for-step measures in stages. Whereas the interim agreement calls for actions to be taken within six to 12 months, the implementation steps for a comprehensive agreement would be measured in years.

A comprehensive agreement will set forth deadlines for the completion or initiation of certain actions by each side. Some provisions would be temporary and time limited, while other actions, such as more-extensive IAEA monitoring under the terms of an additional protocol to guard against the development of a secret nuclear weapons program, would be indefinite in duration.

The two sides appear to have made progress in several areas, but differences on some major issues must still be bridged, and time is running short.

It is possible that the negotiators will not be able to conclude a final, comprehensive agreement by their target date of July 20. By mutual consent, the two sides could agree to extend the interim agreement for as much as six months while they seek to reach agreement on any remaining issues.

Defining Iran's Uranium-Enrichment Capacity

The most challenging issue appears to be how to negotiate a "mutually defined enrichment programme" with "agreed limits on the scope and level of enrichment, activities, capacity…and stocks of uranium" that are "consistent with practical needs."

Since 2005, Iran increased its centrifuge capacity from 300 first-generation IR-1 machines at one site to about 19,000 installed, first-generation IR-1 machines at two sites. Today, about 10,200 are operating. About 1,000 advanced IR-2M centrifuges are installed at the Natanz enrichment plant, but are not operational.

Iran's operating IR-1 machines could allow Tehran to enrich natural uranium stock into a sufficient quantity of highly enriched uranium (HEU) (25 kilograms in gaseous form) for one nuclear bomb in about six months, although such an effort would be detected first.

Taking into account Iran's current stockpile of low-enriched uranium (LEU) (8,784 kilograms), Iran could use these operating centrifuges to produce enough HEU for one bomb in two to three months.

It is extremely unlikely that Iran would invite further sanctions or a military attack in order to produce enough fissile material for just one nuclear weapon, which is not an effective deterrent. If Iran tried to build a militarily significant nuclear arsenal, it would take considerably more than a year to amass enough material for additional weapons, convert the HEU gas to metal form, assemble and perhaps test a nuclear device, and mate the bombs with an effective means of delivery.

One critical goal for the P5+1 is to increase the time it would take to produce enough fissile material for an arsenal and enhance inspections and monitoring to ensure that any such effort could be detected and disrupted.

An agreement that significantly reduces Iran's present-day enrichment capacity and its enriched uranium stocks would increase that time even further and still would provide Iran with more than sufficient capacity for its nuclear fuel needs, which are very limited for the next decade or more.

Yet, Iranian officials insist that Iran's nuclear fuel needs will increase over the course of the next 10 to 15 years or more and say they cannot depend on foreign suppliers, given the unreliability of foreign suppliers in the past. It is estimated that Iran would need about 100,000 operational IR-1 centrifuges by 2021 to provide fuel for its Bushehr reactor if the current fuel supply contract with Russia is not renewed. Iran says it has plans for other power and research reactors.

To reach a comprehensive agreement, the two sides must find a formula that limits Iran's uranium-enrichment capacity at the Natanz site in a way that precludes an Iranian dash to produce enough HEU for weapons without being detected and disrupted but allows for Iran's practical civilian needs, which are very minimal for the next several years but could increase over time.

Iran and the P5+1 should be able to agree to several straightforward steps, such as

- limiting uranium enrichment to levels of less than 5 percent;
- keeping Iran's LEU stockpile to a minimum (less than 1,000 kilograms or so); and
- halting production-scale work at the smaller Fordow enrichment plant and convert it to a research-only facility.

Some independent analysts and some Israeli officials argue that Iran should mothball the underground Fordow plant, which is less vulnerable to an airstrike. Iran strongly opposes such an outcome.

Negotiators have other options available that could help square the circle on uranium-enrichment capacity and address the concerns of each side.

- A comprehensive agreement could allow for appropriate increases in Iran's uranium-enrichment capacity in the later stages of the deal. Such adjustments could be conditioned on Iran providing sufficient information to the IAEA to show that any past experiments with possible military dimensions have been discontinued and demonstrating that it cannot obtain foreign nuclear fuel supplies for the new nuclear power reactors that it builds.
- Iran could agree to phase out, remove, and store under IAEA seal its less efficient, first-generation centrifuges and, over a period of years, replace them with a smaller number of more-efficient centrifuges. During the transition period, the total operating enrichment capacity would be held below agreed limits, ideally less than Iran's current capacity. Iran could agree not to assemble the more efficient centrifuges until there is a demonstrable need for commercial-scale enrichment. This would increase the time it would take Iran to operate the machines, providing added insurance against rapid breakout scenarios.
- To reduce Iran's rationale for greater enrichment capacity to fuel future reactors, a comprehensive agreement could commit the P5+1 to provide fuel supply guarantees to Iran for any such needs.

Reducing the Proliferation Potential of the Arak Reactor

Another major issue that the two sides must resolve through a comprehensive agreement is the reduction of the proliferation risks posed by Iran's effort to build a 40-megawatt thermal (MWt) heavy-water reactor at Arak. The reactor, as currently envisioned, is ideally suited to produce enough plutonium in its spent fuel for as many as two nuclear weapons annually.

The Arak reactor is a longer-term proliferation threat. The reactor, which is more than a year away from completion, would have to operate for approximately one year before spent fuel could be removed. The spent fuel would have to cool for

several months, and then the plutonium would have to be chemically separated using a facility that Iran is not believed to have.

It appears that the two sides can probably come to terms on reducing the Arak reactor's plutonium-production potential. According to statements made by the head of the Atomic Energy Organization of Iran, Ali Akbar Salehi, Iran is open to technical modifications of the reactor that would reduce its plutonium output. Members of the P5+1 indicate they would support this approach in principle. These design modifications include decreasing the power of the reactor from 40 MWt to 10 MWt and using low-enriched (3.5 percent) reactor fuel instead of natural uranium fuel.

These modifications would reduce the Arak facility's annual output of unseparated plutonium-239 from about eight kilograms to less than one kilogram. The two sides would have to agree on how to ensure that the modifications are difficult to reverse.

The two sides should be able to agree, as they did in the November interim agreement, that Iran would not build a reprocessing facility to extract the weapons-grade plutonium from the reactor's spent fuel.

As an additional safeguard, Iran and the P5+1 could agree to ship the spent fuel produced by the Arak facility out of Iran to prevent any covert reprocessing. Russia would be a likely destination because it is taking the spent fuel from the Bushehr reactor.

Resolving Concerns About Possible Weapons-Related Experiments

Another issue that must be addressed in order to build confidence in the peaceful nature of Iran's nuclear program involves activities having possible military dimensions that Iran is believed to have conducted prior to 2004 and perhaps afterward.

Until this year, Tehran has not cooperated with IAEA efforts over the past several years to comprehensively verify Iran's claims about the peaceful nature of its nuclear program, adding to suspicions about the purpose of Iran's nuclear program.

Iran and the IAEA reached a framework agreement in November 2013 for moving forward to resolve the outstanding concerns. Although some initial progress has been achieved, the IAEA investigation will continue beyond July 20 and probably into 2015.

Dieter Nagl/AFP/Getty Images

IAEA Deputy Director General for Safeguards Tero Varjoranta arrives in Vienna on February 10, 2014, after a trip to Tehran. On Feburary 9, Varjoranta announced that Tehran would take additional measures to assist the agency's investigations into Iran's past nuclear activities.

A comprehensive deal can play a role in facilitating Iranian cooperation and a prompt conclusion to the agency's investigation. A comprehensive deal could,

- clarify that the information that Iran provides to the IAEA will be used only for the IAEA's determination of whether Iran's nuclear program is entirely peaceful;

- be conditioned on the IAEA determination that questions surrounding the possible military dimensions of Iran's nuclear program have been addressed to the extent possible; and

- clarify that international sanctions may be reimposed if Tehran fails to complete the IAEA's requested actions in a timely manner.

These measures should provide sufficient incentives for Iran to follow through on closing its file with the IAEA.

Securing More-Extensive International Inspection Authority

If Iran were to pursue nuclear weapons development in the future, it would most likely try to do so by means of a secret program carried out at undisclosed facilities rather than its declared facilities under international monitoring.

The two sides agree that a comprehensive agreement should include requirements for more-timely notification of Iranian nuclear activities to the IAEA under Iran's current comprehensive safeguards agreement with the IAEA and more-extensive IAEA inspection authority to guard against a secret weapons program under the terms of an additional protocol.

An additional protocol would allow the IAEA to conduct inspections of nondeclared sites without prior notification, which is a strong deterrent against any clandestine nuclear weapons work. In the first phase of a comprehensive agreement, Iran will likely be required to implement an additional protocol. At a later point, Iran would commit to ratify it. Once approved by the Iranian parliament, the duration of the additional protocol would be indefinite.
In addition, the P5+1 will seek more inspection measures for an extended period of time to provide still more confidence to the international community that Iran's nuclear program is being used for entirely peaceful purposes, including ongoing monitoring of Iran's centrifuge manufacturing facilities and support infrastructure.

In the final analysis, serious policymakers in Washington, Tehran, and other capitals...must consider whether their country is better served by an agreement than without one.

Phasing Out Sanctions Against Iran

To secure a comprehensive agreement, the P5+1 will need to agree to phase out the tough, multilateral nuclear sanctions regime now in place, including the international oil and financial sanctions that are devastating Iran's economy.

Iran will likely insist that, with each of the successive steps that it undertakes as part of a comprehensive agreement, there will be commensurate actions to suspend and then lift sanctions.

The step-for-step approach of a possible comprehensive agreement will require a new UN Security Council resolution on Iran's nuclear program and positive, follow-up actions by the EU states and approval by the U.S. Congress of legislation that unwinds U.S. nuclear-related sanctions that impact other nations' affairs with Iran.

Addressing Other Issues in UN Security Council Resolutions

The November 24 agreement stipulates that a comprehensive deal must address other issues in the existing UN Security Council resolutions. This includes Security Council Resolution 1929 (2010), which required Iran to halt all ballistic missile activity that could be used to deliver nuclear weapons.

The missile issue is certainly relevant to the issue of Iran's future nuclear weapons potential, but it must be handled very carefully. Attempts by the P5+1 or the U.S. Congress to impose specific, binding limits on

Iran's ballistic missile capabilities at this point could jeopardize chances to conclude an agreement that establishes verifiable limits on Iran's ability to produce material for nuclear weapons. Without Iran's ability to produce nuclear weapons, its ballistic missiles pose much less of a threat to its neighbors.

Therefore, the most effective way to address the potential threat of nuclear-armed Iranian ballistic missiles is to conclude a robust deal between Iran and the P5+1 to prevent Iran from being able to build nuclear weapons.

Assessing the Outcome of the Negotiations

An agreement between the P5+1 and Iran should not be evaluated on the basis of any single feature. Instead, it must be assessed on the basis of its overall impact, especially the extent to which it limits Iran's nuclear weapons-related capabilities, improves transparency about the program, and enhances the ability of the international community to promptly detect and disrupt any dash toward nuclear weapons.

Neither side can expect that they will achieve everything they seek. Inevitably, there will be critics of any agreement that emerges from the talks who will argue that the deal falls short of their expectations of what they consider to the requirements of any agreement.

In the final analysis, serious policymakers in Washington, Tehran, and other capitals who have responsibility for approving actions necessary to implement an agreement must consider whether their country is better served by an agreement than without one. They must consider that, without a comprehensive diplomatic solution,

- there would be no verifiable limits on Iran's uranium-enrichment capacity and Iran would likely deploy additional and increasingly efficient centrifuges;
- Iran's enriched uranium stockpiles would grow, not shrink;
- the time it would take Iran to produce enough fissile material for nuclear weapons would decrease rather than increase;
- IAEA inspections of Iranian facilities would likely continue but not be expanded to cover undeclared sites and activities, which is the most likely pathway to build nuclear weapons if Iran chose to do so; and
- sanctions would remain in effect and some might be strengthened but sanctions alone cannot halt Iran's nuclear progress and, over time, the willingness of international allies to help implement those sanctions could erode.

Although Iran would still have to overcome significant hurdles if it were to try to build nuclear weapons, this unpleasant scenario would likely increase the possibility of a military confrontation over time.

Yet, any use of military force against Iran's nuclear sites by Israel or the United States and a coalition of the willing would only delay Iran's nuclear program a few years at best and, at worst, would lead to a wider conflict and could very likely prompt Iran's leadership to openly pursue nuclear weapons in order to deter any further attacks.

A 'Win-Win' Deal to Guard Against a Nuclear-Armed Iran

The P5+1 and Iran have a historic opportunity to negotiate a long-term, final-phase agreement that guards against a nuclear-armed Iran and helps avoid a future military confrontation over its nuclear program.

Both sides must focus on realistic and achievable goals that meet their own core requirements and offer solutions that respect the bottom-line needs of the other side.

If either side pushes to include unrealistic requirements or fails to follow through on the commitments established by the agreement, the chances for a negotiated resolution will decrease, and the chances of a military conflict and a nuclear-armed Iran will increase.

An effective, comprehensive nuclear agreement is the best option on the table to help resolve the long-running dispute over Iran's nuclear ambitions.—*KELSEY DAVENPORT, DARYL G. KIMBALL, and GREG THIELMANN*

SECTION 1

Background and Status of Iran's Nuclear Program

The agreement reached between Iran and the P5+1 (China, France, Germany, Russia, the United Kingdom, and the United States) on November 24, 2013, was a significant breakthrough after a decade of negotiations to resolve international concerns about Tehran's nuclear program.

Prior to this historic agreement, Tehran had been steadily improving its capability to produce fissile material for nuclear weapons. Serious questions about Iran's past activities related to developing nuclear weapons also remained unanswered.

Although the U.S. intelligence community assesses that Iran abandoned a coordinated nuclear weapons program in 2003, the 2007 National Intelligence Estimate (NIE) on Iran and more-recent intelligence community testimony assessed that Iran has developed a range of technologies, including uranium enrichment, nuclear warhead mechanics, and delivery systems, that would give it the option to launch a nuclear weapons development effort in a relatively short time frame "if it so chooses."[1]

Such an effort is not the same as a crash program designed to construct a nuclear weapon as soon as possible, which would require that Iran eject inspectors and try to produce weapons-grade material at its declared facilities or perhaps at undeclared facilities before such an effort could be detected and disrupted.

Instead, Tehran appeared to be taking a more deliberate approach, building up as much of its technological base as possible for what is ostensibly a peaceful nuclear energy program while reserving the option to make a political decision to build and deploy nuclear weapons.

As Director of National Intelligence James R. Clapper explained in his 2012 testimony, "We judge Iran's nuclear decision making is guided by a cost-benefit approach, which offers the international community opportunities to influence Tehran."[2]

Iran's Nuclear Ambitions and Capabilities

Iran's interest in pursuing an ambitious nuclear power program preceded the 1979 revolution. The United States provided a kick-start to Iran's nuclear program by signing a nuclear cooperation agreement under President Dwight Eisenhower's Atoms for Peace Program in 1957 and subsequently provided the five-megawatt-thermal (MWt) Tehran Research Reactor. The shah's government later announced plans for building more than 20 nuclear power reactors for generating electricity.[3]

Beginning with the first serious discussions with Tehran in the 1970s about helping to construct nuclear power reactors, the U.S. government sought to impose safeguards beyond those required by the nuclear Nonproliferation Treaty (NPT). For his part, the shah pushed hard for domestic development of the full nuclear fuel cycle, in particular the ability to reprocess spent fuel.[4] Although Iran claims today that Washington accepted a robust nuclear power program in Iran under the shah, the United States insisted at the time that Iran not possess a reprocessing capability due to fears it would be used to produce plutonium for nuclear weapons.[5]

After a brief interregnum following the 1979 revolution, the Iranian government resumed its pursuit of the previous regime's nuclear aspirations, albeit slowly, as Ayatollah Ruhollah Khomeini initially opposed nuclear development for theological reasons. Following Khomeini's death in 1989, the new supreme leader, Ayatollah Ali Khamenei, expanded Iran's undeclared nuclear activities.[6] The

Steps to Building Nuclear Weapons

The most recent U.S. Intelligence Community assessment of Iran's nuclear weapons potential, as expressed by Director of National Intelligence James Clapper in testimony before Congress in January 2012, is that: Tehran has made technical progress in a number of areas—including uranium enrichment, nuclear reactors, and ballistic missiles—from which it could draw if it decided to build missile-deliverable nuclear weapons. These technical advancements strengthen our assessment that Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons.

There are two routes for Iran (or any state) to obtain sufficient fissile material to make nuclear weapons—using highly enriched uranium or plutonium. The following major scientific, technical, and industrial steps are required to build a uranium or plutonium weapon.

Mining or Importation of Uranium Ore
Iran is believed to have large reserves of uranium and two working mines.

Milling of Uranium
Concentrating uranium from ore, i.e., increasing uranium oxide content to 65-85 percent to produce "yellow cake."

Processing (Conversion)
Converting yellow cake, a solid, into uranium hexafluoride, a gas.

URANIUM ENRICHMENT ROUTE
Increasing the relative abundance of the uranium-235 isotope in the uranium hexafluoride

- to light-water power-reactor grade (3.5 percent)
- to research-reactor grade (20 percent)
- to weapons grade (90+ percent)

The IAEA estimates that 25 kg of weapons grade uranium is sufficient to produce one nuclear device.

PLUTONIUM PRODUCTION ROUTE
A nuclear "heavy water" reactor fueled by natural uranium will produce plutonium as a byproduct of reactor operatons. The plutonium must be separated from the spent fuel and the highly radioactive fission product contained in the fuel.

Spent Fuel Reprocessing
A separate reprocessing facility is needed to separate out the plutonium before it can be used in nuclear weapons.

The IAEA estimates that 8 kg of weapons-grade plutonium is sufficient to produce one nuclear device.

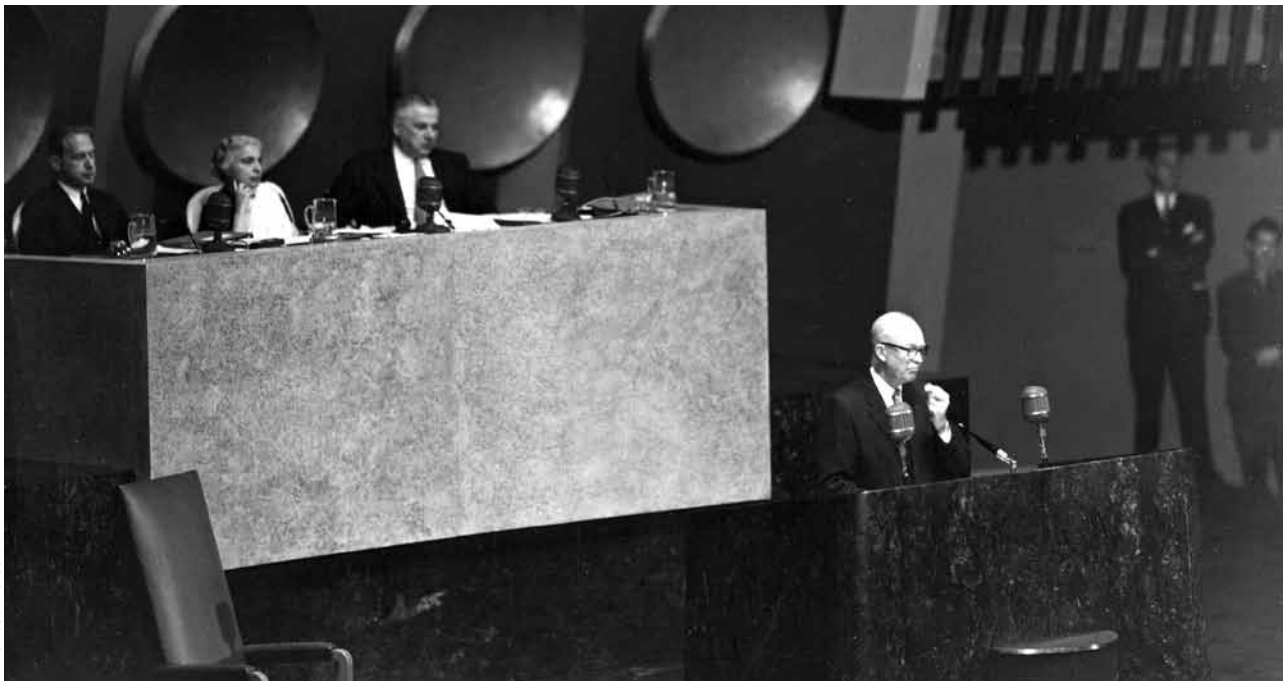
Fabrication
Converting weapons-grade uranium hexafluoride to uranium dioxide powder and into metallic forms for use in the fissile core of a nuclear device, or fabricating plutonium weapons components from reprocessed fuel.

Weapons Design and Assembly
Designing and assembling the other non-nuclear components in and around the fissile material core to make a device capable of forming the "physics package" of a warhead, suitable for use as part of a combat-ready weapons system.

Nuclear Explosive Testing
Detonating the nuclear device as proof of concept. Typically, multiple nuclear test explosions are necessary to perfect warhead designs, particularly smaller, lighter, more efficient designs.

Weapons Integration With a Delivery System
Adapting the warhead for placement into a bomb or the nose cone of a delivery vehicle.

Missile Testing With Inert Warhead
Performing flight tests with an inert warhead to confirm the performance of the non-nuclear functions of the warhead, such as safing, arming, and fusing, which are necessary in order to achieve higher levels of confidence and reliability.



United Nations

Iran received first its first nuclear power reactor, the Tehran Research Reactor, from the United States as part of the Atoms for Peace Program. President Dwight D. Eisenhower announced this program for sharing nuclear technology in a speech at the United Nations in 1953.

nuclear capabilities that Iran has been pursuing can be used for a peaceful nuclear energy program and nuclear weapons development, although some of the capabilities on which Iran has focused strongly suggest an intention to have the option to build weapons.

Iran's interest in developing a nuclear weapons capability is directly aligned with the central priority of its leadership: the survivability of its regime. The Islamic republic's revolutionary government has seen itself under threat since it came to power in 1979 because of Tehran's adversarial relationship with the United States and from the bitter eight-year war with Iraq, which invaded Iran in 1980.

Although Iran's former primary adversary in Baghdad has been replaced by a friendlier government, the presence of U.S. forces in Afghanistan and Iraq likely heightened Tehran's concerns about the external threat posed by the United States. Tehran's national security aims are grounded in deterring threats to the regime.

According to a 2010 Pentagon report on Iran's military power, "Iran's nuclear program and its willingness to keep open the possibility of developing nuclear weapons is a central part of its deterrent strategy."[7] Subsequent reports found that Iran "is developing a range of technical capabilities that could be applied to the production of nuclear weapons if the decision is made to do so."[8]

Iran's nuclear ambitions also are rooted in the country's goal of exerting influence throughout the region. Tehran's military power is not proportionate to its economic power, however, and its conventional military capabilities are limited by lack of training and modern weaponry. Iranian military modernization also has been constrained since the days of the Iran-Iraq war because of limited access to foreign weapons and parts.

Consequently, although Iran has been active in building a domestic arms industry, it still retains U.S.-built weapons from the time of the shah and lower-quality, Russian- and Chinese-built systems acquired in more recent years. Iran has vigorously pursued the development of ballistic missiles, many of which are capable of delivering nuclear weapons in the region.

Any decision by Iran's leadership to pursue nuclear weapons development would need to overcome significant political and technical hurdles. Iran has long said that its nuclear program is exclusively for peaceful purposes. Additionally, there is religious opposition to the development of weapons of mass destruction. Khamenei has called nuclear weapons a "grave sin," claiming that Iran "has never pursued and will never pursue" them.[9]

Iran's apparent work on developing a nuclear warhead, at least prior to 2004, undermines Khamenei's declarations; Iran would need to find some way to explain the reversal of its stated policy to Iranian domestic audiences and the international community.

Major countries and rising powers, such as China, Russia, India, and Brazil, which have been reluctant to apply heavier pressure on Iran so long as it is not obviously pursuing weapons development, would not be able to maintain close relations with Tehran in the event of an open decision by Iran to build nuclear weapons. Iran would suffer even greater political, economic, and very likely military consequences of any such decision.

Today, the most relevant aspects of Iran's nuclear program for a nuclear weapons option are its uranium-enrichment-related facilities, its heavy-water reactor activities, and the work it has carried out on warhead development.

These and other activities must be addressed in a comprehensive deal in a way that increases the time it would require Iran to amass fissile material for nuclear weapons and in a way that reduces the time it would take to detect and disrupt any such efforts. Over time, the agreement must help increase confidence from the international community that Iran is engaged in an exclusively peaceful nuclear program.

Uranium Enrichment

For more than a decade, Iran's uranium-enrichment program has been the focus of international concern about Iran's nuclear aspirations because it provides Iran with the ability to produce one form of fissile material for nuclear weapons: weapons-grade highly enriched uranium (HEU).

The uranium pathway is the most likely route that Iran would use to produce fissile material for nuclear weapons, if the decision was made to pursue them. Iran enriches uranium using a machine called the gas centrifuge, which spins at very high speeds to increase the concentration, or percentage, of the fissionable isotope uranium-235.

Centrifuges are organized in groups called cascades, which generally contain either 164 or 174 machines and produce uranium enriched to different levels. Uranium enriched to less than 5 percent U-235 is typically used to fuel nuclear power plants. Research reactors, such as the Tehran Research Reactor, often run on uranium enriched to 20 percent. Uranium enriched to less than 20 percent is referred to as low-enriched uranium (LEU). Nuclear weapons require HEU, which typically has greater than 90 percent U-235.

Beginning in the mid-1980s, Iran acquired gas centrifuge technology through the nuclear smuggling network led by former Pakistani nuclear official Abdul Qadeer Khan, who provided similar assistance to Libya and North Korea. The centrifuge model that Iran is using to enrich uranium, the IR-1, is based on a Pakistani design, the P-1. The P-1 design was originally smuggled by the Khan network from the European enrichment consortium URENCO in the 1970s.

Iran's Centrifuges, as of May 2014[10]

		Natanz (FEP)*	Natanz (PFEP)*	Fordow (FFEP)*
IR-1	Installed	15,420	328	2,710
	Operating	9,166	328	696
IR-2m	Installed	1,008	0	0
	Operating	0	0	0
Total Operating Centrifuges: 10,190				

*FEP - Fuel Enrichment Plant; PFEP - Pilot Fuel Enrichment Plant; FFEP - Fordow Fuel Enrichment Plant

Note: Not included in this table are research and development centrifuges being tested at the Pilot Fuel Enrichment Plant. These include models IR-1, IR-2M, IR-4, IR-5, IR-6, and IR-6s and total less than 400. Iran is not withdrawing any enriched uranium from these machines.

Iran currently enriches uranium at two sites, Natanz and Fordow. Iran has manufactured more than 20,000 centrifuges domestically for these facilities, but is unlikely to be able to produce indigenously all of the materials, such as high-quality carbon fiber and maraging steel, necessary to expand its nuclear program. Tehran continues to rely on illicit networks to bypass international sanctions prohibiting the purchase of these materials. This dependency on foreign suppliers has slowed Iran's production of centrifuges.

Despite the supply constraints, prior to the November 24, 2013, interim agreement, Iran's centrifuge capacity was gradually increasing as it continued to install more IR-1 machines at both facilities and develop advanced models for Natanz.

The Natanz plant is Iran's primary uranium-enrichment facility. An Iranian opposition group, the National Council of Resistance of Iran, revealed in August 2002 that Iran was building the facility. In February 2003, Iran officially acknowledged the existence of Natanz and allowed the International Atomic Energy Agency (IAEA) to visit the facility. At that time, Iran had about 100 centrifuges installed in a pilot cascade.

The Natanz site comprises an industrial-scale enrichment facility, the Fuel Enrichment Plant, which is intended to eventually house about 50,000 centrifuges, and the Pilot Fuel Enrichment Plant. The Pilot Fuel Enrichment Plant is a research and development facility where Iran is testing more-advanced models of centrifuges, including the IR-2M,

Iran's Major Nuclear Facilities

IR-4, IR-5, IR-6, and IR-6S, to replace the crash-prone IR-1 models. Progress on the advanced machines has been slow. It is unclear which model Iran may choose to deploy, when it would be capable of doing so in large numbers, and how their efficiency measures against the IR-1. In December 2013, Iran announced it would begin testing a new model, the IR-8, which it claimed to be 15 times more efficient than the IR-1. Yet, the IAEA reported in May 2014 that this centrifuge had not been tested.

Prior to the November 24 Joint Plan of Action, Iran had installed 15,420 IR-1 centrifuges at the Fuel Enrichment Plant, of which approximately 9,200 are operational in 54 cascades. The IR-1 machines are currently enriching uranium to 3.5 percent.

In January 2013, Iran informed the IAEA that it planned to install IR-2M machines in production-scale cascades at the Natanz Fuel Enrichment Plant. Prior to the November 24 agreement, Iran had installed 1,008 advanced IR-2M centrifuges there. These centrifuges are not yet enriching uranium.

Experts assess that, when operational, the centrifuges will be three to five times more efficient than the IR-1 centrifuges. Based on the design information provided to the IAEA, Iran wants to install approximately 3,000 IR-2M centrifuges in this area of the facility. According to the Atomic Energy Organization of Iran, these centrifuges would produce uranium enriched to 3.5 percent.

Prior to the November 2013 interim agreement, Iran had produced about 11,100 kilograms of 3.5 percent-enriched uranium, an amount sufficient for several nuclear weapons if enriched further to weapons grade and then fabricated into the weapons' metallic cores. About 3,500 kilograms was further enriched to 20 percent. This left about 7,600 kilograms of 3.5 percent-enriched uranium in the stockpile in November 2013. As of May 2014, the IAEA reported that the stockpile of uranium enriched to 3.5 percent was 8,474 kilograms.

In February 2010, Iran began producing uranium enriched to 20 percent in two cascades of IR-1 centrifuges at the Natanz Pilot Fuel Enrichment Plant. In January 2012, Iran also began enriching uranium to 20 percent at its Fordow plant, using 696 IR-1 centrifuges in four cascades. Enrichment to a level of 20 percent was halted under the November 2013 Joint Plan of Action, and the cascades at each facility now produce uranium enriched to 3.5 percent.

The Fordow facility is located inside a mountain bunker and was built in secrecy, but in September 2009, France, the UK, and the United States publicly revealed its existence. Iran is believed to have informed the IAEA about the plant's existence only after discovering that Western intelligence agencies had learned of it.

An additional 11 cascades containing approximately 1,900 IR-1 centrifuges are installed at Fordow, but are not operating. An additional cascade remains incomplete. The facility now contains almost its full design capacity of nearly 3,000 machines in 16 cascades.

In total, as of January 2014, Iran has produced 447 kilograms of 20 percent-enriched uranium. Dating back to 2012, however, Iran has withdrawn approximately 303 kilograms of the 20 percent-enriched uranium hexafluoride gas for conversion into uranium oxide, a solid, at the Esfahan Fuel Plate Fabrication Plant. The uranium oxide is 20 percent-enriched material in the form of a powder used to produce fuel plates for the Tehran Research Reactor.

In January 2014, when the Joint Plan of Action began to take effect, the IAEA reported that Iran had a stockpile of about 209 kilograms of 20 percent-

Iran's Key Nuclear Facilities

FACILITY NAME	STATUS	FUNCTION
Fuel Enrichment Plant, Natanz	OPERATING, INCOMPLETE	Produces 3.5 percent-enriched uranium
Pilot Fuel Enrichment Plant, Natanz	OPERATING	Research, development, test, and evaluation on advanced centrifuges; produces 3.5 percent-enriched uranium
Fordow Fuel Enrichment Plant	OPERATING, INCOMPLETE	Produces 3.5 percent-enriched uranium
Tehran Research Reactor	OPERATING	Produces medical isotopes
Heavy-Water Reactor (IR-40), Arak	UNDER CONSTRUCTION	Produces medical isotopes; better suited to producing plutonium
Uranium Conversion Facility, Esfahan	SUSPENDED	Produces uranium hexafluoride, the feedstock for uranium enrichment
Fuel Manufacturing Plant, Esfahan	PARTIAL OPERATION	Produces fuel assemblies for reactors; can possibly fashion uranium metal cores for nuclear weapons
Bushehr Nuclear Power Plant, Bushehr	OPERATING	Produces electricity; has limited proliferation risk
Ardakan Yellowcake Production Plant, Ardakan	OPERATING	Processes mined uranium
Enriched UO_2 Powder Plant, Esfahan	OPERATING	Converts 3.5 percentenriched uranium to powder for reactor fuel
Fuel Plate Fabrication Plant, Esfahan	OPERATING	Converts 20 percent enriched uranium to U_3O_8 for research reactor fuel

enriched uranium material in gas form. This is not enough for a single weapon if further enriched to weapons grade. Some 240 to 250 kilograms of 20 percent-enriched material would be required to produce enough weapons-grade uranium required for a single nuclear weapon. By May 2014, the IAEA reported that as a result of dilution and conversion required by the Joint Plan of Action, Iran had decreased its stock of uranium hexafluoride to 38.4 kilograms.[11]

Iran could reconvert the uranium oxide to uranium hexafluoride, but this process would take several months. Under the current safeguards regime, it is highly unlikely that Tehran could avoid IAEA inspectors detecting the reconversion. Also, material would be lost in the conversion process.

Iran was ostensibly enriching uranium to 20 percent to provide fuel for the Tehran Research Reactor, which produces medical isotopes, and for similar research reactors Iran claims it will build in the future.[12] Although enriching uranium to 20 percent is not necessarily indicative of an intention to make a nuclear weapon, stockpiling uranium at this level is worrisome because if Iran attempted to produce weapons-grade uranium, it could do so much faster using 20 percent-enriched uranium than by starting with 3.5 percent-enriched material. Enriching uranium to 20 percent constitutes about 90 percent of the work needed to enrich uranium to weapons-grade levels.

Moreover, the rationale behind Iran's production of 20 percent-enriched uranium is dubious, particularly as experts assess that current stockpiles "exceed any realistic assessment of [Iran's] need."[13] Tehran does not likely have the technical capacity to build additional research reactors that would use 20 percent-enriched uranium fuel.

One important objective for the P5+1 negotiators will be to cap Iran's uranium enrichment at 5 percent and limit the size of its enriched uranium stockpile in order to reduce the proliferation risks posed by ongoing production of 20 percent material and large stockpiles of enriched uranium.

The type of centrifuge Iran would use to produce weapons-grade uranium is a key factor in determining how much time it would take for Iran to produce

enough weapons-grade material for a nuclear weapon, should it decide to do so. Estimates for the time it would take Iran to bolster the enrichment level of its LEU stockpile from 3.5 percent to weapons-grade range from four to 12 months using the commercial-scale Natanz enrichment plant. The longer time frame, believed to be the assessment of the U.S. government, assumes that Iran would need to reconfigure its centrifuges at Natanz in order to carry out the additional enrichment, while some nongovernmental experts suggest that Iran could close off valves as a shortcut to reconfiguring the plant, leading to a much shorter time frame.[14]

Given the unreliability of the IR-1 machine, some U.S. officials and experts have questioned whether Iran would decide to rely on it to enrich uranium to weapons-grade levels. Robert Einhorn, Department of State special advisor for nonproliferation and arms control issues, told an Arms Control Association gathering in March 2011 that "it would make no

Understanding Breakout Calculations

As the U.S. intelligence community has consistently noted since 2007, Iran has the scientific, technical, and industrial capacity to produce nuclear weapons if it chooses to do so. The U.S. intelligence community has also assessed that if Iran were make a decision to build nuclear weapons, it is more likely that it would seek to do so by means of undeclared, secret facilities, a scenario sometimes called a "sneak-out." The realistic goal for a final deal in the ongoing negotiations is not to make breakout impossible but to make it a more difficult and unattractive policy option for Iran.

Seeking to identify adequate constraints on Iran's nuclear program has prompted all manner of intricate calculations of the length of time it would take Iran to get a nuclear weapon. These calculations start with the time required for producing enough fissile material enriched to 90 percent in gaseous form for one bomb, but charting the path to accumulating sufficient fissile material falls short of providing a full understanding of what Iran would require to build nuclear weapons.

Although the production of fissile material is arguably the most resource intensive and difficult step toward building nuclear weapons, there are several additional technical hurdles, including designing and constructing an explosive device and integrating it into a delivery system (most likely a ballistic missile) so it would reliably detonate.

Moreover, these technical criteria constitute an important but incomplete lens through which breakout must be viewed. Real-world timelines must also take into account a broad range of legal and political factors inside and outside Iran. The success or failure of a breakout attempt would depend on the quality and scope of the international inspection regime, the ability of the international community to respond effectively to disrupt the breakout, and the number of weapons Iran would judge to be a credible deterrent.

In most discussions of the subject, it is assumed that Iran would require a minimum of approximately two to three months to produce the fissile material required for one nuclear weapon if it used its existing stockpiles of 3.5 percent-enriched uranium and its 10,200 fully operating IR-1 centrifuges. Two months is a longer period than the timeline estimated prior to last year's Joint Plan of Action, but far less than the one-year often cited as a goal for any comprehensive agreement.

Former U.S. officials have suggested that the Iranians will need to accept drastic reductions in their inventory of some 20,000 existing centrifuges capable of enriching uranium, for example, to 3,000-4,000 IR-1 operating centrifuges. This would certainly be consistent with the limited "practical needs" of Iran's nuclear power program for the next several years and push the time it would take to accumulate enough material for one bomb to more than a year.

However, the out-years become more complicated with Iran's insistence on retaining the right to fuel all future reactors and to develop and install more-efficient centrifuges. Future designs could be even more efficient, dramatically reducing the value of limits on numbers.

Once and if Iran can accumulate a sufficient quantity of uranium hexafluoride for a bomb or several bombs without such an effort being detected and disrupted, it would need to convert the material into powder form, fabricate the metallic core of the weapon from the powder, assemble other weapons components that had been previously developed or acquired on an

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independent track, and integrate the weapons package into a delivery vehicle.

This process could be more easily hidden, but it would require several months or longer.

David Albright of the Institute for Science and International Security argued in 2012 that Iran had not mastered the technology to weaponize weapons-grade uranium. He concluded that "[r]egardless of the extent of its past or on-going nuclear weaponization activities…Iran would have to overcome new technological hurdles before it could manufacture a nuclear weapon successfully."[15]

States developing nuclear weapons typically conduct multiple, large-scale nuclear test explosions to perfect their warhead designs, particularly the smaller, lighter, and more efficient designs needed for missiles.

With existing U.S. national means of intelligence and the International Monitoring System established to verify compliance with the Comprehensive Test Ban Treaty, any Iranian test would very likely be detected. If Iran were to try to "sneak out" to build nuclear weapons, Tehran would have to accept a lower confidence level concerning its warhead design or risk detection.

Iran is very unlikely to break out of the nuclear Nonproliferation Treaty to acquire only one nuclear weapon. Even if Iran were willing to tolerate the large uncertainties deriving from an untested nuclear weapons design, a single weapon would add additional uncertainties regarding missile performance and the ability of the warhead to penetrate the sophisticated missile defenses deployed in the region. Tehran would be staking everything on the perfect performance of one untested system. If it chose to increase the odds of success by planning to build multiple weapons, however, it would increase the need for fissile material, thus lengthening the breakout timelines and increasing the chances of international detection and blocking actions.

sense" for Iran to leave the NPT and produce material for nuclear weapons "with a machine that produces material so inefficiently," referring to the IR-1.

When the IR-2M centrifuges are operational, the time frame could be reduced even further. These machines are estimated to be three to five times more efficient than the IR-1 centrifuges. Yet, it remains unlikely that Iran could do this without alerting IAEA inspectors, who now have daily access to the Natanz and Fordow sites.

Heavy-Water Reactor Project

Another potential path to the construction of nuclear weapons that Iran could pursue is plutonium production using the heavy-water reactor it has been constructing at Arak. This reactor, which Iran claims is intended to produce medical isotopes, is poorly suited for that function but well suited for production of weapons-grade plutonium.

Iran began construction of this reactor, known as the IR-40, in 2004. Construction has been beset by delays, due in part to proliferation-related sanctions, which have prevented Iran from obtaining some of the materials required.

Despite the delays, Iran made noticeable progress on the reactor in 2013 prior to the conclusion of the November 24 Joint Plan of Action. This included installing the upper containment vessel and the reactor vessel and testing prototype uranium fuel assemblies for the reactor in the Tehran Research Reactor. Iran also began producing fuel rods made of natural uranium for the reactor and completed 10 before halting production as part of the November 24 agreement. The reactor will require about 150 fuel rods to operate as intended from the original design.

Prior to the November 24 Joint Plan of Action, it was difficult to determine key reactor design features and a timeline for reactor operations, given Iran's failure to provide the IAEA with updated design information. Although Iran has provided the agency with that information, in February and March 2014, that information is not public. Yet, if the 40-MWt Arak reactor becomes operational under its original design, experts assess that it could potentially produce about eight kilograms of plutonium per year, enough for about two weapons.[16]

In order to use the plutonium from the reactor, Iran would need a reprocessing facility to separate the plutonium from the reactor's spent fuel. In 2004, Iran revised its declaration to the IAEA regarding the Arak site and eliminated plans for constructing a reprocessing facility. Iran currently is not known to be working on such a capability, although Tehran admitted to the IAEA in 2003 that it had carried out reprocessing experiments during 1988-1993 without informing the agency.[17]

Ensuring that Iran modifies the design of the reactor to minimize the output of weapons-grade

Samuel Kubani/AFP/Getty Images

Yukiya Amano, Director General of the IAEA, told the agency's Board of Governors on June 2, 2014, that Iran is complying with the agency's investigations into Tehran's past activities related to developing nuclear weapons.

plutonium or converts the facility to a light-water reactor, which is less useful as a source of plutonium, will be important in preventing Iran from producing material for nuclear weapons.

IAEA Safeguards

For nearly 20 years, Iran pursued much of its sensitive nuclear work in secret without informing the IAEA of its activities. It was not until Iran's facilities at Natanz and Arak were publicly revealed in the fall of 2002 that the agency was able to begin carrying out a thorough accounting of work Iran performed on uranium enrichment and other programs with possible weapons purposes.

Since 2003, many key Iranian facilities have been under IAEA safeguards, with inspections being carried out every few weeks. Most importantly, Iran's Natanz and Fordow enrichment sites and the conversion plant at Isfahan, which provides the feed material for enrichment, are currently being monitored. Tehran would not be able to move its enriched uranium or uranium hexafluoride feedstock or enrich either material to weapons grade without being discovered. From 2004 until early 2006, Iran voluntarily agreed to implement an additional protocol to its IAEA safeguards agreement.

Yet, prior to the November 2013 interim agreement, Iran kept many activities out of the inspections process. For example, Iran's centrifuge manufacturing and development work was not safeguarded after 2006, when Iran stopped implementation of its additional protocol. This was preceded by the IAEA finding Iran in noncompliance with its safeguards agreement in September 2005 and the agency's decision to refer Iran to the UN Security Council in February 2006.

In 2007, Iran stopped sharing early access and design information for its nuclear facilities with the IAEA, as it is obligated to do under the so-called modified Code 3.1 of its safeguards agreement. Although Iran announced it would revert to the original arrangement, the agency said the modified arrangement cannot be unilaterally altered and that Iran was still required to provide the notifications required by Code 3.1.[18]

As a result, the agency did not have regular access to the heavy-water reactor under construction at Arak, and Iran refused to share plans regarding the construction of any additional nuclear facilities. Tehran also refused IAEA requests to install real-time camera monitoring at its enrichment facilities, a measure that would provide the earliest indication of any Iranian move to begin producing weapons-grade material.

International Atomic Energy Agency Verification Measures

Safeguards Agreement

Safeguards are activities that the International Atomic Energy Agency (IAEA) undertakes to verify that a state is living up to its international commitments not to use nuclear programs for nuclear-weapons purposes. State parties to the nuclear Non-Proliferation Treaty are obligated to have a safeguards agreement in place. Safeguard activities undertaken by the agency are based on a state's declaration of its nuclear materials and nuclear-related activities. Verification measures include on-site inspections, monitoring and evaluation.

Status of Iran's Safeguards Agreement: Iran's safeguards agreement entered into force in 1974. It grants the IAEA access to nuclear sites, including Iran's uranium enrichment sites at Natanz and Fordow, the fuel fabrication plant at Esfahan, the Arak heavy water reactor, and the Tehran Research Reactor, for monitoring and verification purposes.

Modified Code 3.1 of the Subsidiary Arrangements to a Safeguards Agreement

Modified Code 3.1 requires countries to submit design information for new nuclear facilities to the IAEA as soon as the decision is made to construct, or authorize construction, of the facility.

Status of Iran's Code 3.1 Agreement: In 2003, Iran accepted modified Code 3.1 but reneged unilaterally in March 2007. The IAEA maintains that subsidiary arrangements, including 3.1, cannot be altered unilaterally. There also is no mechanism in the safeguards agreement to suspend implementation of Code 3.1. Therefore, the IAEA maintains that it remains in force, and Iran is not following through with its obligations under Code 3.1 to provide the agency with updated design information for new and existing nuclear facilities.

Implications of Implementing Code 3.1 in Iran: If Iran implements Code 3.1, the IAEA will receive information about any plans Tehran has to expand its nuclear program earlier than it would under the existing safeguards agreement. Iran would also be obligated to share any design changes to existing nuclear facilities. This would be particularly useful in the case of the Arak heavy water reactor because Iran has not responded to the IAEA's request to provide updated design information.

Additional Protocol

The Additional Protocol is a legal document granting the IAEA inspection authority beyond what is permitted by a safeguards agreement. Additional Protocols are voluntary agreements negotiated on a state-by-state basis with the IAEA. A principal aim is to enable the IAEA inspectorate to provide assurance that there are no undeclared activities and all declared nuclear activities are for peaceful purposes. Under the Additional Protocol, the IAEA is granted expanded rights of access to information and sites. States must provide information about, and IAEA inspector access to, all parts of a State's nuclear fuel cycle - including uranium mines, fuel fabrication and enrichment plants, and nuclear waste sites - as well as to any other location with nuclear material. Additional Protocols typically include provisions granting multiple entry visas to inspectors, access to research and development activities, information on the manufacture and export of sensitive nuclear related technologies and allow for environmental samples.

Status of Iran's Additional Protocol: Iran negotiated an Additional Protocol with the IAEA and signed the agreement in 2003. Between 2003 and 2006 Iran voluntarily implemented the Additional Protocol, but never ratified the document. In 2006, Iran announced that it would no longer implement the provisions of the agreement.

Implications of Implementing the Additional Protocol in Iran: With the Additional Protocol in place, the IAEA will be able to visit all of the facilities associated with Iran's nuclear activities, including sites that it does not currently have access to, such as the uranium mines, Iran's centrifuge production facilities, and its heavy water production plant. The

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Additional Protocol also substantially expands the IAEA's ability to check for clandestine, undeclared, nuclear facilities by providing the agency with authority to visit any facility, declared or not, to investigate questions about or inconsistencies in a state's nuclear declarations.

The IAEA will also be able to visit any site on very short notice. These monitoring and verification measures will give the agency a more complete picture of Iran's nuclear activities and allow for early detection of deviations from peaceful activities. Early notification would give the international community time to respond to any dash Iran might make toward nuclear weapons.

Until 2013, Iranian officials argued that their actions were justified because the IAEA and the UN Security Council were trying to deprive Iran of the inherent rights to which all NPT members are entitled. In fact, Iran is reneging on the terms of the safeguards agreement it concluded with the IAEA, one of its core NPT responsibilities on which its rights to nuclear technology is conditioned. The agency is fulfilling its responsibility by exercising due diligence in monitoring Iran's program so that it can determine whether the program encompasses weapons-related activities.

Warhead Development Program

Although much of Iran's nuclear program consists of dual-use technology that can be dedicated to civil nuclear energy and nuclear weapons use, Tehran is widely believed to have been engaged in a series of activities that can result in development of a nuclear warhead. U.S. intelligence estimates have long referred to these activities as evidence of an Iranian nuclear weapons program.

In November 2011, the IAEA released information in an annex to its quarterly report that detailed Iran's suspected warhead work based on intelligence it received from the United States and several other countries, as well as its own investigation.[19] According to the report, Iran was engaged in an effort prior to the end of 2003 that spanned the full range of nuclear weapons development, from acquiring the raw nuclear material to working on a weapon that could eventually be delivered via a missile.

This judgment is consistent with the 2007 NIE on Iran, which assessed "with high confidence that until fall 2003, Iranian military entities were working under government direction to develop nuclear weapons" and that the program was halted in the fall of 2003. It assessed "with moderate confidence that Tehran had not restarted its nuclear weapons program."

According to the November 2011 IAEA report, however, some information from IAEA member states suggests that some activities that would be "highly" relevant to a nuclear weapons program have resumed since 2004. Subsequent IAEA reports indicate that the agency received further information about periodic activities related to weapons development.

The series of projects that made up what the IAEA in its November 2011 report called "the AMAD Plan," appears to have been overseen by senior Iranian figures who were engaged in working-level correspondence consistent with a coordinated program.[20] Among the key components of this program were the following:

- **FISSILE MATERIAL PRODUCTION.** As documented in previous IAEA reports, Iran maintained an undeclared effort to produce uranium tetrafluoride, also known as Green Salt and a precursor for the uranium used in the enrichment process. The affiliation between this project and other projects directly related to warhead development suggests that Iran's nuclear weapons program included fissile material production and warhead development. Although the report does not detail a uranium-enrichment effort as part of the AMAD Plan, the secret nature of the Natanz enrichment plant prior to 2002 suggests that it was originally intended to produce HEU for weapons.

- **HIGH-EXPLOSIVES TESTING.** Iran's experiments involving exploding bridge wire detonators and the simultaneous firing of explosives around a hemispherical shape point to work on nuclear warhead design. The agency says that this type of high-explosives testing matches an existing nuclear weapons design based on information provided by nuclear-weapon states. Iran admits to carrying out such work, but claims it was for conventional military and civilian purposes and disputes some of the technical details.

- **WARHEAD DESIGN VERIFICATION.** Iran carried out experiments using high explosives to test the validity of its warhead design and engaged in preparatory work to carry out a full-scale underground nuclear test explosion.

- **SHAHAB-3 RE-ENTRY VEHICLE.** Documentation reviewed by the IAEA has suggested that as late as 2003, Iran sought to adapt the payload section of a Shahab-3 missile for accommodating a nuclear warhead. Confronted with some of the studies, Iran admitted to the IAEA that such work would constitute nuclear weapons development, but Tehran denies carrying out the research.

Iran has denied pursuing a warhead-development program and claims that the information on which the IAEA assessment is based is a fabrication. Until this year, Tehran has not cooperated with IAEA efforts over the past several years to verify Iran's claims comprehensively, adding to suspicions about the role of Iran's nuclear intentions. Iran has provided some information in the past related to specific claims, but any optimal resolution to the Iran nuclear issue would need to include a full accounting of Iran's past activities and assurances that any warhead-related activities that occurred or are still occurring have been halted.

In February 2012, Iran and the IAEA began negotiating a framework agreement to resolve the agency's outstanding concerns about Iran's possible weapons-related activities. In a document outlying an approach for addressing the unresolved issues, the IAEA grouped its concerns into three areas. Two concerned the clarity and completeness of Iran's initial declaration to the IAEA, and the third addressed the activities that could be related to the possible military dimensions of Iran's nuclear program.

Iranian and IAEA officials met 10 times between February 2012 and June 2013, but failed to reach an agreement on the scope and sequence of the agency's investigation.

These meetings resumed after Rouhani's inauguration as president of Iran in August 2013. On November 11, 2013, Iran and the IAEA concluded a framework agreement for moving forward to resolve the outstanding concerns. Under the terms of the framework, Iran and the IAEA agreed to resolve all outstanding issues in a step-by-step manner. The first set of actions included six steps for Iran to take within the first three months. At the conclusion of the three months, Iran and the IAEA met again, in February, and agreed on the next set of actions, which Iran was to complete by May 15. This set of seven actions included the first issue concerning the possible military dimensions of Iran's nuclear program. Iran provided the IAEA with information on exploding

Iran-IAEA Framework for Cooperation

Under the Joint Statement on a Framework for Cooperation, signed November 11, 2013, Iran and the International Atomic Energy Agency (IAEA) committed to resolve the agency's concerns through a step-by-step process to address all outstanding issues. An annex to the framework laid out the first six actions that Iran pledged to take within three months. On February 9, 2014, Iran and the IAEA announced an additional seven actions that Iran would take by May 15, 2014. A May 20, 2014, meeting resulted in an agreement on an additional five actions to be taken by August 25, 2014.

IRANIAN ACTIONS TO BE COMPLETED BY FEBRUARY 11, 2014

- Provide mutually agreed relevant information and managed access to the Gchine mine in Bandar Abbas.
- Provide mutually agreed relevant information and managed access to the Heavy Water Production Plant.
- Provide information on all new research reactors.
- Provide information with regard to the identification of 16 sites designated for the construction of nuclear power plants.
- Provide clarification of the announcement made by Iran regarding additional enrichment facilities.
- Provide further clarification of the announcement made by Iran with respect to laser enrichment technology.

IRANIAN ACTIONS TO BE COMPLETED BY MAY 15, 2014

- Provide mutually agreed relevant information and managed access to the Saghand mine in Yazd.
- Provide mutually agreed relevant information and managed access to the Ardakan concentration plant.
- Submit an updated Design Information Questionnaire for the IR-40 reactor (heavy-water reactor at Arak).

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- Take steps to agree with the IAEA on the conclusion of a Safeguards Approach for the IR-40 reactor.
- Provide mutually agreed relevant information and arrange for a technical visit to Lashkar Ab'ad Laser Centre.
- Provide information on source material that has not reached the composition and purity suitable for fuel fabrication or for being isotopically enriched, including imports of such material and on Iran's extraction of uranium from phosphates.
- Provide information and explanations for the IAEA to assess Iran's stated need or application for the development of exploding bridge wire detonators.

IRANIAN ACTIONS TO BE COMPLETED BY AUGUST 25, 2014

- Exchange information with the IAEA with respect to the allegations related to the initiation of high explosives, including the conduct of large-scale high-explosives experimentation in Iran.
- Provide mutually agreed relevant information and explanations related to studies made and papers published in Iran in relation to neutron transport and associated modeling and calculations and their alleged application to compressed materials.
- Provide mutually agreed information and arrange a technical visit to a centrifuge research and development center.
- Provide mutually agreed information and managed access to centrifuge assembly workshops, centrifuge rotor production workshops, and storage facilities.
- Conclude the safeguards approach for the IR-40 reactor.

bridge wire detonators ahead of the May 15 deadline and is working with the IAEA on follow-up questions stemming from its original report.

On May 21, 2014, Iran and the IAEA announced a set of five more actions, to be completed by August 25. These actions included an additional two issues concerning the possible military dimensions of Iran's nuclear program: initiation of high explosives and modeling and calculations related to neutron transport and their alleged application to compressed materials. Both of these activities relate to development of a nuclear weapon.

Iran's Nuclear Weapons Options

If Iran decided to try to build nuclear weapons, it could choose among three basic paths.

1. Enrich safeguarded LEU to weapons-grade uranium at existing facilities (shortest time frame).

2. Use a parallel, clandestine nuclear program with a full series of nuclear facilities built in secret (longest time frame).

3. Divert safeguarded material to a secret facility and enrich to weapons grade (moderate time frame).

Most estimates of the time necessary for Iran to produce a nuclear weapon are based on the use of the Natanz enrichment plant to produce HEU. Assessments range from about two months to one year using IR-1 centrifuges. This discrepancy is based on a number of factors, including the need for Iran to reconfigure the facility for higher-level enrichment and the efficiency of its centrifuges.

Such an approach would carry serious risks for Tehran because its facilities and nuclear material are under IAEA safeguards and any move in the near future to begin enrichment to weapons grade would be discovered almost immediately after the process began.

Efforts by Iran to enrich uranium to weapons grade at Natanz might even provoke an attack on Natanz and Fordow and possibly other nuclear sites by the United States or Israel to disrupt the process. It is highly unlikely that Iran would decide to take such a step unless it could significantly reduce the time frame to produce weapons-grade uranium and avoid detection and disruption. Efforts to reduce that time frame include operating thousands of advanced centrifuges and stockpiling a sufficient amount of reactor-grade enriched uranium needed to produce fissile material for several weapons. Continuous monitoring and a freeze on centrifuge installation under the November 24 agreement make this route even less likely.

The Fordow facility also could be used to carry out enrichment to weapons grade. Because Fordow only has a capacity of about 3,000 centrifuges, however, Iran's options for a rapid breakout at Fordow are more limited. Iran would need to install advanced centrifuges to enrich to weapons grade quickly. As with the Natanz plant, if the time frame for

enrichment was too long, Iran would risk the facility being destroyed or at least rendered inoperable before it could complete the process.

Because of these vulnerabilities, if Iran was to try to enrich uranium to weapons grade, it might seek to use covert facilities in some form. The 2007 NIE assessed with moderate confidence that "Iran would probably use covert facilities—rather than its declared nuclear sites—for the production" of HEU for a weapon.

A clandestine, parallel nuclear program would require that Iran construct a series of additional nuclear facilities along the uranium-enrichment path that mirrors its existing facilities. Because Iran's declared nuclear material is monitored under IAEA safeguards, Iran would need an entirely separate stream of material, beginning with uranium ore. Iran would need parallel facilities for the entire process required to build a bomb, all the way to weaponizing the enriched uranium.

Iran's uranium-mining and -milling operations to produce yellowcake do not currently fall under safeguards, although such activities could be detected through intelligence means. Also, Iran would need to construct another conversion plant to produce uranium hexafluoride, secretly manufacture large numbers of centrifuges, build an enrichment plant or plants to produce weapons-grade uranium, and construct a fabrication plant to manufacture the material into metal cores. Producing weapons-grade uranium using such a covert series of facilities appears to have been Iran's original intent prior to the exposure of its nuclear facilities in 2002.

Using such a path, Iran could potentially develop nuclear weapons without the international community's knowledge as long as all duplicate facilities, related manufacturing processes, and nuclear material remained hidden. In the past, Iran's two major enrichment facilities have been detected by foreign intelligence well before they became operational.

A clandestine program would require more time and far more resources for investment in duplicate facilities. Iran is already believed to be resource strained by sanctions, and an extended period of time would increase the risk that clandestine facilities would be uncovered. With more-intensive international inspections expected to be part of a comprehensive nuclear agreement between the P5+1 and Iran, it is unlikely that Iran would be able to pursue this path.

Iran could develop nuclear weapons through diversion to covert sites, which is an amalgam of

Jewel Samad/AFP/Getty Images

In an April 2011 press conference in Washington, D.C., Soona Samsami reveals images of a site that an Iranian opposition group claims is a facility used to produce centrifuges. Many Iranian nuclear facilities were originally developed in secret.

the first two approaches. This approach might entail the construction of a secret uranium-enrichment plant where Iran would further enrich its stockpile of 3.5 percent-enriched uranium to HEU. Tehran would likely need to construct another facility where that HEU would be fashioned into metallic cores for use in weapons to avoid using its declared fuel-manufacturing plant at Esfahan. Such an approach would avoid the need to completely duplicate many aspects of Iran's nuclear program while carrying out the final stages of weapons development in locations Tehran believed to be safe from pre-emptive attack. This path is less likely, however, with the increased monitoring put in place under the November 2013 Joint Plan of Action. Nevertheless, absent a comprehensive deal or continued increased monitoring, this remains a concern.

Iran announced in 2009 that it planned to build 10 additional uranium-enrichment plants, which is a goal likely beyond Iran's resources, but a decision to build any additional plants without revealing their location suggested that Iran wanted to maintain locations where it could enrich in secret. In 2011, Iranian officials said that plans to construct any additional plants would be postponed for a couple of years. As part of its November 11, 2013, agreement with the IAEA, Iran has provided the agency with information about its plans for future enrichment sites, but these details are not public. Construction cannot begin during the implementation period of the Joint Plan of Action due to provisions in the text that prohibit moving forward on further enrichment facilities. U.S. officials have reportedly expressed confidence that there is no secret uranium-enrichment site at present and attempts to build additional covert facilities would likely be detected.[21]

Under the provisions of the interim agreement, any breakout scenario becomes less likely. With a reduced stockpile of 20 percent-enriched uranium, Iran would need more time to produce significant quantities of fissile material. Moreover, the Natanz and Fordow sites are inspected on a daily basis, and the IAEA has access to Iran's centrifuge production plant and storage facilities. Major construction on the Arak heavy-water reactor has been halted. Any attempt to break out using known enrichment facilities would be detected within days, and the increased information about Iran's centrifuge production and supplies makes it more likely that the agency would detect any diversion to covert facilities.

Iran's Nuclear Delivery Path

Iran has a determined ballistic missile development

Iranian Medium-Range Ballistic Missile Launches

Iran's first medium-range ballistic missiles (MRBMs) were derived from North Korea's Nodong, but Iran's development and testing program for MRBMs has been more intensive and rigorous. Iran has conducted some 26 MRBM launches of solid- and liquid-fueled MRBMs over a 14-year period, compared to North Korea's launch of nine liquid-fueled MRBMs over 24 years.

DATE		MISSILE TYPE
1998	(*July*)	**Shahab-3**
	(*Nov.*)	Sejjil
1999		----
2000	(*July*)	**Shahab-3**
	(*Sept.*)	**Shahab-3**
2001		----
2002	(*May*)	**Shahab-3**
	(*July*)	**Shahab-3**
2003	(*July*)	**Shahab-3**
2004	(*Aug.*)	**Ghadr-1**
	(*Oct.*)	**Ghadr-1**
2005		----
2006	(*Jan.*)	**Shahab-3**
	(*May*)	**Ghadr-1**
	(*Nov.*)	**Ghadr-1**
	(*Dec.*)	**Ghadr-1**
2007	(*Nov.*)	Ashura
2008	(*July*)	**Shahab-3**
	(*July*)	**Shahab-3**
	(*Nov.*)	Sejjil
2009	(*May*)	Sejjil-2
	(*Sept.*)	**Ghadr-1**
	(*Sept.*)	Sejjil-2
	(*Dec.*)	Sejjil-2
2010	(*Oct.*)	Sejjil-2
2011	(*Feb.*)	Sejjil-2
	(*Feb.*)	**Shahab-3**
	(*June*)	**Ghadr-1**
2012	(*July*)	**Shahab-3**
2013		----
2014		----

Source: Various

Note: Launchers of the liquid-fueled Shahab-3 and its more advanced derivative, the Ghadr-1, are shown in bold. It has not always been possible to differentiate these systems from each other in flight tests, based on publicly available information.

program and would likely make such missiles its delivery vehicle of choice if it decided to build nuclear weapons. Indeed, Iran is suspected to have carried out R&D on mounting a nuclear warhead on a missile and detonating it at an appropriate height.[22] Ballistic missiles offer a preferred delivery path compared to Iran's aging air force, which remains predominately based on 1970s-era, U.S.-supplied aircraft and would be very vulnerable to the air defenses of target states.

Although Iran is believed to have the largest and most diverse missile arsenal in the region, official U.S. assessments say that Iran's ballistic missile program has been focused on increasing the sophistication of its short- and medium-range ballistic missiles.[23] With a range of up to 3,000 kilometers, missiles in these categories are capable of striking targets as far as Israel and Turkey.

Iran's currently operational medium-range ballistic missile systems are derived from 1950s-era Soviet Scud short-range ballistic missile technology, which Iran received from North Korea. The liquid-fueled Shahab-3, Iran's principal medium-range ballistic missile, is essentially identical to the North Korean Nodong missile. The most capable ballistic missile in Iran's confirmed operational inventory is the Ghadr-1, which is an enhanced version of the Shahab-3 and is able to carry a 750-kilogram warhead at least 1,600 kilometers and possibly up to 2,000 kilometers.

Iran claims to have deployed the two-stage, solid-fueled Sejjil-2 medium-range ballistic missile, with a range of 2,000 kilometers, but the United States has not confirmed that this system is operational.

A key aspect of Iranian efforts to increase the sophistication of its missile program is the development of solid-fuel missile technology. Solid-fueled missiles hold some advantages over Tehran's predominately liquid-fueled missile arsenal, including shorter launch times, greater mobility, and easier handling and storage.

If Iran developed a nuclear warhead for threatening Israel, the Sejjil-2 missile would be the most likely delivery platform. Its range would permit it to be fired at Israel from any part of Iran. A September 2013 military parade in Tehran included 12 Sejjil-2 missiles. The system was first flight-tested successfully in May 2009 and last tested in February 2011.

Ballistic Missle Range Categories

Short-range ballistic missile	<1,000 km
Medium-range ballistic missile	1,000-3,000 km
Intermediate-range ballistic missile	3,000-5,500 km
Intercontinental-range ballistic missile	>5,500 km

In addition to enhancing its medium-range ballistic missile capabilities, Iran has been gradually improving its technical capacity to develop and produce longer-range ballistic missiles. Iran's satellite launch program and its successful use of space-launch vehicles is central to this effort. The ability to put a satellite in space does not guarantee an ability to accurately target and deliver a warhead at long ranges, but there is sufficient overlap in propulsion, staging, and other important component technologies used by space-launch vehicles to make them a useful test bed for developing long-range missile systems. Nonetheless, Iran appears to have a genuine interest in developing space-launch capabilities beyond their military applications.

Iran placed a satellite in orbit on several occasions, in February 2009, June 2010, June 2011, and February 2012. All four launches used a two-stage Safir space-launch vehicle, and in the February 2012 launch, a modified Shahab-3 ballistic missile was identified by experts as the first stage. The Safir itself is not suitable as a military system because of its limited carrying capacity, and Iran is unlikely to convert it into a military missile. Iran showed a mockup of a larger space-launch vehicle called the Simorgh in 2010, but it has yet to launch this new system.

Because Iran has not flight-tested a long-range military system or a space-launch vehicle capable of being converted to such a system, an intercontinental ballistic missile capable of targeting the United States is unlikely to be available before 2020.

SECTION 2

Understanding the Joint Plan of Action

The November 24 Joint Plan of Action contains first-phase steps for Iran and the P5+1 to take over a six-month period that address urgent concerns of both sides. It also contains the broad parameters of a comprehensive agreement. This breakthrough accord was reached after three rounds of talks between the P5+1 and Iran, following Rouhani's inauguration as president of Iran and his appointment of a new negotiating team led by Foreign Minister Mohammed Javad Zarif.

The framework agreement's first-phase steps verifiably freeze progress in all areas of acute concern regarding Iran's nuclear program. It also rolled back Iranian capabilities in some areas and significantly increased IAEA monitoring and verification of Iranian nuclear activities.

In exchange, Iran received some relief from proliferation-related sanctions imposed by the United States and the European Union, including the repatriation of $4.2 billion in frozen Iranian oil revenue, and a pledge that new nuclear-related sanctions would not be imposed for the duration of the agreement. Meanwhile, the core of the existing international financial and oil sanctions regime against Iran would remain in place.

Implementation of the agreement began on January 20. The six-month time frame for the first-phase actions will end on July 20, but can be extended for another six months if both parties agree.

Under the interim agreement, the IAEA submits monthly reports on the status of the implementation. Also, the Joint Plan of Action set up a joint commission to evaluate any disputes that might arise over the course of the six-month period. The rationale was that these issues should be separate from the negotiations on a comprehensive agreement.

Enriched Uranium

Implementation of the first phase of the agreement rolled back Iran's uranium-enrichment program by capping the levels of enrichment, freezing the number of centrifuges enriching uranium, and neutralizing the most proliferation-sensitive aspect of Iran's nuclear program: its stockpile of uranium enriched to 20 percent.

In the Joint Plan of Action, Iran committed to enrich uranium to no more than 5 percent over the course of the agreement.

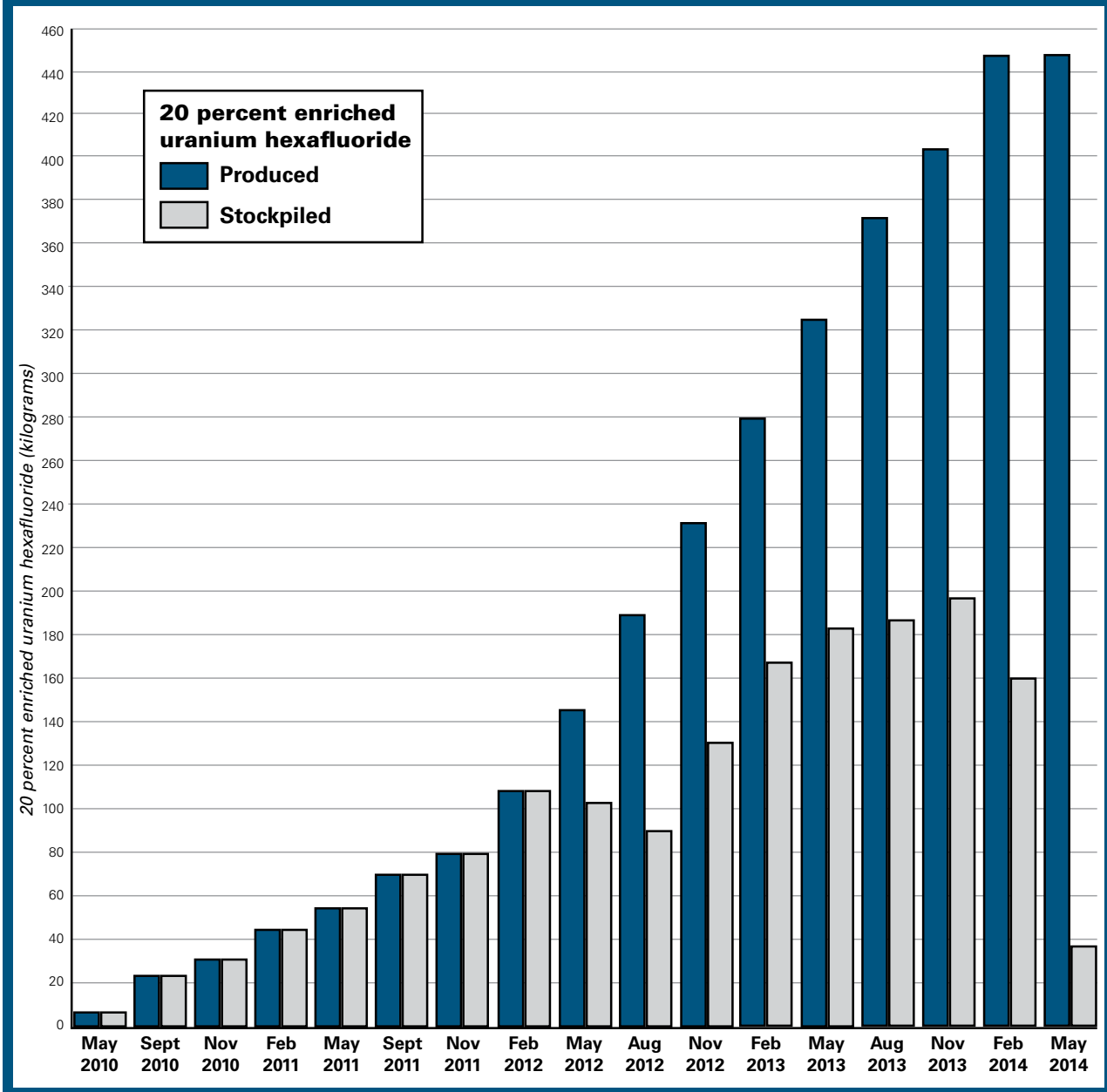
On January 20, the IAEA confirmed that Iran halted production of uranium enriched to 20 percent at Fordow and the Pilot Fuel Enrichment Plant at Natanz. Fordow, which only produced uranium enriched to 20 percent, was repurposed by the Iranians to produce reactor-grade uranium, but the cascades at Fordow cannot operate in an interconnected design as they had in the past.

As part of the agreed monitoring and verification mechanism, the Joint Plan of Action allows the IAEA to visit Natanz and Fordow on a daily basis and the IAEA installed real-time monitoring to ensure that Iran does not begin operating additional centrifuges or restart enriching uranium to 20 percent. Under the terms of the agreement, Iran can replace broken or damaged centrifuges, but not put any new centrifuges into operation.

On January 20, Iran's stockpile of uranium hexaflouride gas enriched to 20 percent was 209.1 kilograms, just short of the estimated 240 to 250

Iran's Production of Uranium Enriched to 20 Percent

Iran began enriching uranium to 20 percent in February 2010. In May 2012, Iran began converting some of its 20 percent enriched uranium hexafluoride gas to uranium oxide, a solid to make fuel plates for the Tehran Research Reactor. Using quarterly reports from the IAEA, this graph shows Iran's total production of uranium enriched to 20 percent and how much uranium enriched to this level remains stockpiled as uranium hexafluoride gas.



*In February 2012, Iran began enriching uranium to 20 percent at its Fordow Fuel Enrichment Plant. Prior to this point, all enrichment to 20 percent occurred at the Natanz Pilot Fuel Enrichment Plant. Beginning with the May 2012 report, the quantity of uranium enriched to 20 percent reflects the combined total of both sites.

kilograms that, when further enriched, is enough for one weapon. In May, the IAEA reported that Iran's stock of uranium enriched to 20 percent was 38.4 kilograms as a result of the implementation of the agreement.

In the Joint Plan of Action, Iran committed to take steps to reduce the threat posed by its stockpile of uranium enriched to 20 percent. Half of its 20 percent stockpile of hexafluoride gas was to be down-blended to 3.5 percent-enriched uranium hexafluoride gas; the other half is being converted into a powder form that can be used to make fuel plates for the Tehran Research Reactor.

The powder form can be reconverted to gas, but Iran committed not to set up a line to do so, and the IAEA has confirmed that no such line exists. During

any reconversion process, Iran would lose a significant quantity of material, perhaps as much as 30 percent, according to some experts.

The April 17, 2014, IAEA report on implementation confirmed that Iran completed the dilution of half of the 20 percent-enriched material to reactor-grade levels within the first three months, which was the time frame required by the agreement.

As of the May 23 IAEA report, Iran had converted 67 kilograms of 20 percent enriched uranium hexafluoride gas to powder form. An additional 38 kilograms remain to be converted.

Iran is allowed to continue enriching uranium to 3.5 percent under the November 24 agreement, but Tehran agreed to convert the uranium enriched to that level during the six months of the initial deal to a powder form that can be used to fuel nuclear power reactors.

In total, Iran's stockpile of uranium enriched to 3.5 percent was about 7,600 kilograms at the time that implementation of the Joint Plan of Action began in January. Since January, the stockpile has grown to 8,475 kilograms, according to the May 23 IAEA report.

This growth is a result of the continued production of uranium enriched to 3.5 percent and the dilution of 105 kilograms of uranium enriched to 20 percent. Iran did not complete construction of the conversion plant that will allow it to convert the 3.5 percent-enriched uranium hexafluoride gas to uranium dioxide powder until May 2014. Conversion should begin in June 2014.

Iran originally said that the facility would begin operations in December 2013. Iran maintains that, despite the delay, it will be able to complete the necessary conversion of the 3.5 percent-enriched uranium to ensure that there is no net growth in the stockpile between January 20 and July 20.

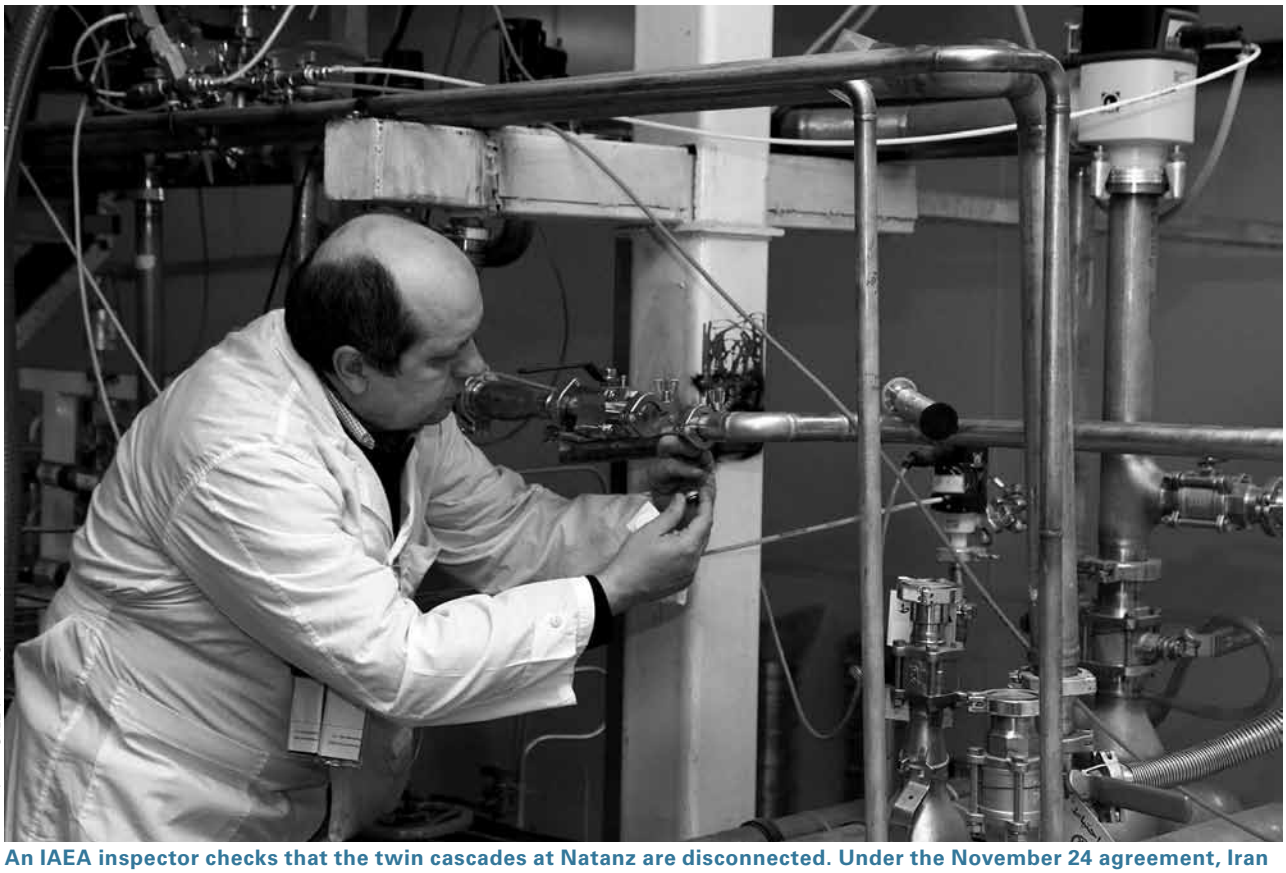
Natanz

Under the November 24 agreement, Iran committed not to install any additional centrifuges at the Natanz Fuel Enrichment Plant and not to operate any more centrifuges than were operating at the time of the November agreement.

The monthly IAEA reports confirm that the number of centrifuges installed at Natanz remained the same: 15,420 IR-1 machines in 90 cascades and 1,008 IR-2M machines.

The number of IR-1 centrifuges enriching uranium to 3.5 percent at Natanz is unchanged from the November report, with about 9,200 IR-1 machines operating in 54 cascades.

An additional two cascades that had been producing

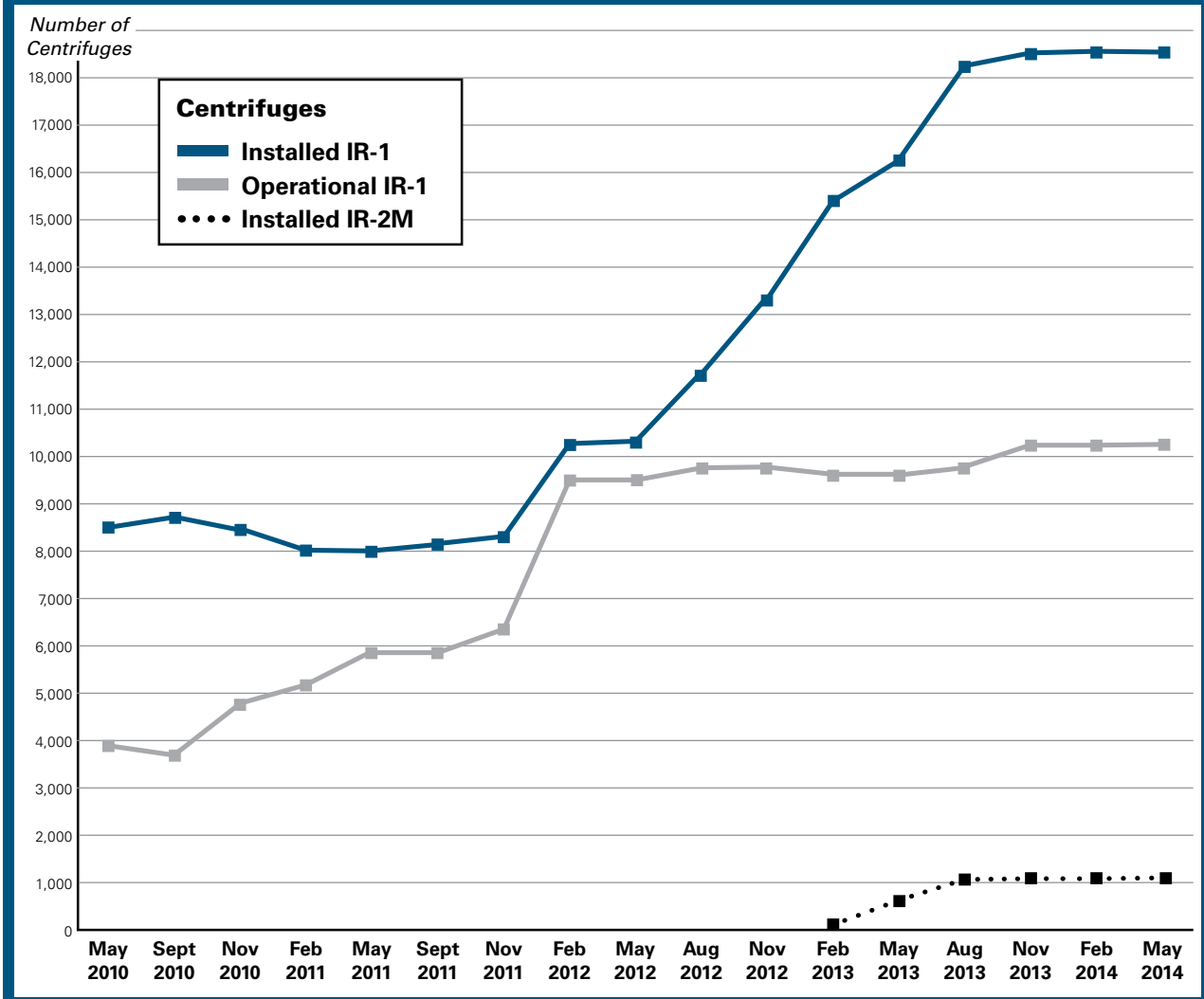


Kazem Ghane/AFP/Getty Images

An IAEA inspector checks that the twin cascades at Natanz are disconnected. Under the November 24 agreement, Iran is no longer allowed to enriched uranium using interconnected cascades.

Iran's Deployment of Centrifuges

Iran continues to install centrifuges at its Natanz and Fordow uranium enrichment plants. This graph shows the number of centrifuges that Iran has installed and is operating at the two facilities using data from the quarterly IAEA reports on Iran. The numbers do not include advanced centrifuges being tested in the research and development area at Natanz.



uranium enriched to 20 percent at the Pilot Fuel Enrichment Plant at Natanz have been converted to enrich uranium to 3.5 percent and are no longer enriching in an interconnected design.

The IAEA has set up additional surveillance at Natanz that will allow the agency to confirm that Iran does not begin operating any additional centrifuges on the days that it does not visit the facility.

Fordow

Iran committed to halt uranium enrichment to 20 percent at the Fordow facility and not to operate or install any additional centrifuges at the facility as part of the November 24 agreement. Iran also said it would no longer operate the four cascades running at Fordow in an interconnected design.

On January 20, Iran halted enrichment of uranium to 20 percent in the 696 IR-1 centrifuges operating at Fordow and notified the IAEA that it would begin enriching to 3.5 percent using the same 696 centrifuges. The monthly IAEA reports confirm these actions and that the agency has surveillance in place to ensure that Iran does not begin operating any of the 12 additional cascades at Fordow.

Centrifuge Production and Monitoring

Under the Joint Plan of Action, the IAEA was allowed managed access for the first time to Iran's centrifuge assembly workshops, rotor production sites, and centrifuge storage areas. This access will help the

IAEA ensure that Iran has limited its production of IR-1 centrifuges to those needed to replace damaged machines, as per the conditions of the November 24 agreement.

This access will help guard against the pursuit of any clandestine enrichment programs because it will give the IAEA greater oversight of Iran's centrifuge production capabilities and allow it to better track the total number and locations of centrifuges Iran has produced.

As part of the agreement, Iran committed not to move forward on any new centrifuge enrichment plants over the agreement's six-month time span. In 2010, Iran declared that it intended to construct an additional 10 facilities, but did not give any time frame for these plants or information to the IAEA about the facilities. As part of separate negotiations with the IAEA, Iran provided these details in early 2014, but they have not been made public.

Arak

Under the November 24 agreement, Iran was required to provide the IAEA with updated design information for the heavy-water reactor at Arak (IR-40), refrain from installing any major components, and halt production of fuel assemblies. Also, Iran committed not to engage in any reprocessing activities or build a facility to reprocess plutonium from spent fuel.

As originally designed, the 40-MWt Arak heavy-water reactor poses a proliferation threat because when operational, the spent fuel would contain plutonium, which, when separated, is useable for nuclear weapons.

According to the May IAEA report, the agency has monthly access to the reactor as required under the Joint Plan of Action. The monthly reports confirm that no major components were installed since the November 2013 report and that updated design information was provided to the IAEA in February and March. The reports also confirm that Iran halted production of the fuel assemblies for the Arak reactor. As of the November IAEA report, Iran had produced 11 fuel assemblies made of natural uranium. The reactor is designed to contain 150 fuel assemblies.

The IAEA was able to access the Heavy Water Production Plant at the Arak site in December 2013 for the first time in more than two years. The IAEA reported that the plant has produced 100 tons of reactor-grade heavy water since it began operations in 2006.

The quarterly May 2014 IAEA report said that the

Majid Saeedi/Getty Images

Technicians work on Iran's heavy water production facility at Arak in 2004. Under the November 24 agreement, IAEA inspectors are now able to access this facility, which produces heavy water for the reactor under construction at the Arak site.

agency is working with Iran to conclude a safeguards agreement for the Arak heavy-water reactor. On May 5, Iran and the IAEA met to continue discussions on the appropriate safeguards approach. The parties committed to complete the updated safeguards approach by August 25.

Research and Development

Under the terms of the November 24 agreement, Iran is allowed to continue its R&D activities under existing IAEA safeguards.

According to the IAEA's quarterly report issued in May, Iran is continuing to test its advanced centrifuges (the IR-2M, IR-4, IR-6, and IR-6s machines) as single machines and in cascades at its R&D plant at Natanz. Iran also has an IR-5 centrifuge at the facility that it is not yet testing.

On December 4, Iran informed the IAEA that it will begin testing a new model, the IR-8. According to the May 2014 report, the IAEA noted that as of December 2013, a new centrifuge casing was installed in the R&D area but it was not yet connected for testing.

Sanctions Relief

In return for Iran's actions limiting and rolling back its nuclear activities, the P5+1 committed to provide relief from proliferation-related sanctions over the course of the first-phase agreement. The Joint Plan of Action also committed the United States, the EU, and UN Security Council from passing any further sanctions related to proliferation concerns.

As part of the sanctions relief package, when implementation of the deal began on January 20, the United States and the EU suspended sanctions that prohibited the purchase of Iranian petrochemical products and trade with Iran using gold or other precious medals.

The United States also suspended sanctions on Iran's auto industry and allowed for the supply of spare parts for civilian aircraft and installation services for the necessary repairs. On April 4, Boeing Co. announced that it received a license from the U.S. Department of the Treasury that will allow it to export spare aircraft parts.

Sanctions relief also targeted Iran's oil sector. A December 2011 U.S. law required countries to stop importing oil from Iran unless granted a six-month waiver by the United States. Failure to comply would result in exclusion from the U.S. financial system. The waivers were renewable if countries continued to reduce their oil imports from Iran. Beginning in July 2012, the EU began its own oil embargo for all member states.

By the time of the November 24 agreement, Iran's oil exports were limited to six countries: China, Japan, South Korea, India, Turkey and Taiwan. In total, this amounted to approximately 1 million barrels per day by mid-2013, roughly one-third of what Iran exported in mid-2011.

Under the November 24 agreement, the United States suspended its requirement that countries continually reduce their oil imports from Iran and froze Iran's export levels at the November 2013 levels.

In addition, the agreement enabled the repatriation of $4.2 billion in Iranian oil revenue held abroad. Provisions that went into effect in 2013 prevented Iran from transferring oil payments back to Iran and required that the money only be used for trade between the country holding the funds and Iran. This has resulted in billions of dollars of Iranian oil revenues being held in foreign banks. The $4.2 billion was repatriated to Iran over the course of the first-phase agreement. Some of the payments were tied to the completion of Iranian actions, such as completion of the dilution of uranium enriched to 20 percent.

The first-phase agreement established a financial channel to facilitate humanitarian trade using the oil revenues held abroad. This channel was designed to allow for the purchase of food, medicine, and medical products and to pay for Iran's UN obligations and tuition for Iranian students abroad.

The EU announced on January 20 a 10-fold increase in the authorizations for nonsanctioned trade with Iran.

SECTION 3

A Comprehensive Agreement

To prevent a nuclear-armed Iran and find a permanent resolution to the Iran nuclear challenge, a long-term agreement that addresses a complex array of interrelated issues must be negotiated.

In February 2014, senior diplomats and technical experts from Iran and the P5+1 started formal negotiations on a comprehensive agreement on Iran's nuclear program with the goal of reaching a deal by July 20. Arriving at such a diplomatic settlement will not be easy and will require that each side be willing to address the "core" requirements of the other side. The success of the effort will depend as much on the political will in Tehran, Washington, and other major capitals as it depends on the substantive and often very technical issues on the table.

The broad parameters of a comprehensive agreement were outlined in the November 24 Joint Plan of Action. The two sides agreed that the agreement will:

- have a specified long-term duration to be agreed on;
- reflect the rights and obligations of parties to the NPT and IAEA Safeguards Agreements;
- comprehensively lift UN Security Council, multilateral, and national nuclear-related sanctions, including steps on access in areas of trade, technology, finance, and energy, on a schedule to be agreed on;
- involve a mutually defined enrichment program with mutually agreed parameters consistent with practical needs, with agreed limits on scope and level of enrichment activities, capacity, where it is carried out, and stocks of enriched uranium, for a period to be agreed on;
- fully resolve concerns related to the reactor at Arak (IR-40);
- include provisions committing Iran not reprocess spent nuclear fuel;
- fully implement the agreed transparency measures and enhanced monitoring;
- ratify and implement an additional protocol, consistent with the respective roles of the Iranian president and the Majlis (Iranian parliament); and
- include international civil nuclear cooperation, including among others, on acquiring modern light-water power and research reactors and associated equipment; the supply of modern nuclear fuel; and agreed R&D practices.

The Joint Plan of Action established that any deal would address UN Security Council resolutions, be comprehensive, meaning that "nothing is agreed until everything is agreed."

After determining an agenda for the next three months of talks during the February meeting, Iran and the P5+1 met again in March and April in Vienna. During these two rounds of talks, each side outlined their positions. When the parties met again on May 13, they presented more-specific proposals and began the difficult task of negotiating to narrow the gaps between their positions in a draft document.

The parties hope to reach an agreement by July 20, when the six-month phase of the Joint Plan of Action expires. Although the interim deal can be extended for another six months, domestic pressures in the United States and Iran are motivating the parties to conclude a deal by the end of July. Lead negotiator for the P5+1, EU foreign policy chief Catherine Ashton, will complete her term later this fall, which could disrupt the negotiation process if it continues for many months more.

If either side pushes unrealistic requirements, the chances for a negotiated resolution will decrease, and the chances of a conflict and a nuclear-armed Iran will increase.

The considerations and potential options on the main issues confronting the negotiators are outlined below. Due to the complexity of these negotiations and the interplay of different elements of a deal, there is not a single solution to this puzzle.

Any agreement that is struck between the P5+1 and Iran should not be evaluated on the basis of any single feature, but must be assessed on the basis of its overall impact and in comparison to the alternative: no diplomatic solution.

Limits on Iran's Uranium-Enrichment Capacity

In the November 24 interim agreement, the parties agreed that Iran's uranium-enrichment program would be based on an assessment of its "practical needs." In other words, Iran's enrichment capacity and stockpile of material should not exceed what it requires for its civilian nuclear reactors.

Determining practical needs, however, is still a political decision on which the parties differ widely. The divergence in thinking about the size of Iran's uranium-enrichment program is tied in part to Tehran's future plans for its civilian nuclear power program.

Currently, if practical needs are based solely on operating nuclear facilities, Iran's requirements for enriched uranium are minimal. Iran operates the Tehran Research Reactor, which requires fuel plates fabricated from uranium enriched to 20 percent. Iran's current stockpile of material enriched to 20 percent will fuel the reactor for the foreseeable future.

Given that Iran has no other reactors requiring uranium enriched to this level, capping Iran's uranium enrichment to reactor grade, or less than 5 percent, is reasonable. Iran has indicated in the past that it is willing to accept a cap on enrichment to reactor-grade levels.

Iran's current needs for uranium enriched to reactor-grade levels are also minimal. Currently, Iran's sole nuclear power plant at Bushehr is fueled by Russia. Under the original contract, Russia agreed to provide fuel for the reactor for 10 years, or until 2021-2022. As part of the agreement to complete construction of the reactor in 1995, Russia committed to supply the fuel for the lifetime of the reactor, should Iran chose to renew the contract.

Iran may need to produce small amounts of reactor-grade uranium to fuel the Arak heavy-water reactor, depending on how the parties agree to resolve concerns over that facility. If the reactor is converted to use reactor-grade enriched uranium, Iran could produce fuel for the reactor using less than 2,000 IR-1 centrifuges per year.

Kazem Ghane/AFP/Getty Images

Inspectors from the IAEA and Iranian nuclear technicians disconnect the twin cascades at Natanz that were producing uranium enriched to 20 percent. Iran agreed to halt production of uranium enriched to this level under the November 24 agreement.

If the P5+1 defines "practical needs" by this strict accounting, Iran could be required to reduce its enrichment capacity by 80 percent, from about 10,400 operating IR-1 centrifuges to less than 2,000.

Iran will strenuously resist such a dramatic reduction. Iranian negotiators insist that Iran's nuclear fuel needs may increase over time and say they cannot depend on foreign suppliers, given the unreliability of foreign sources in the past when Tehran was attempting to develop its nuclear program.

Moreover, considering the resources that Iran has dedicated to developing its enrichment program over the years, Tehran's leaders would be hard-pressed to win sufficient domestic support for a deal that reduces its centrifuge inventory by such a significant amount.

Iran asserts that its practical needs include fueling the Bushehr reactor after the original contract with Russia ends. This would require operating approximately 100,000 IR-1 centrifuges per year.

According to the IAEA's most recent quarterly report, Iran is planning to build another reactor to produce medical isotopes, a 10-MWt light-water reactor near Shiraz. This would require 20 percent-enriched uranium fuel, according to a February 8 letter that Iran submitted to the IAEA. The P5+1 could agree to provide fuel for this reactor in order to limit Iran's enrichment to normal reactor-grade levels (below 3.5 percent). This commitment from the P5+1 would be consistent with the parameters of the Joint Plan of Action, which commit the P5+1 to civilian nuclear cooperation, including the supply of "modern nuclear fuel."

Iran has made numerous other statements about expanding its civilian nuclear power program. Tehran has already declared to the IAEA its intention to build a 360-megawatt electric power plant at Darkhovin. In February 2014, Iran provided the IAEA with information about site selection for an additional 16 nuclear power plants, but did not give the agency any specific timetables for construction.

According to Ali Akbar Salehi, the head of the Atomic Energy Agency of Iran, Iran intends to start construction on the first in a series of four new nuclear power plants this (Iranian) year.[24] Iranian officials have made announcements about negotiations with Russia to build another two nuclear power plants at Bushehr and an additional four to six plants elsewhere in the country.

If these reactors are built according to the plan outlined by Salehi, the first reactor could begin operation as early as 2020 with additional reactors in 2022, 2024, and 2026.[25]

Many independent experts, however, dismiss this timeline as unrealistic, particularly given the slow pace at which the Bushehr reactor was completed. According to Einhorn, "[A]ny power reactor that Iran may wish to construct and fuel indigenously is at least 15 to 20 years away."[26] Additionally, Russian contracts for nuclear power plants usually include a five- to 10-year fueling contract, so it is unlikely that Iran would need to produce fuel domestically for these reactors for years after they are built.

If the duration of any comprehensive agreement is 10 years or less, it is unlikely that additional reactors with additional fuel needs will be built within the time frame of the agreement. Therefore, the negotiators need not include them now in any calculation of practical need.

Iran, however, is likely to calculate domestic fuel requirements for the Bushehr reactor into its calculation of practical needs. Reports from the May 13-16 negotiations bear out this expectation. Yet, a steady increase in Iranian enrichment capacity to 100,000 operating IR-1 centrifuges by 2021 would not be acceptable to the P5+1.

Even an agreement to operate a smaller number of more-efficient, advanced centrifuges would be unacceptable to the P5+1 because the output would be the same. Experts assess that 25,000 IR-2M centrifuges would likely have a similar capacity as 100,000 IR-1 centrifuges.

There are options for bridging these gaps. One option is to increase Iran's uranium-enrichment capacity over time, contingent on the growth of actual practical needs. A phased approach could begin with a number of operating IR-1 centrifuges similar or slightly below the number currently operating, which is about 10,200. This number could be increased depending on a re-evaluation of Iran's needs as its nuclear power situation progresses. Tying centrifuge capacity to specific actions within a comprehensive deal and allowing Iran to increase capacity over time as trust builds and as actual fuel needs emerge is likely to be far more acceptable to Iran than long-term, severe limits on its uranium-enrichment capacity and restrictions on research on more-advanced machines.

Some researchers note that it is in Iran's interest to stop pursuing and building more of the less efficient IR-1 machines and to make a transition to a smaller number of more-efficient IR-2M centrifuges. During this transition period, they propose that the two sides could agree to hold total operating separative work unit (SWU) capacity constant, but phase out the IR-1 machines and replace them with IR-2Ms. Iran could also continue R&D and even stockpile components for more-advanced centrifuges but not assemble them

until there is a demonstrable need for commercial-scale enrichment. This would increase the time it would take Iran to operate the machines, providing added insurance against rapid breakout scenarios. The R&D facilities and centrifuge production plants would be subject increased transparency measures. To provide further assurances, surplus IR-1 centrifuges and components could be removed from Natanz and Fordow and stored under IAEA supervision.[27]

To provide further assurances to Iran about the future availability of fuel supplies for Iran's existing reactors, a comprehensive agreement could include a fuel guarantee by the international community, whereby a supply of reactor-grade enriched uranium for Bushehr is guaranteed over the lifetime of the reactor, so long as Iran continues to comply with the terms of the comprehensive agreement. This could allay any Iranian concerns about the reliability of Russian fuel supply.

If Iran insists on supplying the Bushehr reactor after 2021 with domestically produced fuel, increases in centrifuge capacity could be tied to actions taken by Iran in a comprehensive agreement. For instance, when Iran completes its disclosure to the IAEA on the possible military dimensions of its nuclear program and the agency determines that Iran's nuclear program is entirely peaceful, centrifuge capacity could be increased. An additional step tied to increasing centrifuge capacity could be Iran's ratification of an additional protocol. This would expand IAEA access to Iran's nuclear facilities permanently, which is key to detecting violations early.

An additional step could be to require Iran to convert all of the reactor-grade enriched uranium that it produces from uranium hexafluoride gas to uranium dioxide powder. Uranium dioxide powder is used to make fuel rods for nuclear power reactors and poses less of a proliferation threat because it must be converted back into gas in order to be further enriched. The IAEA would quickly detect this reconversion process.

In May 2014, Iran completed a facility for this process. This "zero stockpile" approach would make it more difficult and time consuming for Iran to move quickly toward nuclear weapons production. Also, Iran would have to anticipate some loss of fissionable material as a result of reconversion. As an additional step, the uranium dioxide could be exported to Russia for fabrication into fuel elements for the Bushehr nuclear power plant.

If there is to be a comprehensive agreement, the two sides must find a suitable formula that limits Iran's uranium-enrichment capacity in a way that precludes an Iranian dash to produce enough HEU for weapons without being detected and disrupted, but allows for Iran's practical civilian needs.

Getting to "yes" on such an approach will require difficult compromises for both sides, but solutions that prevent a nuclear-armed Iran and still provide Iran with the means to pursue a civil nuclear program are available.

Fordow

The two sides must also reach an agreement on the future status of the Fordow uranium-enrichment facility. During earlier negotiations with Iran in the spring of 2013, the P5+1 wanted uranium enrichment at Fordow to end and for the facility to close. The facility, buried deep inside a mountain outside of the

Understanding SWUs

Uranium-enrichment capacity is measured in separative work units (SWUs). An SWU is roughly a measurement of the amount of separation done during enrichment. Centrifuge efficiency can be expressed in SWUs. More efficient centrifuges have a higher SWU capacity.

A nuclear deal with Iran may define Iran's practical needs for uranium enrichment based on SWUs. This would allow Iran to operate a smaller number of advanced centrifuges, as opposed to a larger number of less-efficient, crash-prone IR-1s.

Each IR-1 centrifuge has an efficiency of approximately 0.8-1 SWU per year. Currently, Iran is operating about 10,200 IR-1 centrifuges, which is about 10,200 SWU per year. Iran is working on more-advanced models, including the IR-2M, which it had begun installing in production-scale cascades before the Joint Plan of Action froze new centrifuge installation. The IR-2M is estimated to be three to five times more efficient than the IR-1.

For example, if Iran's SWU capacity was capped at 10,200 under a comprehensive deal, it could operate 10,200 IR-1 centrifuges, or 2,100 to 3,300 IR-2M centrifuges. Either configuration would keep them below the SWU cap.

To assess this need, the tables on page 34 presents estimates of the fuel requirements for current and possible future Iranian nuclear reactors.

Estimated Fuel and Enrichment Requirements for Existing and Potential Iranian Reactors

Reactor Description	Reactor Purpose	Currently Operating?	Earliest possible fuel needs	Fuel Enrichment	Fuel Required (kg, U mass)	Seperative Power Required (kg-SWU)	IR-1 Centrifuges Required
IR-40 (Arak)	research	no	2017	3.5-19.75%	88 - 175	500 - 6,000	700 - 7,000
Additional foreign-built power reactors	power	no	2020?	3.5-5%	2,600	96,000	100,000
Tehran Research Reactor	research	yes	2024	19.75%	9.2	310	380
Bushehr	power	yes	2022?	3.5-5%	2,600	96,000	100,000
Indigenous research reactors	research	no	2024	19.75%	28	910	1,100
Indigenous power reactor (Darkhovin)	power	no	2029	3.5-5%	11,000	38,000	48,000

Reactor Power Level And Corresponding Fuel And Enrichment Requirements

Power Output (MWt)	Fuel Enrichment	Fuel Required (kg)*	Enrichment Required (kg-SWU)**	Enrichment Required (IR-1 centrifuges)***
10	5%	88	540	670
10	19.75%	88	2,900	3,600
20	5%	175	1,100	1,300
20	19.75%	175	5,800	7,200

* Assuming 60% capacity factor, 25 GWd/t burnup
** Assuming natural uranium (0.711% enriched) feedstock, 0.4% tails assay
*** Assuming enrichment power of 0.8 kg-SWU per centrifuge per year

city of Qom, is less vulnerable to an airstrike, which is likely one of the reasons why the P5+1 originally wanted the facility closed.

Iran, however, has stated publicly that it will not accept closure of any of its nuclear facilities in a final deal.

Under the Joint Plan of Action, enrichment activities continue at Fordow, but the 696 operating centrifuges at the facility were converted to producing 3.5 percent-enriched uranium rather than 20 percent-enriched material. It is likely that the P5+1 will oppose the continuation of any production-scale enrichment at the facility, to dispel any Iranian notion that it has a secure breakout option.

In a final deal, the two sides might compromise by agreeing that Iran will effectively halt any enrichment activities at Fordow for production purposes and convert it to a "research-only" facility. Under this configuration, Iran could use the facility to develop and test advanced centrifuges, activities that currently take place at Natanz. The facility would still be subject to intensive IAEA monitoring. This compromise would keep the facility operating, as per the Iranian position, but address the proliferation risk.

Research and Development

Under a comprehensive agreement, Iran will want to continue R&D activities, including the development and testing of advanced centrifuges. Continuing these practices is consistent with the parameters for a comprehensive deal laid out in the Joint Plan of Action, which includes a commitment to respect Iran's rights as an NPT member. If Iran's R&D activities on advanced centrifuges are under safeguards, then it is meeting its obligations under the treaty on R&D.

Additionally, R&D on more-advanced centrifuges does not represent a significant breakout threat if the agreed limits on Iran's enrichment capacity throughout the course of the agreement are determined in terms of SWUs (See "Understanding SWUs").

Options for the Arak Reactor

A comprehensive agreement will need to determine

Zero Enrichment: Myths and Realities

Some policymakers and analysts argue that any negotiated settlement with Tehran must require Iran to give up all enrichment activities. There are numerous credible justifications for this demand, including long-standing U.S. policy that the nuclear Nonproliferation Treaty (NPT) does not include the "right to enrichment."

Additionally, Iran has pursued its enrichment capability in secret for 18 years and did so as part of, or in parallel with, an apparent nuclear weapons program. Tehran only declared its enrichment-related facilities after those facilities were publicly revealed or otherwise discovered. The materials and technology for this work were primarily acquired illicitly through the Abdul Qadeer Khan network and by violating national export controls in other countries. In essence, Iran's enrichment program was infused with illegal activity from the start.

The public rationale for the existence of Iran's enrichment program is questionable. Tehran claims that it wants to enrich uranium to manufacture fuel for an ambitious nuclear energy plan, ultimately producing a total of about 20,000 megawatts of electricity in about 20 nuclear reactors. Yet, Iran's sole nuclear power reactor at Bushehr began operations only last year, and Russia has agreed to provide fuel for that plant for at least the next 10 years. Any additional nuclear reactors that would require Iranian fuel are years away. As a result, Iran does not appear to have any need for low-enriched uranium for at least the next decade. The fact that Iran decided in 2010 to begin enriching uranium to 20 percent, well above the 3.5 percent level of material used in power reactors and in excess of its needs for the Tehran Research Reactor, further elevates concerns about Tehran's motives.

Although the arguments against Iran maintaining an enrichment capability are sound from a nonproliferation perspective, the prospect of achieving such an outcome through negotiations or any other means is not realistic at this point. Iran is not likely to give up such a capacity willingly, and there are no credible options to forcibly eliminate such a capacity from Iran altogether. Additionally, the November 24 agreement stipulated that a final deal will allow Iran a limited uranium-enrichment program based on its practical needs. Insisting on a zero-enrichment result would violate the agreed-on parameters of a comprehensive deal.

Continued on page 36

Mandel Ngan/AFP/Getty Images

U.S. Secretary of State Hillary Clinton testifies before the House Foreign Affairs Committee on March 1, 2011. Clinton said that Iran could be allowed to enrich uranium in the future under strict conditions.

The zero-enrichment stance does not appear to have much support from the international community. Developing countries, including key U.S. partners such as India, have frequently issued statements backing Iran's rights to a peaceful nuclear program. A Brazilian-Turkish diplomatic effort with Iran concluded in a May 2010 statement that Iran has the right under the NPT "to develop research, production and use of nuclear energy (as well as nuclear fuel cycle including enrichment activities) for peaceful purposes without discrimination."

Perhaps most importantly, although China and Russia supported the UN Security Council's demand for enrichment suspension by Iran, they do not appear to favor requiring that Iran forgo enrichment activities permanently. If these key countries are unwilling to enforce a zero-enrichment demand on Iran, efforts to apply political and economic pressure on that basis will not be successful.

Lastly, achieving a zero-enrichment state is not necessary to prevent Iran from obtaining nuclear weapons and should not be the roadblock that prevents an effective, comprehensive deal.

In testimony before the House Foreign Affairs Committee on March 1, 2011, Secretary of State Hillary Rodham Clinton said that, "under very strict conditions Iran would, sometime in the future, having responded to the international community's concerns and irreversibly shut down its nuclear weapons program, have such a right [to enrich uranium] under [International Atomic Energy Agency] inspections."[28]

Although an agreement that allows Iran to maintain a limited enrichment capability could arguably make it more difficult to convince other countries to forgo sensitive fuel-cycle technologies, the damage to the nonproliferation regime would be far greater if the opportunity to resolve the issue diplomatically was lost because the United States insisted on a zero-enrichment outcome.

Without an agreement with Iran that limits its capacity to produce fissile material and improves international monitoring in exchange for phased sanctions relief, Iran's nuclear weapons capabilities would grow over time, and the risk of a military conflict would rise. If the international community perceives that the negotiations fell short due to U.S. demands that Iran halt all uranium-enrichment activity, it would be very difficult to sustain, let alone toughen the international sanctions against Iran.

Even if the P5+1 agree that Iran can continue to enrich uranium on a limited basis, it is unlikely that other countries will be encouraged to follow Iran's example. For the vast majority of countries, national enrichment capabilities are not economically viable, they would be very costly politically, and, given abundant global fuel supply options, they are unnecessary for any state that wishes to pursue a nuclear energy program.

the future of the 40-MWt, heavy-water reactor at Arak, which remains years away from completion. For the P5+1, this reactor presents a serious, long-term proliferation concern because heavy-water reactors are well suited to the production of weapons-grade plutonium. Iran maintains that the Arak reactor is intended to produce medical isotopes, although its large size far exceeds what is necessary for isotope production.

Under the current design configuration, the reactor will produce enough weapons-grade plutonium per year once operational for about two nuclear weapons. The spent fuel would need to be removed from the reactor and allowed to thermally cool for several months, then the weapons-grade plutonium-239 would need to be reprocessed, or separated from the spent reactor fuel, before it could be used in weapons. Iran currently does not have a reprocessing facility and says it has no intention to build one, but could construct a reprocessing plant relatively quickly if it chose to do so.

Additionally, because the Arak site represents Iran's only indigenously developed and domestically constructed nuclear facility, Tehran strongly opposes any outcome that would require it to shut the facility and opposes to converting it to a more proliferation-resistant light-water reactor.

Shutting down the Arak reactor is not the only way to guard against its possible use for fissile material production. Its design can be modified in ways that significantly reduce the amount of weapons-grade plutonium in its spent fuel, while allowing Iran to use the facility for medical isotope production and research.

Salehi said that Iran could "make some change in the design in order to produce less plutonium in this reactor and in this way allay the worries and mitigate the concerns."[29]

One of these design modifications would be to reduce the reactor from 40 MWt to 20MWt, 15

MWt or 10 MWt. This would reduce the annual output of weapons-grade plutonium from approximately eight to nine kilograms to around one kilogram. Approximately four kilograms of plutonium-239 are required for the construction of the core of a nuclear weapon.[30] Some analysts suggest it would be useful to modify the reactor vessel containing the fuel rods to ensure the modification is irreversible, so that Iran could increase the power of the reactor over time.[31]

Another option that would reduce the output of weapons-grade plutonium in the spent fuel would involve conversion of the reactor to use uranium fuel enriched to 3.5 percent or 20 percent instead of the natural uranium fuel that the reactor's design currently requires.

Reactors that use natural uranium fuel are especially well suited for plutonium production because virtually all of the neutrons they produce that are excess to the requirements for maintaining the fission chain reaction are absorbed. There is less excess when using enriched uranium fuel.

Although fueling the reactor with enriched uranium would increase Iran's practical needs for enriched uranium, the plutonium produced in the spent fuel would pose less of a concern for weapons use. Additionally, the need to produce 3.5 percent-enriched uranium for the Arak reactor could not be used by Iran to legitimize a large enrichment capacity. About 1,300 IR-1 centrifuges could produce enough material annually to fuel the Arak reactor operating at 20 MWt.[32]

From a nonproliferation standpoint, converting the Arak reactor to use 3.5 percent-enriched fuel would be preferable to converting it to use 19.75 percent-enriched fuel. If Iran produces its own fuel for the Arak reactor, it would be better that it not have a reason, in the near term at least, to produce more uranium that is enriched to almost 20 percent. Uranium enriched to that level requires much less additional enrichment to reach weapons grade (an enrichment level of 90 percent or more). Iran has produced enough uranium enriched to almost 20 percent to fuel the Tehran Research Reactor for several years at least and has suspended further production as a confidence-building measure under the Joint Plan of Action.

Under either of these configurations, Iran could use the Arak reactor for the production of medical isotopes and nuclear research as originally intended.

An additional option to reduce the Arak reactor's proliferation potential would be to require that all spent fuel from the reactor be verifiably removed for disposition in a third country, possibly Russia, to prevent it from becoming a source of plutonium for nuclear weapons development. Russia is already responsible for removing the spent fuel produced by the Bushehr reactor. The quantities of spent fuel from Bushehr far exceed what would be produced by the Arak reactor. This option would put the weapons-usable plutonium even further out of reach for separation by Iran.

Another possible compromise that would effectively neutralize the Arak facility's plutonium potential would be to convert it to a more proliferation-resistant light-water reactor, but this option would require Iran to abandon its original heavy-water technology choice and would be strongly resisted by Iran, given its indigenous development of the reactor and its investment in technologies and facilities for the production of heavy-water.

Monitoring and Verification Measures

To provide greater assurance that any ongoing Iranian nuclear activities are not diverted for weapons purposes, the two sides will likely include additional international monitoring and transparency measures, including inspections of undeclared nuclear sites in

Plutonium Production for Different Fuel Enrichments and Power Outputs

The table below lists the calculated annual plutonium production in the fuel of the current Arak design and in alternative cores assuming full-power operation 300 days per year. The highlighted line shows that when fueled with 5 percent-enriched uranium, the Arak reactor would produce about the same amount of plutonium in its fuel as a light-water research reactor of the same power fueled with 19.75 percent-enriched uranium.

Reactor/fuel combination	Annual plutonium production *(kilograms per year)*		
	40 MWt	20 MWt	10 MWt
Heavy-water research reactor, *natural uranium fuel*	7.70		
Heavy-water research reactor, *5 percent-enriched fuel*		0.72	0.34
Heavy-water research reactor, *19.75 percent-enriched fuel*		0.18	0.09
Light-water research reactor, *19.75 percent-enriched fuel*		0.70	0.35

Source: Ali Ahmad, Frank von Hippel, Alexander Glaser, and Zia Mian.

order to guard against rapid breakout and a potential secret program.

Currently, Iranian nuclear sites that are part of its safeguards agreement are covered by IAEA monitoring and verification rules in place between NPT members and the agency. Safeguards are activities that the IAEA undertakes to verify that a state is living up to its international commitments not to use nuclear programs for nuclear weapons purposes. NPT states-parties are obligated to have a safeguards agreement in place. Safeguard activities undertaken by the agency are based on a state's declaration of its nuclear materials and nuclear-related activities. Verification measures include on-site inspections, monitoring, and evaluation.

Iran's safeguards agreement entered into force in 1974. It grants the IAEA access to Iran's declared nuclear sites, including uranium-enrichment sites at Natanz and Fordow, the fuel fabrication plant at Esfahan, the Arak heavy-water reactor, and the Tehran Research Reactor, for monitoring and verification purposes.

The starting point for increasing the robustness of the monitoring and verification regime is the ratification and implementation by Iran of an additional protocol to its safeguards agreement with the IAEA. The Model Additional Protocol was developed to compensate for the deficiencies of the core safeguards regime that were revealed in the wake of the 1991 war with Iraq.

An additional protocol is a legal document granting the IAEA inspection authority beyond what is permitted by a safeguards agreement. Additional protocols are voluntary agreements negotiated on a state-by-state basis with the IAEA. A principal aim is to enable the IAEA inspectorate to provide assurance that there are no undeclared activities and all declared nuclear activities are for peaceful purposes.

Once an additional protocol is adopted and implemented by a state, the IAEA is granted expanded rights of access to information and sites. States must provide information about and IAEA inspector access to all parts of a state's nuclear fuel cycle, including uranium mines, fuel fabrication and enrichment plants, and nuclear waste sites, as well as to any other location with nuclear material. Additional protocols typically include provisions granting visas to inspectors, granting access to R&D activities, and granting information on the manufacture and export of technologies, and allowing for environmental samples.

These inspections allow the IAEA to access nondeclared sites without prior notification, which is a strong deterrent against any clandestine nuclear weapons work.

The IAEA has stated repeatedly in its reports that

Nuclear "Rights" and Responsibilities

Iranian leaders have argued for years that attempts to limit Iran's nuclear program and impose sanctions infringe on Iran's sovereign rights as a member of the nuclear Nonproliferation Treaty (NPT). Article IV of the NPT says that the states-parties have an "inalienable right to the peaceful use of nuclear energy."

U.S. and other Western government officials, however, note that the NPT does not specifically give states parties a "right" to engage in sensitive nuclear fuel-cycle activities, including uranium enrichment and plutonium separation. They also point out that the treaty obliges non-nuclear-weapon states under Article II "not to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices" and under Article III "to accept safeguards" in accordance with International Atomic Energy Agency standards and practices "with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices."

Some critics of the November 24, 2013, interim agreement argue that "allowing" Iran to continue enriching uranium is counter to the U.S. policy position that does not recognize the right to enrich as part of the NPT, especially if states have engaged in illicit nuclear weapons-related research.

The P5+1 and Iran did not agree on the nature of Iran's nuclear energy "rights" in their November 24 first-phase agreement, but the P5+1 recognized that Iran already has a nuclear enrichment program and would insist on retaining some enrichment capacity.

As such, as part of the broad parameters of the final deal, the parties agreed to negotiate practical limits on the scope of the enrichment program and additional safeguards on ongoing Iranian enrichment activities at its Natanz and Fordow facilities in order to reduce Iran's nuclear weapons potential.

unless Iran implements an additional protocol, "the agency will not be in a position to provide credible assurance about the absence of undeclared nuclear material and activities in Iran."

Iran negotiated an additional protocol with the IAEA and signed the agreement in 2003. Between 2003 and 2006, Iran voluntarily implemented its additional protocol, but never ratified the document. In 2006, Iran announced that it would no longer implement the provisions of the agreement.[33]

It is likely that, under the terms of a still-to-be-negotiated comprehensive agreement, Iran would be required to implement its additional protocol at an early stage, with ratification at a later point in time. Once the Iranian parliament approves ratification, the duration of the additional protocol would be unlimited.

With an additional protocol in place, the IAEA would be able to visit all facilities associated with Iran's nuclear activities, including sites to which it does not currently have access, such as uranium mines, Iran's centrifuge production facilities, and its heavy-water production plant. The additional protocol would also substantially expand the IAEA's ability to check for clandestine, undeclared nuclear facilities by providing the agency with authority to visit any facility, declared or not, to investigate questions about or inconsistencies in a state's nuclear declarations.

The IAEA would be able to visit any site on very short notice. These monitoring and verification measures would give the agency a more complete picture of Iran's nuclear activities and allow for early detection of deviations from peaceful activities. Early notification would give the international community time to respond to activities that might indicate Iran is violating any comprehensive agreement and is pursuing nuclear weapons development.

Under a comprehensive agreement, it is very likely that Iran would be required to comply with the terms of the modified Code 3.1 version of IAEA safeguards, which requires that countries submit design information for new nuclear facilities to the IAEA as soon as the decision is made to construct or authorize construction of a facility.

In 2003, Iran accepted the terms of the modified Code 3.1, but reneged unilaterally on its implementation in March 2007. The IAEA maintains that subsidiary arrangements, including Code 3.1, cannot be altered unilaterally. Also, there is no mechanism in the safeguards agreement to suspend implementation of Code 3.1. Therefore, the IAEA maintains that it remains in force and Iran is not adhering to its obligations under Code 3.1 to provide the agency with updated design information for new and existing nuclear facilities.

If Iran implements Code 3.1, the IAEA would receive information about any plans Tehran has to expand its nuclear program earlier than it would under the existing safeguards agreement. Iran would also be obligated to share any design changes to existing nuclear facilities.

Yet, an additional protocol and Code 3.1 will not be enough to provide sufficient assurance against proliferation if Iran continues to maintain an enrichment program.

The P5+1 will likely seek additional inspection measures for an extended period of time to provide still more confidence to the international community that Iran's nuclear program is being used for entirely peaceful purposes. This could include additional formal verification requirements and confidence-building measures. Such steps would need to cover all of Iran's nuclear activities, including its uranium mines, and would need to ensure that Iran would not be left with an LEU stockpile it could quickly convert to weapons-grade material.

One of the key objectives for any enhanced safeguards regime in Iran would be instituting measures that would provide an accurate and thorough accounting of nuclear material being used at Iran's enrichment-related facilities. Any nuclear facilities Iran maintains would continue to pose a risk that nuclear material might be diverted. Therefore, more-stringent material accountancy in key nuclear facilities would provide greater assurance that no material has been diverted and impose a stronger deterrent against such action.

Such stronger measures could include measuring the mass balance of uranium going into and coming out of Iran's uranium-conversion plant and using the destructive analysis technique at Iran's enrichment plant to reduce errors in measuring the amount of nuclear material present. Under these procedures, Iran would find it more difficult to siphon some of its nuclear material for any parallel, secret program.

An intensified safeguards regime would need to provide the earliest-possible indication of any diversion or any other attempted misuse of nuclear material and facilities. The expedited inspections regime under an additional protocol would need to be supplemented by real-time monitoring of key facilities, in particular Iran's enrichment and conversion plants. If Iran decided to move its stores of uranium hexafluoride or LEU from those facilities to enrich either to weapons-grade levels, a real-time monitoring arrangement would provide the earliest-

possible indication of such an action, allowing the international community to respond before Iran could manufacture nuclear devices.

Finally, Iran could institute confidence-building measures regarding the nuclear material it produces, such as exporting the LEU it produces for fuel fabrication, thereby preventing it from holding on its territory a stockpile of LEU that could be further enriched to produce nuclear weapons. Such a measure would not likely be agreeable on a long-term basis, but could be instituted following a suspension period to provide additional confidence and until Iran develops a domestic need for such LEU.

These measures should be of limited duration, particularly as the Joint Plan of Action stipulates that additional measures have an agreed-on duration. The lifting of more-intrusive monitoring and verification measures could be tied to actions taken by Iran, including the ratification of an additional protocol.

Sanctions Relief

Determining the sequence of sanctions relief within the terms of a comprehensive agreement will be difficult. Although the Joint Plan of Action stipulates that all proliferation-related sanctions, including U.S., EU, and UN measures, be lifted as part of a final agreement, the sequence of relief will be determined by the negotiations.

Iran will likely press for a deal that front-loads sanctions relief, whereas the P5+1 will probably push for sanctions to be waived for the short term before being lifted. In the United States, the president has considerable waiver authority to relieve sanctions, but actually lifting many of the measures will require congressional action.

In the short term, waivers could be a good compromise because they grant meaningful sanctions relief while leaving the core of the legislation in place that will allow for the rapid reimposition of restrictions if Iran breaks the agreement. Early relief could include releasing frozen Iranian oil assets on a monthly schedule, similar provisions in the Joint Plan of Action. The United States also could allow for Iran to repatriate its funds from oil sales. On the EU side, a meaningful measure could be to allow for insurance of tankers carrying Iranian crude. The United States also could waive the requirement that countries importing oil from Iran reduce the levels of their imports every six months.

Taken together, these measures would provide considerable financial relief for Iran.

In the United States, given that lifting sanctions in the long term requires legislation in Congress, that action could be tied to a reciprocal action in Iran that requires the approval of its parliament. Ratification of an additional protocol could be the reciprocal action for congressional action lifting oil, financial, and nonproliferation sanctions.[34]

Sanctions relief is not the only incentive for Iranian compliance. The Joint Plan of Action pledges civil nuclear cooperation with Iran. International assistance on these civil nuclear projects should be phased in through during the course of the agreement. Civil nuclear cooperation on new facilities, such as light-water reactors, could be linked to resolution of the issue concerning possible military dimensions of Iran's nuclear program. When the IAEA is satisfied that Iran's nuclear program is entirely peaceful, the P5+1 could work with Iran on constructing and potentially fueling these reactors.

UN Security Council Resolutions

The preamble of the Joint Plan of Action requires that the negotiations on a comprehensive deal address the conditions of the six UN Security Council resolutions dealing with Iran's nuclear program.

The core demands of the resolutions are that Iran halt its nuclear activities, including uranium enrichment and construction of the Arak reactor, and address outstanding IAEA concerns.

Notably, the UN Security Council's earlier demands for Iran to "suspend" uranium enrichment does not require that a comprehensive agreement must end all Iranian enrichment activity.

The purpose of UN Security Council demands for the suspension of uranium enrichment and other sensitive fuel-cycle activities was to prevent Iran from accumulating more enriched uranium and a larger fissile material production capacity until it restored confidence in the peaceful nature of its nuclear program, not to cease all uranium enrichment activities permanently.[35]

None of the six resolutions call for Iran to dismantle its enrichment facilities or permanently halt enrichment. All six contain the same language promoting a diplomatic resolution to the concerns over Iran's nuclear program that respects Tehran's right to a peaceful nuclear program.

During debate before the most recent resolution was adopted on June 9, 2010, British Ambassador to the UN Mark Lyall Grant, speaking on behalf of the P5+1, said the resolution was intended to keep "the door open for continued engagement" with Iran over its nuclear program. He said that the purpose of such diplomatic efforts must be to achieve a comprehensive, long-term settlement that respects

Iran's legitimate right to the peaceful use of atomic energy.[36]

That resolution, Resolution 1929, expanded the scope of sanctions and for the first time demanded that Iran suspend any activities related to the testing and development of ballistic missiles "capable of delivering nuclear weapons." In addition, the resolution banned all transfers of heavy weaponry to Iran.

Iranian officials have publicly and privately expressed their strong opposition to any discussion of Iran-specific ballistic missile limitations in the ongoing nuclear talks. They argue that Iran's missiles are a legitimate means of self-defense in an unstable region where other countries are threatening to attack it, and they note that the first-phase agreement made no mention of missiles in its framework for a final deal.

Some members of Congress and independent experts believe limits on Iran's nuclear-capable ballistic missiles should be on the agenda of ongoing negotiations between Iran and the P5+1. For example, a bill introduced earlier this year by Senators Robert Menendez (D-N.J.) and Mark Kirk (R-Ill.) would require that any comprehensive agreement include specific limits on Iranian missiles.

In response, senior administration officials have provided assurances that the issue of Iranian missiles would be "addressed, in some way" during the ongoing negotiations because UN Security Council Resolution 1929 references it, but they have not elaborated how it might be addressed.

The missile issue is certainly relevant to the issue of Iran's future nuclear weapons potential, but it must be handled very carefully. Attempts by the P5+1 to impose specific, binding limits on Iranian ballistic missile capabilities at this point could jeopardize chances to conclude an agreement that establishes verifiable limits on its ability to produce material for nuclear weapons. Without its ability to produce nuclear weapons, Iran's ballistic missiles pose much less of a threat to its neighbors.

Therefore, the most effective way to address the potential threat of nuclear-armed Iranian ballistic missiles is to conclude a robust deal between Iran and the P5+1 to prevent Iran from being able to build nuclear weapons.

As the lead U.S. negotiator, Undersecretary of State Wendy Sherman noted in a February 4 hearing of the Senate Foreign Relations Committee, "[I]f we can get to the verifiable assurance that [the Iranians] cannot obtain a nuclear weapon,…then a delivery mechanism, important as it is, is less important."[37]

The primary means of ensuring that Iran cannot obtain a nuclear weapon is to ensure that Iran's fissile

Mario Tama/Getty Images

British Ambassador to the U.N. Mark Lyall Grant votes in favor of U.N. Security Council Resolution 1929 in June 2010. Resolution 1929 expanded sanctions against Iran and repeated demands that Tehran halt its nuclear activities.

material production capacity is sufficiently limited and transparent. This requires that a comprehensive agreement lead to limits on Iran's overall uranium-enrichment capacity that are commensurate with a realistic assessment of Iran's practical needs for civilian nuclear activities, the implementation of a more rigorous IAEA safeguards regime, and the resolution of concerns about the possible military dimensions of Iran's nuclear program. Within such a framework, the international community would have the tools to detect and the time to disrupt a possible attempt by Iran to break out of the NPT to build nuclear weapons.

The ballistic missile issue could be addressed in a comprehensive agreement under a requirement that Iran cooperate with the IAEA within the next year or so to resolve allegations that Iran has conducted research for adapting the front section of a Shahab-3 medium-range ballistic missile to accommodate the installation of a nuclear warhead. The final deal between Iran and the P5+1 should provide direction and a time frame to the IAEA and Tehran to finally resolve these and other outstanding issues with possible military dimensions.

It might be possible to persuade Iran to make a voluntary commitment to greater transparency with regard to its missile activities outside the terms of a comprehensive agreement. Such transparency measures might include providing timely notification of flight tests, exercises, and field deployments.

Iran could also pledge to join the Hague Code of Conduct Against Ballistic Missile Proliferation, a confidence-building regime to which 137 states subscribe. The provisions of this code include commitments to provide prelaunch notifications of launches of ballistic missiles and space launch vehicles. Subscribing states also commit to submitting an annual declaration of their policies on ballistic missiles and space launch vehicles.

Because no Middle Eastern countries currently subscribe to this code of conduct, a proposal to Iran and its key regional neighbors simultaneously seems the most likely way to induce Iran to participate.

In addition to the requirements on Iran imposed by the UN Security Council, four council resolutions include a series of progressively restrictive sanctions against Iran for failing to halt its nuclear and ballistic missile activities. These sanctions must be removed as part of a final deal.

Resolving Questions About Possible Military Dimensions

The preamble to the Joint Plan of Action requires

Behrouz Mehri/AFP/Getty Images

Iranian soldiers pose next to a Shahab-3 missile in Tehran in 2010. According to a 2011 IAEA report, Iran may have sought to adapt the Shahab-3 front end to accommodate a nuclear warhead.

that a comprehensive agreement address concerns listed in the UN Security Council resolutions on Iran's nuclear program. Also, the IAEA has passed six resolutions calling for a halt to Iran's nuclear activities and cooperation with IAEA investigations into its outstanding concerns about Iran's initial declaration and the possible military dimensions of Iran's nuclear program.

Iran and the IAEA are negotiating on these concerns in a separate track under a November 11, 2013, framework for cooperation. Yet, the issues of past activities with possible military dimensions will need to be addressed in a comprehensive agreement that allows the IAEA to continue its investigation uninhibited and ensures that Iran provides the agency with the information necessary to complete its task.

Given the pace of these investigations, Iran and the IAEA will not complete this process before the July 20 deadline. It is unlikely that the process can be completed by January, in the event that the P5+1 and Iran agree to an extension to the Joint Plan of Action.

It is vital that Iran cooperate with the investigation in a timely manner. Given the need for a thorough investigation, however, it would be unwise to rush the IAEA into a quick resolution of its investigation solely to meet negotiating deadlines. To make the determination that Iran's nuclear program is entirely peaceful, the agency will need to investigate each of the issues involving possible military dimensions individually and as a system to gain a complete understanding of Iran's past work on nuclear weapons development. Measures proposed in the U.S. Congress that require Iran to resolve all questions about the possible military dimensions of Iran's nuclear program before the conclusion of negotiations on a comprehensive agreement would be counterproductive.

A comprehensive agreement can play a role in facilitating Iranian cooperation and a prompt conclusion to the agency's investigation. A comprehensive deal could state that the information that Iran provides to the IAEA will be used only for the IAEA's determination of whether Iran's nuclear program is entirely peaceful. In other words, Iran should be assured that it will not be penalized for fully disclosing its past activities.

A comprehensive agreement could address the issue of possible military dimensions by tying UN Security Council sanctions relief to successful resolution of these issues and containing language that would reimpose sanctions if Tehran failed to complete the IAEA track. This should provide sufficient incentives for Iran to follow through on cooperating with the IAEA's investigations into its work.

Bottom Line: A 'Win-Win' Deal to Guard Against a Nuclear-Armed Iran

To guard against an Iran armed with nuclear weapons and avoid a future confrontation over its nuclear program, the P5+1 and Iran must expeditiously negotiate and implement a long-term, final-phase agreement on the basis of realistic and achievable goals that meets the core requirements and respects the bottom-line needs of each side.

A "win" for the P5+1 is a comprehensive agreement that establishes verifiable limits on Iran's nuclear program that substantially increase the time required for Iran to break out of the NPT and build nuclear weapons, increases the ability to promptly detect and effectively respond to a breakout, and decreases Iran's incentive to pursue nuclear weapons development in the future.

A "win" for Iran would be preservation of key elements of its nuclear program, including some uranium-enrichment and R&D activities; protection of its "right" under the NPT to a peaceful nuclear program; and removal of international, nuclear-related sanctions.

If either side pushes to include unrealistic requirements, the chances for a negotiated resolution will decrease, and the chances of a conflict and a nuclear-armed Iran will increase.

A final-phase agreement will require difficult compromises on both sides, but it is the far more preferable and effective way to resolve the long-running dispute over Iran's nuclear ambitions.

APPENDIX A

Timeline of Nuclear Diplomacy with Iran

NOVEMBER 1967: Iran's first nuclear reactor, the U.S.-supplied five-megawatt Tehran Research Reactor (TRR), goes critical. It operates on uranium enriched to about 93 percent (it is converted to run on 20 percent in 1993), which the United States also supplies.

FEBRUARY 1970: The Iranian parliament ratifies the nuclear Nonproliferation Treaty (NPT).

1974: Shah Reza Pahlavi establishes the Atomic Energy Organization of Iran (AEOI) and announces plans to generate about 23,000 megawatts of energy over 20 years, including the construction of 23 nuclear power plants and the development of a full nuclear fuel cycle. Initiating this plan, Iran reaches an agreement with Germany to build two nuclear power reactors at Bushehr. A U.S. National Intelligence Estimate (NIE) expresses concerns that the shah's regional and nuclear ambitions may lead Iran to develop nuclear weapons.

1979: The Iranian Revolution and the seizure of the U.S. embassy in Tehran result in a severing of U.S.-Iranian ties and damages Iran's relationship with the West. Iranian nuclear projects are halted. Germany halts construction of the Bushehr power plants.

JANUARY 19, 1984: The U.S. Department of State adds Iran to its list of state sponsors of terrorism, effectively imposing sweeping sanctions on Tehran.

1987: Iran acquires technical schematics for building a P-1 centrifuge from the Abdul Qadeer Khan network.

1992: Congress passes the Iran-Iraq Arms Nonproliferation Act of 1992, which prohibits the transfer of controlled goods or technology that might contribute "knowingly and materially" to Iran's proliferation of advanced conventional weapons.

1993: Conversion of the TRR is completed by Argentina's Applied Research Institute. It now runs on fuel enriched to just under 20 percent, 115 kilograms of which is provided by Argentina. The contract for the conversion was signed in 1987.

JANUARY 1995: Iran signs a contract with Russia to finish constructing one of the Bushehr nuclear power plants.

AUGUST 5, 1996: Congress passes the Iran-Libya Sanctions Act, also known as the Iran Sanctions Act, that penalizes foreign and U.S. investment exceeding $20 million in Iran's energy sector in one year.

MAY 18, 1998: Following an EU threat to bring U.S. sanctions against companies investing in Iran's energy sector before the World Trade Organization, the United States waives sanctions against a French firm and its partners in return for EU cooperation on counterproliferation and counterterrorism issues.

AUGUST 2002: The National Council of Resistance on Iran, the political wing of the terrorist organization Mujahideen-e Khalq (MeK), holds a press conference where the organization declares Iran has built nuclear facilities near Natanz and Arak. The United States is believed to have already known about the existence of the facilities.

MAY 4, 2003: Swiss Ambassador to Iran Tim Guldimann faxes an Iranian proposal to the U.S. State Department outlining a "road map" for a comprehensive agreement on the nuclear issue. The proposal suggests an Iranian willingness to cooperate on the nuclear issue, terrorism, Iraq, and the

Middle East peace process in return for a lifting of sanctions, access to technology, and cooperation against the MeK. U.S. officials later express mixed views about the seriousness and provenance of the proposal.

SEPTEMBER 12, 2003: The International Atomic Energy Agency (IAEA) Board of Governors adopts a resolution calling for Iran to suspend all enrichment- and reprocessing-related activities. The resolution requires Iran to declare all material relevant to its uranium-enrichment program and allow IAEA inspectors to conduct environmental sampling at any location. Finally, the resolution urges Iran to implement an additional protocol to its safeguards agreement. The IAEA set a deadline of Oct. 31 for Iran to meet these conditions.

OCTOBER 21, 2003: Iran agrees to meet IAEA demands by the Oct. 31 deadline. In a deal struck between Iran and European foreign ministers, Iran agrees to suspend its uranium-enrichment activities and ratify an additional protocol to its safeguard agreement.

DECEMBER 18, 2003: Iran signs an additional protocol to its IAEA safeguards agreement.

JUNE 18, 2004: The IAEA rebukes Iran for failing to cooperate with IAEA inspectors. Iran responds by refusing to suspend enrichment-related activities as it had previously pledged.

NOVEMBER 14, 2004: Iran notifies the IAEA that it will suspend enrichment-related activities following talks with France, Germany, and the United Kingdom. According to the so-called Paris Agreement, Iran would maintain the suspension for the duration of talks among the four countries. As a result, the IAEA Board of Governors decides not to refer Tehran to the UN Security Council.

FEBRUARY 27, 2005: Russia and Iran conclude a nuclear fuel supply agreement in which Russia would provide fuel for the Bushehr reactor it is constructing and Iran would return the spent nuclear fuel to Russia. The arrangement is aimed at preventing Iran from extracting plutonium for nuclear weapons from the spent nuclear fuel.

AUGUST 8, 2005: Iran begins producing uranium hexafluoride at its Isfahan facility. As a result, France, Germany, and the United Kingdom halt negotiations with Tehran.

SEPTEMBER 24, 2005: The IAEA adopts a resolution finding Iran in noncompliance with its safeguards agreement by a vote of 22-1 with 12 members abstaining. The resolution says that the nature of Iran's nuclear activities and the lack of assurance in their peaceful nature fall under the purview of the UN Security Council, paving the way for a future referral.

FEBRUARY 4, 2006: A special meeting of the IAEA Board of Governors refers Iran to the UN Security Council in a 27-3 vote, with five abstentions. The resolution "deems it necessary for Iran to" suspend its enrichment-related activities, reconsider the construction of the Arak heavy-water reactor, ratify the additional protocol to its safeguards agreement, and fully cooperate with the agency's investigation.

FEBRUARY 6, 2006: Iran tells the IAEA that it will stop voluntarily implementing the additional protocol and other non-legally binding inspection procedures.

APRIL 11, 2006: Iran announces that it has enriched uranium for the first time. The uranium enriched to about 3.5 percent was produced at the Natanz pilot enrichment plant.

JUNE 6, 2006: China, France, Germany, Russia, the United Kingdom, and the United States (the so-called P5+1, referring to the five permanent members of the UN Security Council and Germany) propose a framework agreement to Iran offering incentives for Iran halt its enrichment program for an indefinite period of time. The proposal requires Iran to do three things before negotiations begin: cooperate fully with the IAEA investigation, resume implementing its additional protocol, and suspend all enrichment-related activities.

JULY 31, 2006: The UN Security Council adopts Resolution 1696, making the IAEA's calls for Iran to suspend enrichment-related and reprocessing activities legally binding for the first time. The resolution is approved by 14 members of the council, with Qatar voting against. The resolution also endorses the P5+1 proposal for a "comprehensive arrangement" on the Iran nuclear issue.

AUGUST 22, 2006: Iran delivers a response to the

P5+1 proposal, rejecting the requirement to suspend enrichment but declaring that the package contained "elements which may be useful for a constructive approach."

DECEMBER 23, 2006: The UN Security Council unanimously adopts Resolution 1737, imposing sanctions on Iran for its failure to suspend its enrichment-related activities. The sanctions prohibit countries from transferring sensitive nuclear- and missile-related technology to Iran and require that all countries to freeze the assets of 10 Iranian organizations and 12 individuals for their involvement in Iran's nuclear and missile programs.

MARCH 24, 2007: The UN Security Council unanimously adopts Resolution 1747 in response to Iran's continued failure to comply with the council's demand to suspend uranium enrichment. The resolution expands sanctions against Iran, prohibiting it from exporting any arms, and targets an additional 15 individuals and 13 entities for financial sanctions, including Bank Sepah, one of Iran's largest banks.

AUGUST 21, 2007: Following three rounds of talks in July and August, the IAEA and Iran agree on a "work plan" for Iran to answer long-standing questions about its nuclear activities, including work suspected of being related to nuclear weapons development. The United States and European governments said that the work plan does not constitute compliance with UN demands and that they would continue to seek additional sanctions against Iran.

DECEMBER 3, 2007: The United States publicly releases an unclassified summary of a new National Intelligence Estimate (NIE) on Iran's nuclear program. The NIE says that the intelligence community judged "with high confidence" that Iran halted its nuclear weapons program in the fall of 2003 and assessed with moderate confidence that the program had not resumed as of mid-2007. The report defines Iran's nuclear weapons program as "design and weaponization work" as well as clandestine uranium conversion and enrichment. The NIE also said that Iran was believed to be technically capable of producing enough highly enriched uranium for a nuclear weapon between 2010 and 2015.

MARCH 3, 2008: The UN Security Council passes Resolution 1803, further broadening sanctions on Iran. The resolution was adopted in a 14-0 vote with Indonesia abstaining. It requires increased efforts on the part of member states to prevent Iran from acquiring sensitive nuclear or missile technology and adds 13 persons and seven entities to the UN blacklist. The resolution calls on states to inspect the cargoes of transports suspected of violating the sanctions.

MAY 13, 2008: Iran offers a negotiating proposal to the P5+1, highlighting a number of areas for cooperation, but does not mention any Iranian action related to its nuclear program.

JUNE 14, 2008: The P5+1 present a new comprehensive proposal to Iran updating its 2006 incentives package. The new proposal maintained the same basic framework as the one in 2006, but highlighted an initial "freeze-for-freeze" process wherein Iran would halt any expansion of its enrichment activities while the UN Security Council agreed not to impose additional sanctions. Officials from P5+1 countries said that a key aim of the new initiative was demonstrating clearly to the Iranian people the benefits of cooperation.

FEBRUARY 3, 2009: Iran announces that it successfully carried out its first satellite launch, raising international concerns that Iran's ballistic missile potential was growing.

APRIL 8, 2009: Following an Iran policy review by the new Obama administration, the United States announces that it would participate fully in the P5+1 talks with Iran, a departure from the previous administration's policy requiring Iran to meet UN demands first.

JUNE 12, 2009: Iran holds presidential elections. Incumbent Mahmoud Ahmadinejad is declared the winner amid many indications that the election was rigged. This sparks weeks of protests within Iran and delays diplomatic efforts to address Iran's nuclear program.

SEPTEMBER 25, 2009: President Barack Obama, British Prime Minister Gordon Brown, and French President Nicolas Sarkozy announced that Iran has been constructing a secret, second uranium-enrichment facility in the mountains near the holy city of Qom. IAEA spokesman Marc Vidricaire said that Iran informed the agency Sept. 21 about the existence of the facility, but U.S. intelligence

officials said Iran offered the confirmation only after learning that it had been discovered by the United States.

OCTOBER 1, 2009: The P5+1 and Iran agree "in principle" to a U.S.-initiated, IAEA-backed proposal to fuel the TRR. The proposal entails Iran exporting the majority of its 3.5 percent-enriched uranium in return for 20 percent-enriched uranium fuel for the TRR, which has exhausted much of its supply. This agreement was later met with domestic political opposition in Iran, resulting in attempts by Tehran to change the terms of the "fuel swap."

FEBRUARY 9, 2010: Iran begins the process of producing 20 percent-enriched uranium, ostensibly for the TRR.

MAY 17, 2010: Brazil, Iran, and Turkey issue a joint declaration attempting to resuscitate the TRR fuel-swap proposal. In the declaration, Iran agrees to ship 1,200 kilograms of 3.5 percent-enriched uranium to Turkey in return for TRR fuel from France and Russia. France, Russia, and the United States reject the arrangement, citing Iran's larger stockpile of 3.5 percent-enriched uranium and the failure of the declaration to address Iran's enrichment to 20 percent.

JUNE 9, 2010: The UN Security Council adopts Resolution 1929, significantly expanding sanctions against Iran. In addition to tightening proliferation-related sanctions and banning Iran from carrying out nuclear-capable ballistic missile tests, the resolution imposes an arms embargo on the transfer of major weapons systems to Iran. It highlights the connection between the revenues from Iran's energy sector and its nuclear and missile programs, providing some basis for the European Union to adopt restriction on Iran's oil and gas sector. The resolution received 12 votes in favor, with Brazil and Turkey voting no and Lebanon abstaining.

JUNE 24, 2010: Congress adopts the Comprehensive Iran Sanctions, Accountability, and Divestment Act, tightening U.S. sanctions against firms investing in Iran's energy sector, extending those sanctions until 2016, and imposing new sanctions on companies that sell refined petroleum to Iran. The law seeks to identify countries at risk of serving as a conduit for sensitive technologies to Iran to bolster their export controls to prevent sales of these technologies to Iranian entities. Obama signs the legislation into law July 1.

JULY 26, 2010: The EU agrees to further sanctions against Iran. A statement issued by EU member state foreign ministers refers to the new sanctions as "a comprehensive and robust package of measures in the areas of trade, financial services, energy, [and] transport, as well as additional designations for [a] visa ban and asset freeze."

SEPTEMBER 16, 2010: The Stuxnet computer virus is first identified by a security expert as a directed attack against an Iranian nuclear-related facility, likely to be the Natanz enrichment plant.

JANUARY 21-22, 2011: Following a December meeting in Geneva, the P5+1 meets with Iran in Istanbul, but the two sides do not arrive at any substantive agreement. Iran's two preconditions for further discussions on a fuel-swap plan and transparency measures, recognition of a right to enrichment and the lifting of sanctions, were rejected by the P5+1.

FEBRUARY 16, 2011: U.S. intelligence officials tell a Senate committee that Iran has not yet decided whether it wants to develop nuclear weapons but is keeping that option open through development of its material capabilities.

MAY 8, 2011: Iran's Bushehr nuclear power plant begins operations and successfully achieves a sustained chain reaction two days later, according to Atomstroyexport, the Russian state-owned company constructing and operating the plant.

JUNE 8, 2011: Iran announces that it intends to triple the rate of 20 percent-enriched uranium production using more-advanced centrifuge designs. It also says it will move production to the Fordow enrichment plant near Qom, which is still under construction.

JULY 12, 2011: Russian Foreign Minister Sergey Lavrov unveils a proposal wherein Iran would take steps to increase cooperation with the IAEA and carry out confidence-building measures in return for a gradual easing of sanctions.

OCTOBER 21, 2011: EU foreign policy chief, Catherine Ashton, sends a letter to Iranian nuclear negotiator Saeed Jalili calling for "meaningful discussions on concrete confidence-building steps" to address

international concerns about Iran's nuclear ambitions.

NOVEMBER 8, 2011: The IAEA releases a report detailing a range of activities related to nuclear weapons development in which Iran is suspected to have engaged as part of a structured program prior to 2004. The report raises concerns that some weapons-related activities occurred after 2003. The information in the report is based primarily on information received from other countries, but also includes information from the agency's own investigation. The findings appear consistent with the U.S. 2007 NIE on Iran.

DECEMBER 31, 2011: As part of the fiscal year 2012 National Defense Authorization Act, Congress passes legislation that will allow the United States to sanction foreign banks if they continue to process transactions with the Central Bank of Iran.

JANUARY 2012: The EU passes a decision that will ban all member countries from importing Iranian oil beginning July 1, 2012. Other provisions of the decision will prevent member countries from providing the necessary protection and indemnity insurance for tankers carrying Iranian oil.

FEBRUARY 15, 2012: Jalili responds to Ashton's Oct. 21 letter, while Iran simultaneously announces a number of nuclear advances, including the production of a fuel plate for the TRR.

APRIL 14, 2012: Iran meets with the P5+1 in Istanbul for talks both sides call "positive." They agree on a framework of continuing negotiations with a step-by-step process and reciprocal actions.

MAY 23-24, 2012: Iran and the P5+1 meet in Baghdad for a second set of talks.

JUNE 18-19, 2012: Talks between Iran and the P5+1 continue in Moscow. Representatives discuss the substance of a P5+1 proposal and an Iranian proposal. Lead negotiators decide to hold a technical-level meeting July 3 in Istanbul, followed by a meeting between the deputy negotiators Helga Schmid and Ali Bagheri. After the experts meet, Ashton and Jalili will determine if political-level talks will continue.

JULY 3, 2012: Experts representing the six parties meet in Istanbul to discuss the technical aspects of the P5+1 proposal and the Iranian proposal.

AUGUST 10, 2012: The United States passes further sanctions legislation that prevents foreign banks from repatriating funds paid to Iran for oil purchases. The legislation also further targets individuals or entities that provide services to Iran's energy sector, help Iran evade sanctions, or transport Iranian oil.

OCTOBER 15, 2012: The EU approves further sanctions on limiting natural gas imports and on financial transactions between EU countries and Iranian banks.

NOVEMBER 16, 2012: The IAEA reports that Iran completes the installation of centrifuges at Fordow, although the number of centrifuges enriching uranium remains unchanged.

JANUARY 2, 2013: The United States adopts new sanctions targeting international companies that do business with Iran's shipping sector and imposes sanctions on the sale of certain commodities.

FEBRUARY 25, 2013: Negotiations between Iran and the P5+1 resume in Almaty, Kazakhstan. The P5+1 proposal is based on the 2012 negotiations.

MARCH 14, 2013: Representatives from Iran and the P5+1 hold technical level talks in Istanbul.

APRIL 5-6, 2013: Iran and the P5+1 meet again in Almaty, Kazakhstan to resume talks. Both sides bring proposals to talks, but agree that the sides are too far apart to continue negotiating.

JUNE 3, 2013: IAEA Director General Yukiya Amano tells the agency Board of Governors that talks between Iran and the IAEA are not have not made any progress.

JUNE13, 2013: Hassan Rouhani, a former nuclear negotiator for Iran from 2003-2005, is elected the new president of Iran. Rouhani promises greater transparency in Iran's nuclear program in a speech following his election.

JULY 1, 2013: Further sanctions against Iran go into effect, including a ban on the sale of all precious metals to any Iranian entity or individuals.

AUGUST 3, 2013: Hassan Rouhani is inaugurated as the president of Iran.

SEPTEMBER 26, 2013: Iranian Foreign Minister Mohammed Javad Zarif, who will lead the Iranian nuclear negotiating team, presents Rouhani's approach to the nuclear talks to the P5+1 on the sidelines of the UN General Assembly meeting in New York. Secretary of State John Kerry meets with Zarif after the presentation.

SEPTEMBER 27, 2013: Obama and Rouhani speak by telephone about Iran's nuclear program, after which Obama tells reporters that he believes a nuclear deal can be reached.

OCTOBER 15-16, 2013: Iran and the P5+1 resume talks in Geneva.

NOVEMBER 7-10, 2013: Iran and the P5+1 meet again in Geneva. The political directors are joined by the Kerry and the other P5+1 Foreign Ministers after two days of talks.

NOVEMBER 11, 2013: Iran and the IAEA reach a framework for the agency to resolve its outstanding concerns about Iran's nuclear program, including its investigations in the possible military dimensions of Iran's past activities. An initial set of actions for Iran to take within the next three months is announced.

NOVEMBER 20-24, 2013: The P5+1 and Iran reach a first-phase agreement, known as the Joint Plan of Action, that halts Iran's nuclear progress, rollsback its capabilities in some areas, and increases IAEA monitoring, in exchange for limited sanctions relief. The deal will last six months.

DECEMBER 9-12, 2013: The P5+1 and Iran meet in Vienna to discuss the details for implementing the Joint Plan of Action.

DECEMBER 30-31, 2013: The P5+1 and Iran meet again to continue discussions on implementing the Joint Plan of Action.

JANUARY 9-12, 2014: The P5+1 and Iran reach an agreement on the implementation of the Joint Plan of Action and agree to being on January 20.

JANUARY 20, 2014: Implementation of the first-phase agreement begins. The IAEA confirms that Iran has taken the necessary actions to limit and roll back aspects of its nuclear program and the United States and the European Union announce the sanctions waivers as specified by the deal.

FEBRUARY 9, 2014: Iran and the IAEA meet to discuss further actions for Iran to take under the November 11 framework agreement to resolve the agency's concerns about Iran's nuclear program. They agree on additional actions, including Iran's past work on exploding bridgewire detonators, one of the past activities with possible military dimensions.

FEBRUARY 17-20, 2014: Negotiations between Iran and the P5+1 on the comprehensive agreement begin in Vienna. The parties agree on an agenda and framework to guide the talks

MARCH 17-20, 2014: The P5+1 and Iran meet in Vienna to continue negotiations.

APRIL 7-9, 2014: Another round of talks between Iran and the P5+1 take place in Vienna.

MAY 13-16, 2014: The P5+1 and Iran begin drafting the comprehensive agreement in Vienna.

MAY 21, 2014: Iran and the IAEA announce an additional five actions for Iran to complete before August 25. Two of the activities that Iran agrees to provide information on relate to possible military dimensions.

JUNE 16, 2014: Another round of talks between Iran and the P5+1 begins in Vienna.

JULY 20, 2014: Target date for the conclusion of a comprehensive agreement.

APPENDIX B

History of Official Proposals on the Iranian Nuclear Issue

Diplomatic initiatives to resolve the Iranian nuclear issue have produced several proposals for a negotiated settlement. Thus far, none of those proposals have gained acceptance from all of the involved parties, and efforts to address Iran's nuclear program continue.

SPRING 2003 PROPOSAL

MAY 2003: Iran's proposal to address a number of outstanding contentious issues with the United States, including

- relief of all U.S. sanctions on Iran;
- cooperation to stabilize Iraq;
- full transparency over Iran's nuclear program, including implementation of the additional protocol to its safeguards agreement;
- cooperation against terrorist organizations, particularly the Mujahedin-e Khalq and al Qaeda;
- Iran's acceptance of the Arab League's 2002 "land for peace" declaration on Israel and Palestine; and
- Iran's full access to peaceful nuclear technology, as well as chemical and biotechnology.

PROPOSALS DURING THE 2005 EU-3 (FRANCE, GERMANY, UNITED KINGDOM)-IRAN NEGOTIATIONS

JANUARY 17, 2005: Iranian proposal to the EU-3/Iran Political and Security Working Group outlining general possible commitments, including

- an Iranian commitment not to pursue weapons of mass destruction (WMD);
- a rejection of any attacks, threats of attack, or sabotage of Iran's nuclear facilities;
- cooperation on combating terrorism, including intensifying the exchange of information and the denial of safe havens;
- regional security cooperation, including on Afghanistan and Iraq; and
- cooperation on strategic trade controls and the EU removal of restrictions on transfers of conventional arms and dual-use goods to Iran.

MARCH 23, 2005: Iranian proposals to the EU-3/Iran steering committee detailing proposed "objective guarantees" regarding its nuclear program, such as

- Iran's adoption of an additional protocol to its safeguards agreement and continuous on-site inspections at key facilities;
- limiting the expansion of Iran's enrichment program and a policy declaration of no reprocessing;
- immediately converting all enriched uranium to fuel rods;
- an EU declaration recognizing Iran as a major source of energy for Europe;
- Iran's guaranteed access to advanced nuclear technology along with contracts for the construction of nuclear plants in Iran by the European Union; and
- normalizing Iran's status under Group of Eight export controls.

APRIL 29, 2005: Iran's outline for a phased approach, building off the March proposal and including new provisions, such as

- Iran's adoption of an additional protocol to its safeguards agreement;
- a policy declaration of no reprocessing by Iran;
- continued enrichment suspension for six months;
- establishment of joint task forces on counterterrorism and export control; and
- an EU declaration recognizing Iran as a major source of energy for Europe.

JULY 18, 2005: Iranian message from Hassan Rouhani, then-secretary of Iran's Supreme National Security Council, to the EU-3, proposing

- an agreement on initial limitations on uranium enrichment at Natanz;
- negotiations for the full-scale operation of Natanz;
- arrangements to import material for uranium conversion and the export of uranium hexafluoride; and
- negotiation of an "optimized" International Atomic Energy Agency (IAEA) monitoring mechanism for Natanz.

AUGUST 5, 2005: EU-3 package framework for a long-term agreement, which entailed

- arrangements for the assured supply of low-enriched uranium (LEU) for any light-water reactors (LWRs) constructed in Iran;
- establishing a buffer store of nuclear fuel located in a third country;
- a commitment by Iran not to pursue fuel cycle technologies, reviewable after 10 years;
- a legally binding commitment by Iran not to withdraw from the nuclear Nonproliferation Treaty (NPT) and Iran's adoption of an additional protocol to its safeguards agreement;
- arrangements for Iran to return spent nuclear fuel to supplier countries;
- EU recognition of Iran as a long-term source of fossil fuel energy; and
- EU-Iran cooperation in a variety of political-security areas, including Afghanistan and Iraq, terrorism, and drug trafficking.

PROPOSALS BETWEEN THE P5+1 AND IRAN

JUNE 6, 2006: China, Russia, and the United States join the EU-3 to offer another proposal for comprehensive negotiations with Iran, involving

- Iran's suspension of enrichment-related and reprocessing activities;
- the establishment of a mechanism to review this moratorium;
- Iran's resumption of implementation of an additional protocol to its safeguards agreement;
- the provision of state-of-the-art LWRs to Iran through joint projects, along with nuclear fuel guarantees and a five-year buffer stock of fuel;
- suspension of the discussion of Iran's nuclear program in the UN Security Council; and
- cooperation on civil aviation, telecommunications, high technology, agriculture, and other areas between the United States and the EU and Iran.

MAY 13, 2008: Iranian package to the P5+1, proposing

- "[e]stablishing enrichment and nuclear fuel production consortiums in different parts of the world-including Iran";
- improved IAEA supervision "in different states";
- cooperation on nuclear safety and physical protection;
- cooperation on export controls; and
- cooperation on regional security and global economic issues.

JUNE 12, 2008: The revised P5+1 package includes the 2006 proposal plus the following updates

- treatment of Iran's nuclear program as with any other NPT non-nuclear-weapon state once confidence is restored;
- technological and financial assistance for Iran's nuclear energy program;
- reaffirmation of the UN Charter obligation to refrain from the use and threat of use of force;
- cooperation on Afghanistan, including drug trafficking, refugee return, reconstruction, and border controls;
- steps toward normalizing economic and trade relations, including support for Iran's membership in the World Trade Organization; and
- prospective cooperation on agriculture, the environment and infrastructure, civil aviation, and social development and humanitarian issues.

SEPTEMBER 9, 2009: Iranian proposal for cooperation on political-security, international, and economic issues (there was no section on nuclear issues), such as

- cooperation to address terrorism, drug trafficking, organized crime, and piracy;
- UN and Security Council reform;
- the codification of rights for the use of space;
- promoting a "rule-based" and "equitable" IAEA oversight function; and
- promoting NPT universality and WMD nonproliferation.

TEHRAN RESEARCH REACTOR (TRR) PROPOSAL

OCTOBER 1, 2009: Iran agreed "in principle" to a fuel swap with the IAEA, France, Russia, and the United States, exporting most of its LEU in exchange for fuel for the Tehran Research Reactor (TRR).

- Iran exports 1,200 kilograms of LEU before the end of the 2009.

- Russia further enriches Iran's LEU to about 20 percent, a process producing about 120 kilograms of 20 percent-enriched uranium for the TRR fuel rods.
- France manufactures the TRR fuel rods for delivery about one year after the conclusion of the agreement, prior to the depletion of the current TRR fuel supply.
- The United States works with the IAEA to improve safety and control implementation at the TRR.
- The six countries make a statement of political statement for the deal to guarantee that the TRR fuel would be delivered to Iran.
- Financing is provided for the movement of LEU and fuel.
- The IAEA has the option to hold Iran's LEU in escrow in a third country until the TRR fuel is delivered.

MAY 17, 2010: Brazil and Turkey carried out a diplomatic initiative in the spring of 2010 to broker the 2009 TRR fuel swap with Iran.

- The three countries "recall the right of all State Parties, including the Islamic Republic of Iran, to develop research, production and use of nuclear energy (as well as nuclear fuel cycle including enrichment activities)."
- Iran transfers 1,200 kilograms of LEU to be held in escrow in Turkey within one month.
- Pending their approval of the Tehran Declaration, the IAEA, France, Russia, and the United States (the Vienna Group) would agree to provide 120 kilograms of 20 percent-enriched uranium fuel to Iran within one year.
- If the terms were not filled by the Vienna Group, Turkey would transfer the LEU back to Iran, which maintains legal possession of the material.

RUSSIAN "STEP-BY-STEP" PROPOSAL

JULY 12, 2011: Russian Foreign Minister Sergey Lavrov first publicly proposed a "road map" to implement the P5+1's proposed incentives package.

Step 1
- Iran limits enrichment to Natanz, does not install any additional centrifuges, and halts the production of advanced centrifuges.
- The P5+1 suspends some UN sanctions, including financial sanctions and ship inspections.

Step 2
- Iran agrees to provide early design information to the IAEA under Code 3.1 of its safeguards agreement, caps its enrichment level at 5 percent, and allows greater IAEA monitoring over its centrifuges.
- The P5+1 suspends most UN sanctions and gradually lifts unilateral sanctions.

Step 3
- Iran implements the additional protocol to its safeguards agreement.
- The P5+1 suspends all UN sanctions in a phased manner.

Step 4
- Iran suspends all enrichment-related activities for three months.
- The P5+1 lifts all sanctions and begins to implement the group's proposed incentives.

2012 PROPOSALS

MAY 18, 2012: Iran and the P5+1 held a second high-level political meeting in Baghdad after agreeing the previous month to pursue negotiations based on a step-by-step approach with reciprocal actions. Each side laid out a proposal for discussion.

2012 IRANIAN FIVE-STEP PROPOSAL

Step 1 - Guidelines
- Iran emphasizes commitments under the NPT and its opposition to nuclear weapons based on the supreme leader's fatwa.
- The P5+1 recognizes and openly announces Iran's nuclear rights, particularly its enrichment activities, based on Article 4 of the NPT.

Step 2 - Transparency measures
- Iran continues broad cooperation with the IAEA and will transparently cooperate with the IAEA on "possible military dimensions."
- The P5+1 will end unilateral and multilateral sanctions against Iran outside of UN Security Council resolutions.

Step 3 - Confidence-building steps
- Beyond continuous IAEA monitoring of enrichment activities for TRR fuel, Iran will cooperate with the P5+1 to provide enriched fuel needed for the TRR.
- The P5+1 will terminate the UN sanctions and

remove Iran's nuclear file from the UN Security Council agenda.

Step 4 - Strengthening cooperation on mutual interests

- Parties will start and boost cooperation on designing and building nuclear power plants and research reactors (Iran's priorities) and light-water research reactors, nuclear safety and security, and nuclear fusion (the P5+1's priorities).

Step 5 - Strengthening joint cooperation

- Parties will start cooperating on regional issues, especially Syria and Bahrain (Iran's priorities), and combating piracy and countering narcotics activities (the P5+1's priorities).

2012 P5+1 PROPOSAL

Iranian actions:

- Iran halts all 20 percent-enrichment activities.
- Iran transfers all 20 percent-enriched uranium to a third country under IAEA custody.
- Iran shuts down the Fordow facility.

P5+1 actions:

- The P5+1 will provide fuel assemblies for the TRR.
- The P5+1 will support IAEA technical cooperation to modernize and maintain the safety of the TRR.
- The P5+1 could review the IAEA technical cooperation projects and recommend to the IAEA Board of Governors restarting some of them.
- The P5+1 will provide medical isotopes for cancer patients in Iran.
- The United States is prepared to permit safety-related inspection and repair in Iran for Iranian commercial aircraft and provide spare parts.
- The P5+1 will cooperate in acquiring a light-water research reactor to produce medical isotopes.

ALMATY PROPOSALS

APRIL 5-6, 2013: Iran and the P5+1 hold talks in Almaty, Kazakhstan. The two sides had resumed negotiations in Almaty in February 2013 after a nine-month interval. Each side brought a proposal to the April talks, but failed to reach consensus on a way forward. The P5+1 proposal was based on the proposal from the 2012 negotiations.

2013 P5+1 PROPOSAL

Iranian Actions:

- Iran stops production of 20 percent enriched uranium.
- Iran suspends operations at Fordow.
- Iran ships part of its stockpile of 20 percent enriched uranium out of the country.
- Iran provides the IAEA with information to address the outstanding allegations of possible military activities, commits to the additional protocol and the modified version of the subsidiary arrangement to Iran's safeguards agreement, known as Code 3.1

P5+1 actions:

- The P5+1 will provide fuel assemblies for the TRR.
- The P5+1 will support IAEA technical cooperation to modernize and maintain the safety of the TRR.
- The P5+1 could review the IAEA technical cooperation projects and recommend to the IAEA Board of Governors restarting some of them.
- The P5+1 will provide medical isotopes for cancer patients in Iran.
- The United States is prepared to permit safety-related inspection and repair in Iran for Iranian commercial aircraft and provide spare parts.
- The P5+1 will cooperate in acquiring a light-water research reactor to produce medical isotopes.

The P5+1 will provide sanctions relief on sales of precious metals and petrochemicals.

IRAN'S PROPOSAL:

Iran's proposal on day 1 of the April Alamty talks was similar to the five-step proposal Tehran brought to the negotiations in 2012. However, after the P5+1 expressed dissatisfaction with this proposal, which it viewed as a step backward, Iran revised its proposal for the second day of talks to include the following:

Iran's Actions:

- Iran freezes centrifuge installation at Fordow.
- Iran continues talks with the IAEA.
- Iran continues converting 20 percent enriched uranium hexafluoride to uranium oxide.
- Iran suspends enrichment of uranium to 20 percent.

P5+1 Actions:

- The P5+1 lifts all sanctions against Iran.
- The P5+1 recognizes Iran's nuclear rights.

APPENDIX C

Text of the Joint Plan of Action

Preamble

The goal for these negotiations is to reach a mutually-agreed long-term comprehensive solution that would ensure Iran's nuclear programme will be exclusively peaceful. Iran reaffirms that under no circumstances will Iran ever seek or develop any nuclear weapons. This comprehensive solution would build on these initial measures and result in a final step for a period to be agreed upon and the resolution of concerns. This comprehensive solution would enable Iran to fully enjoy its right to nuclear energy for peaceful purposes under the relevant articles of the NPT in conformity with its obligations therein. This comprehensive solution would involve a mutually defined enrichment programme with practical limits and transparency measures to ensure the peaceful nature of the programme. This comprehensive solution would constitute an integrated whole where nothing is agreed until everything is agreed. This comprehensive solution would involve a reciprocal, step-bystep process, and would produce the comprehensive lifting of all UN Security Council sanctions, as well as multilateral and national sanctions related to Iran's nuclear programme.

There would be additional steps in between the initial measures and the final step, including, among other things, addressing the UN Security Council resolutions, with a view toward bringing to a satisfactory conclusion the UN Security Council's consideration of this matter. The E3+3 and Iran will be responsible for conclusion and implementation of mutual near-term measures and the comprehensive solution in good faith. A Joint Commission of E3/EU+3 and Iran will be established to monitor the implementation of the near-term measures and address issues that may arise, with the IAEA responsible for verification of nuclear-related measures. The Joint Commission will work with the IAEA to facilitate resolution of past and present issues of concern.

Elements of a first step

The first step would be time-bound, with a duration of 6 months, and renewable by mutual consent, during which all parties will work to maintain a constructive atmosphere for negotiations in good faith.

Iran would undertake the following voluntary measures:

- From the existing uranium enriched to 20%, retain half as working stock of 20% oxide for fabrication of fuel for the TRR. Dilute the remaining 20% UF6 to no more than 5%. No reconversion line.
- Iran announces that it will not enrich uranium over 5% for the duration of the 6 months.
- Iran announces that it will not make any further advances of its activities at the Natanz Fuel Enrichment Plant[1], Fordow[2], or the Arak reactor[3], designated by the IAEA as IR-40.
- Beginning when the line for conversion of UF6 enriched up to 5% to UO2 is ready, Iran has decided to convert to oxide UF6 newly enriched up to 5% during the 6 month period, as provided in the operational schedule of the conversion plant declared to the IAEA.
- No new locations for the enrichment.
- Iran will continue its safeguarded R&D practices, including its current enrichment R&D practices, which are not designed for accumulation of the enriched uranium.
- No reprocessing or construction of a facility capable of reprocessing.
- Enhanced monitoring:
    - Provision of specified information to the IAEA, including information on Iran's plans for nuclear facilities, a description of each building on each nuclear site, a description of the scale of operations for each location engaged in specified nuclear activities, information on uranium mines and mills, and information on source material. This information would be provided within three months of the adoption of these measures.

- Submission of an updated DIQ for the reactor at Arak, designated by the IAEA as the IR-40, to the IAEA.
- Steps to agree with the IAEA on conclusion of the Safeguards Approach for the reactor at Arak, designated by the IAEA as the IR-40.'
- Daily IAEA inspector access when inspectors are not present for the purpose of Design Information Verification, Interim Inventory Verification, Physical Inventory Verification, and unannounced inspections, for the purpose of access to offline surveillance records, at Fordow and Natanz.
- IAEA inspector managed access to:
  - centrifuge assembly workshops[4];
  - entrifuge rotor production workshops and storage facilities; and
  - uranium mines and mills.

In return, the E3/EU+3 would undertake the following voluntary measures:

- Pause efforts to further reduce Iran's crude oil sales, enabling Iran's current customers to purchase their current average amounts of crude oil. Enable the repatriation of an agreed amount of revenue held abroad. For such oil sales, suspend the EU and U.S. sanctions on associated insurance and transportation services.
- Suspend U.S. and EU sanctions on:
  - Iran's petrochemical exports, as well as sanctions on associated services.[5]
  - Gold and precious metals, as well as sanctions on associated services.
- Suspend U.S. sanctions on Iran's auto industry, as well as sanctions on associated services.
- License the supply and installation in Iran of spare parts for safety of flight for Iranian civil aviation and associated services. License safety related inspections and repairs in Iran as well as associated services.[6]
- No new nuclear-related UN Security Council sanctions.
- No new EU nuclear-related sanctions.
- The U.S. Administration, acting consistent with the respective roles of the President and the Congress, will refrain from imposing new nuclear-related sanctions.
- Establish a financial channel to facilitate humanitarian trade for Iran's domestic needs using Iranian oil revenues held abroad. Humanitarian trade would be defined as transactions involving food and agricultural products, medicine, medical devices, and

Fabrice Coffrini/AFP/Getty Images

Iranian Foreign Minister Mohammad Javad Zarif, Chinese Foreign Minister Wang Yi, U.S. Secretary of State John Kerry, Russian Foreign Minister Sergei Lavrov and French Foreign Minister Laurent Fabius gather in Geneva November 24, 2013, to announce an interim agreement on Iran's nuclear program.

medical expenses incurred abroad. This channel would involve specified foreign banks and non-designated Iranian banks to be defined when establishing the channel.
    - This channel could also enable:
        - transactions required to pay Iran's UN obligations; and,
        - direct tuition payments to universities and colleges for Iranian students studying abroad, up to an agreed amount for the six month period.
- Increase the EU authorisation thresholds for transactions for non-sanctioned trade to an agreed amount.

*Elements of the final step of a comprehensive solution**

The final step of a comprehensive solution, which the parties aim to conclude negotiating and commence implementing no more than one year after the adoption of this document, would:

- Have a specified long-term duration to be agreed upon.
- Reflect the rights and obligations of parties to the NPT and IAEA Safeguards Agreements.
- Comprehensively lift UN Security Council, multilateral and national nuclear-related sanctions, including steps on access in areas of trade, technology, finance, and energy, on a schedule to be agreed upon.
- Involve a mutually defined enrichment programme with mutually agreed parameters consistent with practical needs, with agreed limits on scope and level of enrichment activities, capacity, where it is carried out, and stocks of enriched uranium, for a period to be agreed upon.
- Fully resolve concerns related to the reactor at Arak, designated by the IAEA as the IR-40. No reprocessing or construction of a facility capable of reprocessing.
- Fully implement the agreed transparency measures and enhanced monitoring. Ratify and implement the Additional Protocol, consistent with the respective roles of the President and the Majlis (Iranian parliament).
- Include international civil nuclear cooperation, including among others, on acquiring modern light water power and research reactors and associated equipment, and the supply of modern nuclear fuel as well as agreed R&D practices.

Following successful implementation of the final step of the comprehensive solution for its full duration, the Iranian nuclear programme will be treated in the same manner as that of any non-nuclear weapon state party to the NPT.

* With respect to the final step and any steps in between, the standard principle that "nothing is agreed until everything is agreed" applies.

ENDNOTES

1. Namely, during the 6 months, Iran will not feed UF6 into the centrifuges installed but not enriching uranium. Not install additional centrifuges. Iran announces that during the first 6 months, it will replace existing centrifuges with centrifuges of the same type.

2. At Fordow, no further enrichment over 5% at 4 cascades now enriching uranium, and not increase enrichment capacity. Not feed UF6 into the other 12 cascades, which would remain in a non-operative state. No interconnections between cascades. Iran announces that during the first 6 months, it will replace existing centrifuges with centrifuges of the same type.

3. Iran announces on concerns related to the construction of the reactor at Arak that for 6 months it will not commission the reactor or transfer fuel or heavy water to the reactor site and will not test additional fuel or produce more fuel for the reactor or install remaining components.

4. Consistent with its plans, Iran's centrifuge production during the 6 months will be dedicated to replace damaged machines.

5. "Sanctions on associated services" means any service, such as insurance, transportation, or financial, subject to the underlying U.S. or EU sanctions applicable, insofar as each service is related to the underlying sanction and required to facilitate the desired transactions. These services could involve any non-designated Iranian entities.

6. Sanctions relief could involve any non-designated Iranian airlines as well as Iran Air.

APPENDIX D

Sanctions on Iran

Iran has been subjected to fairly comprehensive U.S. sanctions since the early 1980s for a variety of reasons, including the regime's support for terrorism, human rights violations, and proliferation concerns.

Additionally, since the UN Security Council took up the Iran nuclear file in 2006, Iran has been subjected to increasingly rigorous multilateral sanctions aimed at encouraging compliance with its nuclear nonproliferation obligations and addressing international concerns about the nature of its nuclear program. These sanctions focus on preventing Iran from acquiring the technologies and materials needed for its nuclear and missile programs by requiring all countries to restrict sensitive exports to Iran. The sanctions geared toward slowing Iran's nuclear and missile programs appear to be increasingly effective as additional countries strengthen controls over exporting sensitive goods to Iran. But they have not prevented Iran from improving its domestic capabilities nor led Iran's leadership to abandon the pursuit of a nuclear weapons capability.

U.S.-led sanctions have increasingly targeted the Iranian energy sector, the most critical part of its economy, to impose economic pressure on Iran in the hopes of influencing the decision-making of Iran's leadership. More recently, the Iranian banking sector has been targeted by sanctions designed to isolate it from the global financial system by both the United States and the European Union.

Sanctions should remain an important component of efforts to demonstrate to Iran that it has nothing to gain and much to lose from its current nuclear ambitions, but sanctions will not be enough to end any nuclear aspirations.

UN Security Council Sanctions:

The UN Security Council first resorted to employing sanctions in 2006 when Iran refused to comply with a binding resolution that required, among other measures, that Iran suspend all uranium-enrichment and heavy-water-related activity. Three other resolutions tightening sanctions followed, with a June 2010 resolution introducing some of the most sweeping measures against Iran to date. Taken together, sanctions introduced under these resolutions prohibit Iran's access to proliferation-sensitive items, technical assistance, and technology. The resolutions also target designated Iranian entities and persons involved in the nuclear and ballistic missile activities that are barred by the resolutions.

RESOLUTION	KEY PROLIFERATION-RELATED PROVISIONS
1737 (2006)	• Prevent the supply of all items which could contribute to Iran's enrichment-related, reprocessing, or heavy water-related activities, or to the development of weapon delivery systems; • Iran may not export any items or technology related to nuclear programs or ballistic missile programs; • Iran should not receive financial services related to the supply or use of prohibited materials or technology; • States should freeze economic assets owned or controlled by people associated with supporting Iran's nuclear activities or weapon delivery systems.
1747 (2007)	• Iran should not receive grants, financial services, or loans except for humanitarian reasons;

1803 (2008)	• States should inspect the cargoes and from Iran of any Iranian owned or operated companies, provided there is reason to suspect the cargo may contain prohibited materials; • States should monitor the activities of Iranian financial institutions operating in their territories to prevent any activities that may contribute to the proliferation sensitive nuclear activities; • Individuals who are associated with Iran's proliferation sensitive nuclear activities or nuclear weapon delivery systems should not be allowed to enter the states.
1929 (2010)	• States should seize and dispose of any items being supplied or transferred to Iran which could contribute to Iran's nuclear program; • Iran should not acquire interest in uranium mining, production, or use of nuclear materials and technology; • All states should prohibit Iranian investment in uranium mining and production in their territory; • States should inspect all cargo to and from Iran if the state has reasonable reason to believe the cargo is related to Iran's pursuit of nuclear technology. States should refuse to fuel or supply ships for the same reason; • Iran should not receive financial services related to the supply or use of prohibited materials or technology; • States should not allow new branches or representative offices of Iranian banks in their territory if there is reason to believe they may be connected to proliferation-sensitive activities.

European Union Sanctions

Council Document	Proliferation-Related Sanctions
Council Regulation 423 (2007)	• Freezes the assets of individuals and entities related to Iran's nuclear and ballistic missile programs; • Prohibits the transfer of dual-use goods that could be used for Iran's nuclear program;
Council Regulation 961 (2010)	• Bans investments, sales, and supply of equipement and technology to Iran's energy sector; • Requires members states to inspect suspicious cargo going to and from Iran.
Council Regulation 267 (2012)	• Bans member states from importing oil or purchasing petrochemical products from Iran; • Bans insurance on shipments of Iranian oil; • Freezes assets connected to the Central Bank of Iran; • Prohibits trade using precious metals with Iran.

Summary of Major U.S. Sanctions on Iran

FINANCIAL AND TRADE RESTRICTIONS	
Banking	On Nov. 6, 2008, the Department of the Treasury banned U.S. banks from handling indirect transactions with Iranian banks.
	The Comprehensive Iran Sanctions, Accountability, and Divestment Act (CISADA) of 2010 excludes foreign banks from the U.S. financial system if they conduct transactions with the Islamic Revolutionary Guard Corps or entities sanctioned by executive orders or the United Nations.
	On Nov. 21, 2011, Secretary of the Treasury Timothy Geithner used Section 311 of the USA PATRIOT Act to identify Iran as a "jurisdiction of primary money laundering concern."
	The National Defense Authorization Act of 2012 restricts foreign banks that do business with Iran's central bank from accessing the U.S. financial system.
Assets Freeze	*Executive Order 13224 (2001)* authorizes the president to freeze assets of entities supporting international terrorism and bar U.S. transactions with these entities.
	Executive Order 13382 (2005) grants the President the authority to block the assets of WMD proliferators.
Trade and Investment	*Executive Order 12959 (1995)* bans U.S. firms from trading with or investing in Iran, with exemptions for food and medical products.
OIL AND GAS SECTOR RESTRICTIONS	
Crude Oil Purchases	*Executive Order 12613 (1987)* bans U.S. companies from importing Iranian oil.
Refined Petroleum	The CISADA amended the Iran Sanctions Act (ISA) of 1996 by sanctioning the sale of gasoline and the sale of equipment related to Iranian energy imports and production to Iran.
Trade and Investment	The ISA sanctions foreign entities that invest in Iran's energy sector.
	Executive Order 13590 (2011) modifies the ISA to include the sanctioning of sales to Iran of oil and gas exploration and extraction equipment.
STRATEGIC TRADE CONTROLS	
Nuclear and Missile Technology	*The Iran-Iraq Arms Nonproliferation Act of 1992* imposes sanctions on foreign entities that supply Iran with WMD technology or "destabilizing" conventional arms.
	The Iran-North Korea-Syria Nonproliferation Act of 2000 authorizes sanctions on individuals or corporations that are assisting Iran's WMD programs.
Conventional Arms	*The Arms Export Control Act of 1976* bans U.S. arms sales to Iran, given its status as a state sponsor of terrorism.
	The International Emergency Economic Powers Act of 1977, implemented by executive orders, allows for restrictions on the sale of dual-use items to Iran.
Shipping	*Executive Order 13382 (2005)* freezes the U.S.-based property of Islamic Republic of Iran Shipping Lanes and other related entities.
Travel	The CISADA imposes travel bans on Iranians determined to be involved in human rights abuses since Iran's June 12, 2009, presidential elections.

APPENDIX E

The Military Option

U.S. President Barack Obama has stated that the United States will not allow Iran to obtain nuclear weapons and that "all options are on the table" to prevent this outcome. This expression is generally used as shorthand for a preventive military strike against Iran's nuclear facilities, presumably even without international authorization or broad support and absent any imminent military threat from Iran.

The objective of such an attack would be to seriously damage Iran's potential ability to develop nuclear weapons. In September 2012, however, more than 30 former high-ranking U.S. officials and military officers endorsed a report concluding that a sustained military strike on Iran by the United States would only set back Iran's nuclear program up to four years and subsequently increase Iran's motivation to build nuclear weapons to inhibit any future attack.[38]

A military attack against Iran's nuclear facilities would likely prompt Iran to withdraw from the International Atomic Energy Agency, probably accompanied by an Iranian revocation of its safeguards agreement and withdrawal from the nuclear Nonproliferation Treaty. These actions would close off the most important source of information available to the international community on the status of Iran's nuclear program and increase uncertainty over time about the extent of Iran's nuclear activities.

A military operation targeting Iran's nuclear

Shaiegan/AFP/Getty Images

Iran prepares to test a Shahab-3 missile in 2009. The range of the Shahab-3 allows Iran to target Israel and other U.S. assets in the Middle East.

capability would require a major, sustained air campaign. The target list would likely extend far beyond Iran's 25 declared nuclear facilities and related sites to include Iran's air defenses, command and control nodes, and means of retaliation, such as its ballistic and cruise missile forces and the naval vessels used to lay anti-ship mines. Such a military campaign would probably continue for weeks.

Beyond the strike assets, additional resources would be required for personnel recovery and post-strike battle damage assessments. A campaign of this magnitude would necessarily involve phases, allowing some Iranian assets not initially struck to be removed and hidden. Afterward, the United States would soon confront difficult decisions concerning the need to go back and attack surviving facilities or disrupt the reconstruction of those that had been destroyed.

The Iranian government's natural inclination to retaliate in response to an attack would be reinforced by popular sentiment. Iran's nationalistic population is overwhelmingly supportive of the country's nuclear program and sensitive about perceived threats to national sovereignty.

Such retaliation could take a number of forms, from ballistic missile attacks against U.S. military bases in the region and the cities, ports, and oil terminals of U.S. allies in the Persian Gulf to missile and rocket attacks against Israel. One of the most vulnerable retaliatory targets would be oil tanker traffic flowing through the Strait of Hormuz. Ninety percent of the oil produced by Persian Gulf states passes through the strait, as does almost 35 percent of all seaborne-traded oil and almost 20 percent of all oil traded worldwide.[39]

In 2006, Supreme Leader Ayatollah Ali Khamenei warned that if the United States punished or attacked Iran, then "definitely the shipment of energy from this region will be seriously jeopardized."[29] The most effective way to drive up oil costs would be to block the strait, halting or at least reducing the passage of shipping by laying several hundred mines in the water. Iran has a variety of platforms it could use for this task. From the first evidence that mines had been laid, maritime insurance rates and the price of oil would skyrocket, compelling the United States to undertake a mine-clearing campaign.

Given the limited number of mine countermeasure assets available and their vulnerability to Iranian attack, clearing even a relatively safe channel for passage would take several days; clearing the entire strait could take a month.

During a January 31, 2012, Senate Intelligence Committee hearing, Defense Intelligence Agency Director Lt. Gen. Ronald Burgess said the Iranians "have the capability, we assess, to temporarily close" the strait.[40] Other experts stated that efforts to reopen the vital waterway in the event of an Iranian closure could only be accomplished as part of a major military operation, which "could quickly become a war to clear the Iranian harbors and coast of most remnants of the country's military."[41]

Another vector of Iranian retaliation might be to sponsor Hezbollah and Hamas attacks against Israel. Thousands of short-range rockets of varying degrees of sophistication are available in Gaza and southern Lebanon for such action.

Iran could use surrogates to launch attacks on U.S. military forces deployed in the region, which has already happened sporadically and in varying degrees. In the wake of an unprovoked U.S. attack on Iran, the governments in Kabul, Baghdad, Islamabad, and elsewhere would be much less inclined to help provide protection for U.S. forces and more inclined to make deals with the militant opposition in Iran.

A close look at the military option reveals that it would fail at permanently halting Iran's nuclear weapons pursuits and present grievous new challenges for U.S. foreign, domestic, and security policies, adding incalculable costs to the nation in blood and treasure.

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The Arms Control Association (ACA), founded in 1971, is a national nonpartisan membership organization dedicated to promoting public understanding and support for effective policies to address the threats posed by the world's most dangerous weapons. Through its research, public education, and media outreach programs, including the monthly journal, *Arms Control Today,* ACA provides policy-makers, the press and the interested public with authoritative information, analysis and commentary on arms control proposals, negotiations and agreements, and related national security issues.

For well over a decade, the sensitive nuclear fuel cycle activities of the Islamic Republic of Iran have been at the center of international concern about the further spread of nuclear weapons.

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This briefing book is designed to provide casual observers and experts alike with an overview of Iran's nuclear history and diplomatic efforts to prevent a nuclear-armed Iran, and an up-to-date summary of the status and capabilities of Iran's nuclear program.

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