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Iran's Nuclear Program: Status

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Summary

Iran's nuclear program began during the 1950s. The United States has expressed concern since the mid-1970s that Tehran might develop nuclear weapons. Iran's construction of gas centrifuge uranium enrichment facilities is currently the main source of proliferation concern. Gas centrifuges can produce both low-enriched uranium (LEU), which can be used in nuclear power reactors, and weapons-grade highly enriched uranium (HEU), which is one of the two types of fissile material used in nuclear weapons.

The United States has assessed that Tehran has technological and industrial capacity to produce nuclear weapons, but has not yet mastered all of the necessary technologies for building such weapons. Whether Iran has a viable design for a nuclear weapon is unclear. A National Intelligence Estimate made public in 2007 assessed that Tehran "halted its nuclear weapons program" in 2003. The estimate, however, also assessed that Tehran is "keeping open the option to develop nuclear weapons" and that any decision to end a nuclear weapons program is "inherently reversible." U.S. intelligence officials have reaffirmed this judgment on several occasions. Director of National Intelligence James Clapper testified before Congress in February 2016 that "[w]e do not know whether Iran will eventually decide to build nuclear weapons."

Obtaining fissile material is widely regarded as the most difficult task in building nuclear weapons. As of January 2014, Iran had produced an amount of LEU containing up to 5% uranium-235 which, if further enriched, could theoretically have produced enough HEU for as many as eight nuclear weapons. Iran has also produced LEU containing nearly 20% uranium-235; the total amount of this LEU would, if it had been in the form of uranium hexafluoride and further enriched, have been sufficient for a nuclear weapon. After the Joint Plan of Action, which Tehran concluded with China, France, Germany, Russia, the United Kingdom, and the United States (collectively known as the "P5+1"), went into effect in January 2014, Iran either converted much of LEU containing nearly 20% uranium-235 for use as fuel in a research reactor located in Tehran, or prepared it for that purpose. Iran has diluted the rest of that stockpile so that it contained no more than 5% uranium-235.

Although Iran claims that its nuclear program is exclusively for peaceful purposes, the program has generated considerable concern that Tehran is pursuing a nuclear weapons program. The U.N. Security Council responded to Iran's refusal to suspend work on its uranium enrichment program by adopting several resolutions that imposed sanctions on Tehran. Despite evidence that sanctions and other forms of pressure have slowed the program, Iran continued to enrich uranium, install additional centrifuges, and conduct research on new types of centrifuges. Tehran has also worked on a heavy-water reactor, which is a proliferation concern because its spent fuel would have contained plutonium—the other type of fissile material used in nuclear weapons. However, plutonium must be separated from spent fuel—a procedure called "reprocessing." Iran has said that it will not engage in reprocessing.

The International Atomic Energy Agency (IAEA) monitors Iran's nuclear facilities and has verified that Tehran's declared nuclear facilities and materials have not been diverted for military purposes. The agency has also verified that Iran has implemented various restrictions on, and provided the IAEA with additional information about, its uranium enrichment program and heavy-water reactor program pursuant to the July 2015 Joint Cooperative Plan of Action (JCPOA), which Tehran concluded with the P5+1. On the JCPOA's Implementation Day, which took place on January 16, 2016, all of the previous Security Council resolutions' requirements were terminated. The nuclear Nonproliferation Treaty (NPT) and U.N. Security Council Resolution 2231, which the Council adopted on July 20, 2015, comprise the current legal framework governing Iran's nuclear program. Iran has complied with the JCPOA and resolution.

Iran and the IAEA agreed in 2007 on a work plan to clarify outstanding questions regarding Tehran's nuclear program, most of which concerned possible Iranian procurement activities and research directly applicable to nuclear weapons development. A December 2015, report to the IAEA Board of Governors from agency Director-General Yukiya Amano contains the IAEA's "final assessment on the resolution" of these outstanding issues.

Then Under Secretary of State for Political Affairs Wendy Sherman explained during an October 2013 hearing of the Senate Committee on Foreign Relations that Iran would need as much as one year to produce a nuclear weapon if the government made the decision to do so. At the time, Tehran would have needed two to three months of this time to produce enough weapons-grade HEU for a nuclear weapon. Iran's compliance with the JCPOA has lengthened this time to one year, according to Clapper's testimony. These estimates apparently assume that Iran would use its declared nuclear facilities to produce fissile material for a weapon. However, Tehran would probably use covert facilities for this purpose; Iranian efforts to produce fissile material for nuclear weapons by using its known nuclear facilities would almost certainly be detected by the IAEA.

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Background

Iran's nuclear program began during the 1950s. Construction of a U.S.-supplied research reactor, called the Tehran Research Reactor (TRR), located in Tehran began in 1960; the reactor went critical in 1967.[1] During the 1970s, Tehran pursued an ambitious nuclear power program; according to contemporaneous U.S. documents, Iran wanted to construct 10-20 nuclear power reactors and produce more than 20,000 megawatts of nuclear power by 1994.[2] Iran also began constructing a light-water nuclear power reactor near the city of Bushehr and also considered obtaining uranium enrichment and reprocessing technology.

Iran took steps to demonstrate that it was not pursuing nuclear weapons. For example, Tehran signed the nuclear Nonproliferation Treaty (NPT) in 1968 and ratified it in 1970. Iran also submitted a draft resolution to the U.N. General Assembly in 1974 that called for establishing a nuclear-weapons-free zone in the Middle East. Nevertheless, mid-1970s U.S. intelligence reports expressed concern that Iran might pursue a nuclear weapons program.[3] Although Iran cancelled its nuclear program after its 1979 revolution, a 1981 Department of State draft paper argued that Iran might develop a nuclear weapons program in response to a then-suspected Iraqi nuclear weapons program, although Iran was not one of several countries of "near to medium term proliferation concern" to which the paper referred.[4]

Tehran "reinstituted" its nuclear program in 1982.[5] According to International Atomic Energy Agency (IAEA) reports, Iran conducted experiments during the 1980s and early 1990s related to uranium conversion, heavy water production, and nuclear reactor fuel fabrication. A 1985 National Intelligence Council report, which cited Iran as a potential "proliferation threat," stated that Tehran was "interested in developing facilities that ... could eventually produce fissile material that could be used in a [nuclear] weapon." The report, however, added that it "would

[1] The United States and Iran signed a nuclear cooperation agreement in 1957; it entered into force in 1959. The two countries negotiated another such agreement during the 1970s, but it was never concluded. For a summary of these negotiations, see William Burr, "A Brief History of U.S.-Iranian Nuclear Negotiations," *Bulletin of the Atomic Scientists*, January/February 2009.

[2] The United States was willing to supply Iran with reprocessing technology, according to 1975 and 1976 National Security Council documents. Tehran also had a 1976 contract for a pilot uranium-enrichment facility using lasers (see *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006) and 1747 (2007) in the Islamic Republic of Iran*, Report by the Director General, GOV 2007/58, November 15, 2007. Additionally, according to a 1976 State Department cable, Iran engaged in uranium exploration in Iran and other countries, planned to reprocess spent reactor fuel in the future, and had contemplated building its own enrichment facility, (U.S. Embassy Tehran Airgram A-76 to State Department, "The Atomic Energy Organization of Iran," April 15, 1976).

[3] *Prospects for Further Proliferation of Nuclear Weapons*, Special National Intelligence Estimate, August 23, 1974. A 1975 Department of State memorandum referred to the "uncertainty over" Iran's "long-term objectives despite its NPT status" ("Memorandum for the Assistant to the President for National Security Affairs: Department of State Response to NSSM 219 (Nuclear Cooperation with Iran)," April 18, 1975). A 1975 CIA report identified Iran as one state with the "potential... to cross the explosives threshold within the next ten years." (*Managing Nuclear Proliferation: The Politics of Limited Choice*, Research Study, CIA, December 1975).And a 1988 CIA report (*Middle East-South Asia: Nuclear Handbook*) indicated that Iran had conducted nuclear weapons "design work" before the 1979 revolution.

[4] "Request for Review of Draft Paper on the Security Dimension of Non-Proliferation," Special Assistant for Nuclear Proliferation Intelligence, National Foreign Assessment Center, Central Intelligence Agency, to Resource Management Staff, Office of Program Assessment et al, April 9, 1981. Iraq pursued nuclear, chemical, and biological weapons during the 1980s. The paper argued that Iraq's nuclear program was "intended to provide the option of developing nuclear explosives in the future."

[5] *Middle East-South Asia: Nuclear Handbook*, CIA, May 1988.

take at least a decade" for Iran to do so.[6] A U.S. intelligence report published 10 years later stated that Iran was "aggressively pursuing a nuclear weapons capability and, if significant foreign assistance were provided, could produce a weapon by the end of the decade."[7]

The Iranian government says that it plans to expand its reliance on nuclear power in order to generate electricity. This program will, Tehran says, substitute for some of Iran's oil and gas consumption and allow the country to export additional fossil fuels; the previous Iranian regime also made this argument.[8] Iran has begun to operate the Bushehr reactor and Tehran says it intends to build additional reactors to generate 20,000 megawatts of power within the next 20 years.[9] The 2015 Joint Comprehensive Plan of Action requires Iran to refrain from building heavy water-moderated reactors for 15 years, and Iran pledges to refrain from constructing any such reactors indefinitely. Iranian officials say that Tehran has begun design work on its first indigenously-produced light-water reactor, which is to be constructed at Darkhovin. According to official U.S. and Iranian sources, France agreed to construct the reactor during the 1970s, but ended the project after the 1979 revolution in Iran.[10] According to a February 2011 report from IAEA Director-General Yukiya Amano, satellite imagery indicated that "construction activities" had not begun at the planned reactor site.[11] The project's current status is unclear.

Iranian officials have repeatedly asserted that the country's nuclear program is exclusively for peaceful purposes. For example, Supreme Leader Ayatollah Ali Khamene'i declared during a June 3, 2008, speech that Iran is opposed to nuclear weapons "based on religious and Islamic beliefs as well as based on logic and wisdom." He added, "[n]uclear weapons have no benefit but high costs to manufacture and keep them. Nuclear weapons do not bring power to a nation because they are not applicable. Nuclear weapons cannot be used." Similarly, then-Iranian Foreign Ministry spokesperson Hassan Qashqavi stated November 10, 2008, that "pursuance of nuclear weapons has no place in the country's defense doctrine."[12] Then-Iranian President Mahmoud Ahmadinejad asserted during an April 9, 2009, speech that "those who accumulate

[6] *The Dynamics of Nuclear Proliferation: Balance of Power and Constraints*, National Intelligence Council, September 1985.

[7] *The Weapons Proliferation Threat*, Nonproliferation Center, March 1995.

[8] For example, according to a 1976 State Department cable, the President of the Atomic Energy Organization of Iran cited these arguments as reasons for starting an ambitious nuclear program (U.S. Embassy Tehran Airgram A-76 to State Department, 1976). Ambassador Ali Asghar Soltanieh, then Iran's Permanent Representative to the International Atomic Energy Agency, has explained that nuclear power would only meet "perhaps a small portion" of the projected national electricity demand. "Interview with Iran's Ambassador to IAEA," Campaign Against Sanctions and Military Intervention in Iran, June 29, 2008 (published July 2, 2008).

[9] "Iran to Follow Nuclear Timetable Regardless of IAEA Reports – Official," *Islamic Republic of Iran News Network*, February 25, 2009. A spokesperson for the Atomic Energy Organization of Iran stated on January 11, 2016, that the country "needs to generate 20,000 megawatts of nuclear electricity" and should produce 12,000 megawatts of nuclear electricity by 2025 (Sara Ma'sumi, Interview with Behruz Kamalvandi, "Less Than Seven Day to the Implementation of the JCPOA [Joint Comprehensive Plan of Action]," *E'temad*, January 11, 2016).

[10] "Iran Asks France to Remain Committed to N. Power Plant Construction Deal ," *FARS News Agency*, October 28, 2014. Director of Central Intelligence, Joint Atomic Energy Intelligence Committee, *Iran's Nuclear Program: Building a Weapons Capability*, February 1993. France completed five percent of the project, according to former President of Iran's Atomic Energy Organization Reza Amrollahi ("If We Want Nuclear Energy, We Should Not Make a Fuss," *Sharq*, September 7, 2013).

[11] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2011/7, February 25, 2011.

[12] "Weekly Briefing of the Foreign Ministry Spokesman," November 10, 2008.

nuclear weapons are backwards in political terms."[13] More recently, Khamene'i stated in 2012 that

> Ideologically and religiously speaking, we believe that it is not right [to have nuclear weapons]. We believe that this move [making nuclear weapons] and the use of such weapons are a great sin. We also believe that stockpiling such weapons is futile, expensive and harmful; and we would never seek this.[14]

Asked in 2012 if Iran is trying to develop the capability to produce a nuclear weapon, Ambassador Mohammad Khazaee, Iran's Permanent Representative to the United Nations, "[w]e are not going to develop the capacity to be able to make any weapon of mass destruction."[15] Iranian Foreign Minister Javad Zarif argued in 2014 that Khamene'i "has explicitly declared his opposition with regard to the manufacture, stockpile and use of nuclear weapons," and observed that "nuclear weapons have no place in Iran's defense doctrine."[16]

Nevertheless, the United States and other governments have argued that Iran may be pursuing, at a minimum, the capability to produce nuclear weapons. Discerning a peaceful nuclear program from a nuclear weapons program can be difficult because much nuclear technology is dual-use. In addition, military nuclear programs may coexist with civilian programs, even without an explicit governmental decision to produce nuclear weapons. Jose Goldemberg, Brazil's former secretary of state for science and technology, observed that a country developing the capability to produce nuclear fuel

> does not have to make an explicit early [political] decision to acquire nuclear weapons. In some countries, such a path is supported equally by those who genuinely want to explore an energy alternative and by government officials who either want nuclear weapons or just want to keep the option open.[17]

Some analysts argue that several past nuclear programs, such as those of France, Sweden, and Switzerland, illustrate this approach.[18] A Swedish official involved in that country's nuclear weapons program "argued that the main aim should be the generation of nuclear energy, with plutonium production, which would make possible the manufacture of nuclear weapons as a side-effect."[19] Moreover, a 1975 U.S. intelligence assessment argued that countries might develop an "unweaponized" nuclear explosive device "to further their political, and even military, objectives."[20]

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[13] *Islamic Republic of Iran News Network*, April 9, 2009.

[14] "Leader Says West Knows Iran Not Seeking 'Nuclear Weapons'," *Vision of the Islamic Republic of Iran Network 1*, February 22, 2012.

[15] *The Charlie Rose Show*, January 18, 2012.

[16] "Iran Foreign Minister Calls for Building Mutual Trust with West," *Islamic Republic News Agency*, January 7, 2014.

[17] Jose Goldemberg, "Looking Back: Lessons From the Denuclearization of Brazil and Argentina," *Arms Control Today*, April 2006.

[18] See James Acton, "The Problem with Nuclear Mind Reading," *Survival*, February-March 2009, pp. 119-42; Paul M. Cole, "Atomic Bombast: Nuclear Weapon Decision-making in Sweden 1945–1972," The Henry L. Stimson Center, 1996; "Neutral States: Sweden and Switzerland," in T.V. Paul , *Power Vs. Prudence: Why Nations Forgo Nuclear* Weapons (Montreal: McGill University Press), 2000, pp. 84-98; and Bruno Tertrais, "Has Iran Decided to Build the Bomb? Lessons from the French Experience," January 30, 2007.

[19] Thomas Jonter, "The Swedish Plans to Acquire Nuclear Weapons, 1945–1968: An Analysis of the Technical Preparations," *Science & Global Security*, 18:61–86, 2010.

[20] Memorandum to Holders, Special National Intelligence Estimate, *Prospects for Further Proliferation of Nuclear Weapons*, SNIE 4-1-74, December 18, 1975. The assessment did not discuss whether Iran was pursuing such an option.

The main source of proliferation concern generated by Iran's nuclear program has been Tehran's construction of gas centrifuge uranium-enrichment facilities. Gas centrifuges enrich uranium by spinning uranium hexafluoride gas at high speeds to increase the concentration of the uranium-235 isotope. Such centrifuges can produce both low-enriched uranium (LEU), which can be used in nuclear power reactors, and highly enriched uranium (HEU), which is one of the two types of fissile material used in nuclear weapons. HEU can also be used as fuel in certain types of nuclear reactors.[21] Iran also has a uranium-conversion facility, which converts uranium ore concentrate into several compounds, including uranium hexafluoride.[22]

Iran claims that it wants to produce LEU fuel for its planned light-water nuclear power reactors, as well as the TRR and other planned future research reactors. The latter reactors will be used to produce isotopes for medical purposes, according to Tehran. Although Iran has expressed interest in purchasing nuclear fuel from other countries, Tehran asserts that the country should have an indigenous enrichment capability as a hedge against possible fuel supply disruptions.[23] It is worth noting that an Iranian naval commander's June 12, 2012, announcement that Iran "has taken initial steps to design and build power and engine systems for nuclear submarines" may provide Tehran with a rationale for enriching uranium to levels suitable for use as fissile material in nuclear weapons, although the commander did not mention enrichment.[24] Notably, then-President of Iran's Atomic Energy Organization of Iran, Fereydun Abbasi-Davani Abbasi, stated the next month that, despite Iran's "capability to design nuclear fuel for ships and submarines," the country does not plan to produce enriched uranium containing more than 20% uranium-235.[25]

A reactor moderated by heavy water, which Iran was constructing at Arak, was also been a source of concern. Although Tehran says that the reactor is intended for the production of radioisotopes for medical purposes, it had been a proliferation concern because its spent fuel would have contained plutonium well-suited for use in nuclear weapons. Spent nuclear fuel from nuclear reactors contains plutonium, the other type of fissile material used in nuclear weapons. In order to be used in nuclear weapons, however, plutonium must be separated from the spent fuel—a procedure called "reprocessing." Iran has said that it will not engage in reprocessing. This reactor is designed to use natural uranium fuel, which does not require enrichment.

In addition to the dual-use nature of the nuclear programs described above, Iran's inconsistent cooperation with the IAEA contributed to suspicions that Tehran had a nuclear weapons program.[26] In the past, Iran has taken actions that interfered with the agency's investigation of its nuclear program, including concealing nuclear activities and providing misleading statements. Then-IAEA Director-General Mohamed ElBaradei explained in a 2008 interview that Iran's cooperation lagged behind IAEA demands:

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[21] Highly enriched uranium used in nuclear weapons typically contains about 90 percent uranium-235, whereas low-enriched uranium used in nuclear reactors typically contains less than 5% uranium-235.

[22] For a detailed description of the nuclear fuel cycle, see CRS Report RL34234, *Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power*, coordinated by (name redacted) .

[23] *What Are Iran's "Practical Needs" and Why Does Iran Want to Fuel Reactors on Its Own?*, nuclearenergy.ir, July 2014. "Soltaniyeh: Iran Has No Alternative but to Enrich Uranium," *Islamic Republic News Agency*, October 2, 2008; "Interview with Iran's Ambassador to IAEA," 2008.

[24] "Iran to Make Engine Systems For Nuclear Submarines," *Fars News Agency*, June 12, 2012; "Iran Plans Nuclear-Powered Submarine: Report," *Reuters*, June 12, 2012. Some naval propulsion reactors use weapons-grade HEU.

[25] "Official Underscores Iran's Ability to Produce N. Fuel for Trade Vessels," *Fars News Agency*, July 23, 2012.

[26] For a detailed description of Iran's compliance with its international obligations, see CRS Report R40094, *Iran's Nuclear Program: Tehran's Compliance with International Obligations*, by (name redacted)

> they [the Iranians] have concealed things from us in the past, but that doesn't prove that they are building a bomb today. They continue to insist that they are interested solely in using nuclear power for civilian purposes. We have yet to find a smoking gun that would prove them wrong. But there are suspicious circumstances and unsettling questions. The Iranians' willingness to cooperate leaves a lot to be desired. Iran must do more to provide us with access to certain individuals and documents. It must make a stronger contribution to clarifying the last unanswered set of questions—those relating to a possible military dimension of the Iranian nuclear program.[27]

Consistent with ElBaradei's statement, IAEA Director-General Amano explained in a 2012 interview that the IAEA has not claimed that "Iran [has] made a decision to obtain nuclear weapons."[28] Notably, Tehran has implemented various restrictions on, and provided the IAEA with additional information about, its uranium enrichment program and heavy-water reactor program pursuant to the July 2015 Joint Cooperative Plan of Action (JCPOA), which Tehran concluded with China, France, Germany, Russia, the United Kingdom, and the United States.

Iran and the IAEA agreed in August 2007 on a work plan to clarify the outstanding questions regarding Tehran's nuclear program, most of which concerned possible Iranian procurement activities and research directly applicable to nuclear weapons development. A December 2015, report to the IAEA Board of Governors from agency Director-General Yukiya Amano contains the IAEA's "final assessment on the resolution" of these outstanding issues.[29]

Iran also has extensive programs to develop ballistic missiles and cruise missiles. For more details on Iran's ballistic missile program, see CRS Report R42849, *Iran's Ballistic Missile and Space Launch Programs*, by (name redacted) .

Current Nuclear Controversy

The current public controversy over Iran's nuclear program began in August 2002, when the National Council of Resistance on Iran (NCRI), an Iranian exile group, revealed information during a press conference (some of which later proved to be accurate) that Iran had built nuclear-related facilities at Natanz and Arak that it had not revealed to the IAEA. The United States had been aware of at least some of these activities, according to knowledgeable former officials.[30] During the mid-1990s, Israel's intelligence services detected Iranian "efforts to develop a military nuclear industry," according to a 2004 Israeli Knesset committee report.[31]

Iran ratified the NPT in 1970. States-parties to the treaty are obligated to conclude a comprehensive safeguards agreement with the IAEA; Tehran concluded such an agreement in 1974. In the case of non-nuclear-weapon states-parties to the treaty (of which Iran is one), such agreements are designed to enable the IAEA to detect the diversion of nuclear material from peaceful purposes to nuclear weapons uses, as well as to detect undeclared nuclear activities and material. As a practical matter, however, the IAEA's ability to inspect and monitor nuclear

[27] "Interview with IAEA Boss Mohamed ElBaradei," *Der Spiegel*, June 11, 2008.

[28] Jay Solomon and David Crawford, "An Interview With IAEA's Yukiya Amano," *Wall Street Journal*, June 9, 2012.

[29] *Final Assessment on Past and Present Outstanding Issues Regarding Iran's Nuclear Programme*, GOV/2015/68, December 2, 2015.

[30] Gary Samore, Former Senior Director for Nonproliferation and Export Controls on the National Security Council, personal communication June 5, 2008; Former Director of Central Intelligence George J. Tenet, "DCI Remarks on Iraq's WMD Programs," February 5, 2004.

[31] *Report – Volume 1 (Unrestricted section)*, The Committee of Enquiry into the Intelligence System in Light of the War in Iraq, The Knesset Foreign Affairs and Defence Committee, March 2004.

facilities, as well as obtain relevant information, pursuant to a comprehensive safeguards agreements is limited to facilities that have been declared by the government.[32] Additional Protocols to IAEA safeguards agreements augment the agency's ability to investigate clandestine nuclear facilities and activities by increasing the agency's authority to inspect certain facilities and demand additional information from states-parties.[33] The IAEA's statute requires the agency's Board of Governors to refer cases of non-compliance with safeguards agreements to the U.N. Security Council. Prior to the NCRI's revelations, the IAEA had expressed concerns that Iran had not been providing the agency with all relevant information about its nuclear programs, but had never found Iran in violation of its safeguards agreement.

In fall 2002, the IAEA began to investigate Iran's nuclear activities at Natanz and Arak; inspectors visited the sites the following February. The IAEA board adopted its first resolution, which called on Tehran to increase its cooperation with the agency's investigation and to suspend its uranium enrichment activities, in September 2003. The next month, Iran concluded an agreement with France, Germany, and the United Kingdom, collectively known as the "E3," to suspend its enrichment activities, sign and implement an Additional Protocol to its IAEA safeguards agreement, and comply fully with the IAEA's investigation.[34] After October 2003, Iran continued some of its enrichment-related activities, but Tehran and the E3 agreed in November 2004 to a more detailed suspension agreement. During negotiations between fall 2003 and summer 2005, both Iran and the E3 offered a number of proposals, although the two sides never reached agreement.[35] The IAEA's investigation, as well as information Tehran provided after the October 2003 agreement, ultimately revealed that Iran had engaged in a variety of clandestine nuclear-related activities, some of which violated Iran's safeguards agreement. These activities included plutonium separation experiments, uranium enrichment and conversion experiments, and importing various uranium compounds.

Iran resumed uranium conversion in August 2005 under the leadership of then-President Ahmadinejad, who had been elected two months earlier. On September 24, 2005, the IAEA Board of Governors adopted a resolution that, for the first time, found Iran to be in noncompliance with its IAEA safeguards agreement. The board, however, did not refer Iran to the Security Council, choosing instead to give Tehran additional time to comply with the board's demands. Iran announced in January 2006 that it would resume research and development on its centrifuges at Natanz. In response, the IAEA board adopted a resolution on February 4, 2006, that referred Iran's case to the Security Council. Two days later, Tehran announced that it would stop implementing its Additional Protocol. In March 2006, the U.N. Security Council President issued a statement, which was not legally binding, that called on Iran to "take the steps required" by the February IAEA board resolution. The council subsequently adopted six resolutions concerning Iran's nuclear program: 1696 (July 2006), 1737 (December 2006), 1747 (March 2007), 1803 (March 2008), 1835 (September 2008), and 1929 (June 2010). The second, third, fourth, and sixth resolutions imposed a variety of restrictions on Iran. In addition, these resolutions required Iran to cooperate fully with an ongoing IAEA investigation of its nuclear activities, suspend its uranium

[32] The IAEA does have other investigative tools, such as monitoring scientific publications from member-states. For more information, see CRS Report R40094, *Iran's Nuclear Program: Tehran's Compliance with International Obligations*, by (name redacted)

[33] NPT states are not required to conclude Additional Protocols. However, applicable U.N. Security Council resolutions require Iran to conclude such a protocol.

[34] The text of the agreement is available at http://www.iaea.org/NewsCenter/Focus/IaeaIran/statement_iran21102003.shtml. Iran signed its Additional Protocol in December 2003, but has not ratified it.

[35] These proposals are available at http://www.armscontrol.org/factsheets/Iran_Nuclear_Proposals.

enrichment program, suspend its construction of a heavy water reactor and related projects, and ratify the Additional Protocol to Iran's IAEA safeguards agreement. Resolution 1929 also required Tehran to refrain from "any activity related to ballistic missiles capable of delivering nuclear weapons" and to comply with a modified provision (called code 3.1) of Iran's subsidiary arrangement to its IAEA safeguards agreement.

Beginning in June 2006, Iran later held multiple rounds of talks with China, France, Germany, Russia, the United Kingdom, and the United States, collectively known as the "P5+1," concerning various proposals for resolving the nuclear dispute. Following the June 2013 election of Iranian President Hassan Rouhani, Iran and the P5+1 met three times before concluding the Joint Plan of Action (JPA) on November 24, 2013. This agreement placed certain limitations on Iran's nuclear program and also set out an approach toward reaching a long-term comprehensive solution to international concerns regarding Iran's nuclear program. The two sides began implementing the JPA on January 20, 2014. The P5+1 and Iran reached a framework of a Joint Comprehensive Plan of Action (JCPOA) on April 2, 2015, and finalized the JCPOA on July 14, 2015. The parties began implementing the JCPOA on January 16, 2016. On that day, all of the previous Security Council resolutions' requirements were terminated. The NPT and U.N. Security Council Resolution 2231 comprise the current legal framework governing Iran's nuclear program.[36] For more information about multilateral diplomacy concerning Iran's nuclear program, see **Appendix A**.

Iran's Cooperation with the IAEA

Possible Military Dimensions

As noted, the IAEA investigation of Iran's nuclear program began in 2002. Iran and the IAEA agreed in August 2007 on a work plan to clarify the outstanding questions regarding Tehran's nuclear program.[37] Most of these issues,[38] which had contributed to suspicions that Iran had been pursuing a nuclear weapons program, were essentially resolved by June 2008, but then-IAEA Director-General ElBaradei told the IAEA Board of Governors on June 2, 2008, that there is "one remaining major [unresolved] issue," which concerns questions regarding "possible military dimensions to Iran's nuclear programme."

Iran and the IAEA subsequently held a series of discussions regarding these issues. The agency provided Iran with documents or, in some cases, descriptions of documents which had been provided to the IAEA by several governments. The documents indicated that Iranian entities may have conducted studies related to nuclear weapons development. The subjects of these studies included uranium conversion, missile reentry vehicles for delivering nuclear warheads, and conventional explosives used in nuclear weapons. Iranian officials have claimed that the documents are not authentic,[39] but ElBaradei told the IAEA board on June 17, 2009, that there

[36] "Joint Statement by EU High Representative Federica Mogherini and Iranian Foreign Minister Javad Zarif," January 16, 2016.

[37] The text of the work plan is available at http://www.iaea.org/Publications/Documents/Infcircs/2007/infcirc711.pdf.

[38] These issues included plutonium experiments, research and procurement efforts associated with two types of centrifuges, operations of a uranium mine, and experiments with polonium-210, which (in conjunction with beryllium) is used as a neutron initiator in certain types of nuclear weapons.

[39] In a September 28, 2008, letter to the IAEA, Iran described some characteristics of the documents discussed above. The letter stated that some of the information from the United States was shown to Iranian officials as PowerPoint presentations. Additionally, some of the documents are "in contradiction with typical standard Iranian documentation" and lack "classification seals," the letter said. See, Permanent Mission of the Islamic Republic of Iran, *Explanatory*
(continued...)

was "enough in these alleged studies to create concern in the minds of our professional inspectors." Iranian officials have acknowledged that some of the information in the documents is accurate, but argued that the activities described were exclusively for non-nuclear purposes.[40] Tehran has provided some relevant information about these matters to the IAEA, but ElBaradei reported in August 2009 that the government should "provide more substantive responses" to the IAEA, as well as "the opportunity to have detailed discussions with a view to moving forward on these issues, including granting the agency access to persons, information and locations identified in the documents."[41]

IAEA Director-General Amano issued a report to the IAEA board in November 2011 which stated that Iran had not "engaged with the agency in any substantive way" on the alleged studies since August 2008.[42] This report provided the most detailed account to date of the IAEA's evidence regarding Iran's suspected nuclear weapons-related activities. According to the report, the agency has "credible" information that Iran has carried out activities "relevant to the development of a nuclear explosive device." These include acquisition of "nuclear weapons development information and documentation," work to develop "an indigenous design of a nuclear weapon including the testing of components," efforts "to procure nuclear related and dual use equipment and materials by military related individuals and entities," and work to "develop undeclared pathways for the production of nuclear material." Although some of these activities have civilian applications, "others are specific to nuclear weapons," the report notes. Most of these activities were conducted before the end of 2003, though some may have continued. (See **Appendix B** and "Nuclear Weapon Development Capabilities") for more details.

The IAEA Board of Governors adopted a resolution on November 18, 2011, stating that "it is essential" for Iran and the IAEA "to intensify their dialogue aiming at the urgent resolution of all outstanding substantive issues." IAEA and Iranian officials met 10 times between January 2012 and May 2013 to discuss what the agency termed a "structured approach to the clarification of all outstanding issues related to Iran's nuclear programme."[43] However, during an October 2013 meeting, IAEA officials and their Iranian counterparts decided to adopt a "new approach" to resolving these issues. Iran signed a joint statement with the IAEA on November 11, 2013, describing a "Framework for Cooperation." According to the statement, Iran and the IAEA agreed to "strengthen their cooperation and dialogue aimed at ensuring the exclusively peaceful nature of

(...continued)

Comments by the Islamic Republic of Iran on the Report of the IAEA Director General to the September 2008 Board of Governors (GOV/2008/38), September 28, 2008. INFCIRC/737. Iran also complained that the IAEA has not provided Tehran with original versions of some documentation related to the alleged "military dimensions" of Iran's nuclear program. Several reports from ElBaradei have stated that the agency has not had permission to provide this documentation from the governments which provided it. In his November 2009 report, ElBaradei again called on such governments to authorize the IAEA to share additional information with Iran.

[40] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007) and 1803 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2008/15, May 26, 2008.

[41] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2009/55, August 28, 2009.

[42] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, GOV/2011/65, November 8, 2011.

[43] A September 2012 IAEA Board of Governors resolution reiterated the board's support for the Agency's negotiations with Tehran, and stated that "Iranian cooperation with IAEA requests aimed at the resolution of all outstanding issues is essential and urgent in order to restore international confidence in the exclusively peaceful nature of Iran's nuclear programme."

Iran's nuclear programme through the resolution of all outstanding issues that have not already been resolved by the IAEA." Iran subsequently provided the IAEA with information about several of the outstanding issues. Iran later agreed in May 2014 to provide information to the IAEA by August 25, 2014, about five additional issues, including alleged Iranian research on high explosives and "studies made and/or papers published in Iran in relation to neutron transport and associated modelling and calculations and their alleged application to compressed materials." Iran subsequently provided information about four of these issues.[44]

The July 2015 JCPOA states that Tehran was to "complete" a series of steps set out in an Iran-IAEA "Roadmap for Clarification of Past and Present Outstanding Issues." According to IAEA Director-General Yukiya Amano, this road map, which the two sides concluded in July 2015, set out "a process" under the November 2013 JPA "to enable the Agency, with the cooperation of Iran, to make an assessment of issues relating to possible military dimensions to Iran's nuclear programme."[45] According to a December 2, 2015, report to the IAEA Board of Governors from Amano, "[a]ll the activities contained in the road-map were implemented in accordance with the agreed schedule."[46] The road map required Amano to present this report, which contains the agency's "final assessment on the resolution" of the aforementioned outstanding issues.

In response, the board adopted a resolution on December 15, 2015, that notes Iran's cooperation with the road map and "further notes that this closes the Board's consideration" of the "outstanding issues regarding Iran's nuclear programme."[47] Since the IAEA has verified that Iran has taken the steps required for Implementation Day to take effect, the board is no longer focused on Iran's compliance with past Security Council resolutions and past issues concerning Iran's safeguards agreement. Instead, the board is focused on monitoring and verifying Iran's JCPOA implementation "in light of" United Nations Security Council Resolution 2231, which the Council adopted on July 20, 2015. The December 2015 IAEA resolution requests the Director General to issue quarterly reports to the board regarding Iran's "implementation of its relevant commitments under the JCPOA for the full duration of those commitments." The Director General is also to report to the Board of Governors and the Security Council "at any time if the Director General has reasonable grounds to believe there is an issue of concern" regarding Tehran's compliance with its JCPOA or safeguards obligations.[48]

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[44] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2015/34, May 29, 2015.

[45] For more information about the Joint Plan of Action and the JCPOA, see CRS Report R43333, *Iran Nuclear Agreement*, by (name redacted) and (name redacted)

[46] *Final Assessment on Past and Present Outstanding Issues Regarding Iran's Nuclear Programme*, GOV/2015/68, December 2, 2015.

[47] *Joint Comprehensive Plan of Action Implementation and Verification and Monitoring in the Islamic Republic of Iran in Light of United Nations Security Council Resolution 2231 (2015*), Resolution Adopted by the Board of Governors, GOV/2015/72, December 15, 2015.

[48] The JCPOA and U.N. Security Council Resolution 2231 contain a variety of reporting provisions for the IAEA. For example, the resolution requests the agency's Director General

> to provide regular updates to the IAEA Board of Governors and, as appropriate, in parallel to the Security Council on Iran's implementation of its commitments under the JCPOA and also to report to the IAEA Board of Governors and in parallel to the Security Council at any time if the Director General has reasonable grounds to believe there is an issue of concern directly affecting fulfilment of JCPOA commitments.

Parchin

Parchin is an Iranian military site. As part of its investigation into "possible military dimensions" of Iran's nuclear program, the IAEA wanted Tehran to respond to information which the agency obtained from unnamed governments indicating that in 2000 "Iran constructed a large explosives containment vessel" at Parchin in which to conduct experiments related to the development of nuclear weapons, according to Amano's November 2011 report,[49] which did not say whether Iran actually built the vessel or conducted these experiments at Parchin. IAEA inspectors visited the site twice in 2005, but did not visit the location "believed to contain the building which houses the explosives chamber."[50] The agency requested access to this latter building in February 2012, but Iran did not provide such access until September 2015 as part of the road map described above. At that time, IAEA officials conducted and supervised verification activities, including "visual observation and environmental sampling," but they "did not observe a chamber or any associated equipment inside the building."[51] Iranian officials told their IAEA counterparts in October 2015 that the building in question "had always been used for the storage of chemical material for the production of explosives," but the "information available" to the IAEA, "does not support Iran's statements on the purpose of the building."[52] Beginning in February 2012, Iran apparently undertook efforts to remove evidence of past nuclear-related activities at the site. These efforts, which included landscaping, refurbishing buildings, demolishing buildings, and removing and replacing external wall structures, "seriously undermined the Agency's ability to conduct effective verification," according to Amano's December 2, 2015, report. For more information about the Parchin site, see **Appendix B**.

Other Issues

Iran did cooperate with the IAEA in other respects, albeit with varying consistency. The IAEA has been able to verify that Iran's declared nuclear facilities and materials have not been diverted for military purposes.[53] Moreover, Tehran has provided the agency with "information similar to that which Iran had previously provided pursuant to the Additional Protocol," ElBaradei reported to the IAEA board in February 2008, adding that this information clarified the agency's "knowledge about Iran's current declared nuclear programme."[54] Iran, however, provided this information "on an ad hoc basis and not in a consistent and complete manner," the report said. Indeed, the IAEA requested in April 2008 that Iran provide "as a transparency measure, access to additional locations related ... to the manufacturing of centrifuges, research and development (R&D) on uranium enrichment, and uranium mining."[55] Tehran provided such access pursuant to the 2013 JPA.

ElBaradei's February 2008 report underscored the importance of full Iranian cooperation with the IAEA investigation, as well as Tehran's implementation of its Additional Protocol:

[49] GOV/2011/65.

[50] *Ibid.*

[51] GOV/2015/68

[52] *Ibid.*

[53] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2012/23, May 25, 2012.

[54] GOV/2008/4.

[55] GOV/2008/15.

> Confidence in the exclusively peaceful nature of Iran's nuclear programme requires that the Agency be able to provide assurances not only regarding declared nuclear material, but, equally importantly, regarding the absence of undeclared nuclear material and activities in Iran.... Although Iran has provided some additional detailed information about its current activities on an ad hoc basis, the Agency will not be in a position to make progress towards providing credible assurances about the absence of undeclared nuclear material and activities in Iran before reaching some clarity about the nature of the alleged studies, and without implementation of the Additional Protocol.[56]

The IAEA also asked Iran to "reconsider" its March 2007 decision to stop complying with a portion of the subsidiary arrangements for its IAEA safeguards agreement.[57] That provision (called code 3.1), to which Iran agreed in February 2003, requires Tehran to provide design information for new nuclear facilities "as soon as the decision to construct, or to authorize construction, of such a facility has been taken, whichever is earlier." Previously, Iran was required to provide design information for a new facility 180 days before introducing nuclear material into it.[58] Iran invoked the March 2007 decision when it withheld from the IAEA until September 2009 "preliminary design information" for the planned Darkhovin reactor; the agency first requested the information in December 2007. Although Iran provided the agency with preliminary design information about the Darkhovin reactor in a September 22, 2009, letter, the IAEA has requested Tehran to "provide additional clarifications" of the information, according to a November 2009 report.[59] Amano reported in September 2010 that Iran had "provided only limited design information with respect to" the reactor.[60]

Tehran also refused to provide updated design information for the Arak reactor—a decision which, according to a May 2013 report from Amano, was "having an adverse impact on the Agency's ability to effectively verify the design of the facility."[61] As part of the JPA, Iran submitted this information to the IAEA on February 12, 2014.[62] Pursuant to the JCPOA, Iran has committed to redesign and rebuild the Arak reactor based on a design agreed to by the P5+1 so that it will not produce weapons-grade plutonium. Iran has rendered the reactor's original core inoperable.

Iran had also refused to allow IAEA officials to conduct an inspection of the Arak reactor in order to verify design information that Tehran provided to the agency. ElBaradei argued in a June 2009 report to the IAEA board that this continued refusal "could adversely impact the Agency's ability to carry out effective safeguards at that facility," adding that satellite imagery is insufficient

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[56] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006) and 1747(2007) in the Islamic Republic of Iran*, Report by the Director General, GOV/2008/4, February 22, 2008.

[57] According to the 2001 IAEA Safeguards Glossary, subsidiary arrangements describe the "technical and administrative procedures for specifying how the provisions laid down in a safeguards agreement are to be applied."

[58] For more detail about Iran's safeguards obligations and reporting requirements, see CRS Report R40094, *Iran's Nuclear Program: Tehran's Compliance with International Obligations*, by (name redacted)

[59] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran,* Report by the Director General, GOV/2008/59, November 19, 2008.

[60] *Implementation of the NPT Safeguards Agreement in Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2010/46, September 6, 2010. IAEA reports since 2012 do not appear to address this issue.

[61] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran, Report by the Director General*, GOV/2013/27, May 22, 2013.

[62] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2014/10, February 20, 2014.

because Iran has completed the "containment structure over the reactor building, and the roofing for the other buildings on the site."[63] However, IAEA inspectors visited the reactor facility in August 2009 to verify design information, according to ElBaradei's report issued the same month; IAEA inspectors had last visited the reactor in August 2008. Inspectors have visited the facility several more times, according to reports from Amano.

In addition, Iran failed to notify the IAEA until September 2009 that it was constructing a uranium enrichment facility, called the Fordow Fuel Enrichment Plant, near the city of Qom. Iran revealed in September 2009 that it had been constructing the facility and provided some details about it to the IAEA in a September 21, 2009, letter. Four days after the IAEA received the letter, British, French, and U.S. officials revealed that they had previously developed intelligence on the facility. The three governments provided a detailed intelligence briefing to the IAEA after the agency received Iran's letter. U.S. officials have said that, despite its letter to the agency, Iran intended for the facility to be kept secret. Tehran placed the facility under IAEA safeguards after its September 2009 letter. (For more details, see the "Fordow Enrichment Facility" section below). Pursuant to the JCPOA, Iran has begun to convert its Fordow enrichment facility into "a nuclear, physics, and technology centre" in which no nuclear material will be present.

In a letter published on October 1, 2009, the IAEA asked Iran to provide additional information about the facility, including "further information with respect to the name and location of the pilot enrichment facility, the current status of its construction and plans for the introduction of nuclear material into the facility." The letter also requested that Tehran provide IAEA inspectors with access to the facility "as soon as possible." IAEA officials inspected the facility and met with Iranian officials in late October 2009. According to a November 2009 report from ElBaradei to the IAEA board, Tehran "provided access to all areas of the facility," which "corresponded with the design information provided by Iran" a week before the visit. IAEA officials have since conducted regular inspections of the facility. Although Iran provided additional design information about the facility to the IAEA, the agency still had questions about the facility's "purpose and chronology" and wished to interview other Iranian officials and review additional documentation, according to ElBaradei's report. Amano reported in May 2012 that Iran has provided the IAEA with some requested information regarding the Fordow construction decision, but the agency still wanted more information from Tehran.[64] Tehran, according to Amano's November 2015 report, has not yet provided all of this information.[65] A May 2016 report from Amano does not address the issue.[66]

The IAEA has also requested additional information about Iran's production of heavy water. As noted, Iran is constructing a heavy-water nuclear reactor. ElBaradei's November 2009 report states that, during an inspection of Iran's uranium conversion facility the previous month, IAEA inspectors "observed 600 50-litre drums said by Iran to contain heavy water."[67] The inspectors

[63] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2009/35, June 5, 2009.

[64] GOV/2012/23.

[65] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, GOV/2015/65, Report by the Director General, November 18, 2015.

[66] *Verification and Monitoring in the Islamic Republic of Iran in Light of United Nations Security Council Resolution 2231 (2015)*, Report by the Director General, GOV/2016/23, May 27, 2016.

[67] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2009/74, November 16, 2009.

visited the facility in order to verify updated design information submitted by Iran in August 2009 and observed the drums after gaining access to an area of the facility which agency inspectors had not previously visited.[68] Tehran has told the IAEA that the water originated in Iran and has permitted agency inspectors to count the number of drums and to weigh a "small number of randomly selected drums."[69] For a time, Tehran did not permit the agency to take samples of the heavy water, but did allow such access in February 2014.[70] Similarly, Iran for some time did not grant repeated IAEA requests for "further access" to the country's heavy- water production plant since agency inspectors visited the facility in August 2011.[71] However, Iran granted such access in December 2013.[72]

The IAEA has apparently resolved a discrepancy discovered during an August 2011 inspection of an Iranian research laboratory that had been used to conduct uranium conversion experiments. IAEA measurements revealed that Iran had overstated the amount of material in the facility, described in Amano's November 2011 report as "natural uranium metal and process waste," by almost 20 kilograms.[73] Iran and the IAEA appear to have resolved the issue in 2013.[74]

Status of Iran's Nuclear Facilities

Some non-governmental experts and former U.S. officials have argued that, rather than producing fissile material for nuclear weapons indigenously, Iran could obtain such material from foreign sources.[75] A November 2007 National Intelligence Estimate (NIE) states that the intelligence community "cannot rule out that Iran has acquired from abroad—or will acquire in the future—a nuclear weapon or enough fissile material for a weapon."[76] A senior intelligence official characterized such acquisition as "an inherent option" for Iran.[77] However, Tehran's potential ability to produce its own fissile material highly is a greater cause of concern; the official explained that "getting bits and pieces of fissile material from overseas is not going to be sufficient" to produce a nuclear arsenal.[78] As noted, uranium enrichment facilities can produce highly-enriched uranium (HEU), which is one of the two types of fissile material used in nuclear weapons. The other type is plutonium, which is separated from spent nuclear reactor fuel.

[68] CRS analyst interview with a U.S. official, December 17, 2009.

[69] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2010/10, February 18, 2010.

[70] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran, Report by the Director General*, GOV/2015/15, February 19, 2015.

[71] *Ibid*.

[72] GOV/2015/65.

[73] *Ibid.*

[74] GOV/2013/27.

[75] See, for example, then-Under Secretary of State for U.S. Arms Control and International Security Robert Joseph's testimony before the Senate Committee on Foreign Relations, February 9, 2006, and then-Director of Research Institute for National Strategic Studies National Defense University Stephen Cambone's testimony before the Senate Committee on Governmental Affairs, September 21, 2000.

[76] *Iran: Nuclear Intentions and Capabilities*, National Intelligence Estimate, November 2007.

[77] "Unclassified Key Judgments of the National Intelligence Estimate: Iran: Nuclear Intentions and Capabilities," Background Briefing with Senior Intelligence Officials, December 3, 2007.

[78] *Ibid*.

According to a November 14, 2013, IAEA report, Iran had generally stopped expanding its enrichment and heavy water reactor programs during the negotiations leading up to the JPA, which the parties finalized later that month.[79] That agreement essentially froze most aspects of Iran's nuclear program to allow time to negotiate the July 2015 JCPOA. When the JPA went into effect in January 2014, Iran had enough uranium hexafluoride containing up to 5% uranium-235, which, if further enriched, would have yielded enough weapons-grade HEU for as many as eight nuclear weapons.[80] The total amount of Iranian uranium hexafluoride containing 20% uranium-235 would, if it had been further enriched, have been sufficient for a nuclear weapon. Pursuant to the JCPOA, Iran has restricted and/or dismantled various portions of its nuclear program; Iran currently lacks enough low-enriched uranium hexafluoride to produce a nuclear weapon.

Uranium Enrichment Facilities

Iran has used three centrifuge facilities to enrich uranium: a pilot centrifuge facility and a larger commercial facility, both located at Natanz, and a centrifuge facility located near the city of Qom. Iran also has a variety of facilities and workshops involved in the production of centrifuges and related components. (See **Appendix C** and CRS Report R42443, *Israel: Possible Military Strike Against Iran's Nuclear Facilities*, coordinated by (name redacted).) Iranian officials have denied that the country has undisclosed enrichment-related facilities.[81] No British, French, or U.S. officials have disclosed evidence of such Iranian facilities since Iran acknowledged the Fordow facility in 2009 (see "Fordow Enrichment Facility"). During a July 31, 2015, press briefing about possible Iranian undeclared nuclear facilities, U.S. Secretary of Energy Ernest Moniz stated that "we feel pretty confident that we know their current configuration."[82]

Natanz Commercial Facility

This facility was to have held approximately 50,000 centrifuges.[83] Former Vice President Gholamreza Aghazadeh, who also headed Iran's Atomic Energy Organization until July 2009, explained in February 2009 that Iran intended to install all of the centrifuges by 2015.[84] Iran began enriching uranium in the facility after mid-April 2007; as of November 5, 2013, the facility had produced 10,357 kilograms of low-enriched uranium hexafluoride containing up to 5%

[79] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2013/56, November 14, 2013.

[80] Colin Kahl, Deputy Assistant to the President and National Security Adviser to the Vice President, "Arms Control Association Annual Meeting: Unprecedented Challenges for Nonproliferation and Disarmament," May 14, 2015.

[81] See, for example, Press Conference with Manouchehr Mottaki, Minister for Foreign Affairs of The Islamic Republic of Iran, *Federal News Service*, October 1, 2009.

[82] See also Colin H. Kahl, "Not Time to Attack Iran: Why War Should Be a Last Resort," *Foreign Affairs*, January 17, 2012.

[83] A 2008 IAEA report states that Iran was planning to install 16 cascade units, each containing 18 164-centrifuge cascades. The total number of centrifuges would be 47,232. Iran, however, installed some cascades containing 174 centrifuges (*Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007) and 1803 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2008/15, May 26, 2008). According to September 25, 2009, Obama Administration talking points, the facility "is designed to house 54,000 centrifuges." Gholamreza Aghazadeh, who headed Iran's Atomic Energy Organization (AEOI), said in February 2009 that Iran would install 50,000 centrifuges ("Iran to Follow Nuclear Timetable Regardless of IAEA Reports – Official," *Islamic Republic of Iran News Network*, February 25, 2009). A 2012 AEOI report gives the facility's "overall capacity" as 48,000 centrifuges (*Nuclear Industry in Iran: An Overview on Iran's Activities and Achievements in Nuclear Technology*, Atomic Energy Organization of Iran, 2012, p. 16).

[84] *Islamic Republic of Iran News Network*, February 25, 2009.

uranium-235. This quantity of LEU, if it had been further enriched, would have yielded enough weapons-grade HEU for as many as eight nuclear weapons.[85] [86] As of October 31, 2015, the facility produced 15,525 kilograms of uranium hexafluoride containing up to 5% uranium-235. However, Iran only had approximately 8,305 kilograms of this material because the rest has been converted into various other chemical forms.[87]

Individual centrifuges are linked together in cascades; each cascade in the commercial facility contained either 164 or 174 centrifuges. As of May 17, 2015, Iran had installed about 15,400 first generation (IR-1) centrifuges, approximately 9,150 of which were enriching uranium. Iran had also installed about 1,000 centrifuges of greater efficiency, called IR-2m centrifuges, in the facility. The IR-2m centrifuges were not enriching uranium.[88] Amano reported in May 2016 that, pursuant to its JCPOA commitments, Iran had 5,060 IR-1 centrifuges installed in the facility and had removed all other centrifuges.[89] Iran has been producing enriched uranium hexafluoride continuing no more than 3.67% uranium-235 but also shipped out most of its LEU to Russia on December 28, 2015, to reduce its stockpile to the required levels.[90] Iran's total stockpile of this material does not exceed 300 kilograms.[91]

Natanz Pilot Facility

Iran began enriching uranium up to 20% uranium-235 in the Natanz pilot facility in February 2010. Iranian officials stated that this enriched uranium was to serve as fuel in Iran's Tehran

[85] Colin Kahl, Deputy Assistant to the President and National Security Adviser to the Vice President, "Arms Control Association Annual Meeting: Unprecedented Challenges for Nonproliferation and Disarmament," May 14, 2015.See also calculations from *Iran's Nuclear, Chemical, and Biological Capabilities: A Net Assessment,* International Institute for Strategic Studies, 2011, p.72. The latter report points out that Iran would likely need to produce more uranium-235 in order to produce its first nuclear weapon because "the fabrication of an initial bomb would involve an amount of unavoidable wastage" (p.69).

[86] This number of nuclear weapons assumes that 25 kilograms of uranium-235 (approximately 27.8 kilograms of uranium containing 90 percent uranium-235) would be necessary for one HEU-based nuclear weapon. The IAEA term for this amount of uranium is "significant quantity," defined as the "approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded." A 2011 International Institute for Strategic Studies report points out that Iran would likely need to produce more than this amount in order to produce its first nuclear weapon because "the fabrication of an initial bomb would involve an amount of unavoidable wastage" (*Nuclear, Chemical, and Biological Capabilities*, p.69). Some types of weapons could be developed using less uranium-235.

The term "significant quantity" should be understood in the context of IAEA safeguards objectives. One such objective, according to the agency, is the "timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown."

[87] GOV/2015/65. Iran's Fordow centrifuge facility also produced low-enriched uranium hexafluoride containing up to 5% uranium-235 (see "Fordow Enrichment Facility.") Additionally, Iran produced uranium hexafluoride of a similar isotopic composition by converting low-enriched uranium hexafluoride containing nearly 20% uranium-235.

[88] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, GOV/2015/34, Report by the Director General, May 29, 2015.

[89] GOV/2016/23.

[90] "Press Release on the Export of Enriched Uranium from Iran Assisted by Russia as Part of Preparation for JCPOA Implementation," Ministry of Foreign Affairs of the Russian Federation, December 29, 2015. Daily Press Briefing, Department of State, December 28, 2015." Ambassador Stephen Mull, Coordinator for Implementation of the JCPOA, told the Senate Foreign Relations Committee on December 17, 2015, that the exported material "will end up at a safeguarded facility" in Russia.

[91] GOV/2016/23.

Research Reactor (TRR), as well as future such research reactors.[92] Construction of the U.S. – supplied TRR began in 1960 and it went critical in 1967. Initially fueled by U.S.-supplied HEU, the reactor was converted to use LEU fuel in 1994 after Argentina agreed to supply the reactor with such fuel in 1987.[93] Fereydun Abbasi-Davani, then- President of the Atomic Energy Organization of Iran, stated in a 2012 interview that, once Iran had "enough" uranium enriched to this level, the country would use its enrichment facilities to produce enriched uranium containing 3.5% uranium-235.[94] Iran has also tested several types of more-advanced centrifuges in the pilot facility; these centrifuges could increase the other enrichment facilities' capacity.[95] Iran has altered this facility to comply with the JCPOA's limits on Iranian centrifuge research and development.[96]

Iran's development of new centrifuges has apparently been less successful than development of the IR-1 centrifuge;[97] past estimates from Iranian officials regarding the deployment of more-advanced centrifuges have been excessively optimistic.[98] According to a 2012 report from a U.N. Panel of Experts, the advanced centrifuge program's lack of success "may be the result of sanctions limiting" Tehran's "ability to procure items necessary for its centrifuge programme," as well as "[o]ther variables, including design and manufacturing limitations, or a shortage of other necessary materials."[99]

[92] GOV/2012/23. Iran will need to provide fuel for "at least 4 other research reactors," according to the text of a June Iranian proposal to the P5+1 ("Full Text of Iran's Proposals to Six World Powers in Moscow Talks," *Fars News Agency*, July 7, 2012). Abbasi stated in an April 2012 interview that Iran plans to design and build another 10 megawatt "strong pool reactor." He indicated that the reactor would also use fuel enriched to the level of the TRR fuel, but provided no additional details ("Nuclear Chief: Iran Sees No Reason For Suspending Fordo Activities," *Iranian Students News Agency*, April 8, 2012).

[93] This information is contained in a February 18, 2010, letter from Iran to the IAEA (GOV/INF/2010/5). An undated paper from an AEOI official places the conversion date at November 1993 (Mohammad Zaker, "Conversion and Start Up of Tehran Research Reactor with LEU Fuel," no date given. Available at http://www.iaea.org/inis/collection/NCLCollectionStore/_Public/35/044/35044382.pdf).

[94] *Iranian Students News Agency*, April 8, 2012.

[95] Iran has experimented with a variety of advanced centrifuges. A June 2009 report from ElBaradei states that Iran was testing four other more-advanced centrifuges; Iran informed the IAEA in February 2012 that it intended to install three new types of centrifuges, according to a 2012 IAEA report (*Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2012/9, February 24, 2012). Iran's IR-2m could "improve the enrichment of the Iranian centrifuges threefold," according to a 2012 Israeli intelligence report (Report 9342, Iran/Nuclear/Program Status, October 22, 2012. Available at http://www.aljazeera.com/news/2015/02/leaks-netanyahu-misled-iran-nuclear-programme-guardian-iran-nuclear-speech-2012-150218165622065.html).

[96] *Verification and Monitoring in the Islamic Republic of Iran in Light of United Nations Security Council Resolution 2231 (2015)*, Report by the Director General, GOV/INF/2016/1, January 16, 2016.

[97] Analyst interview with U.S. official, June 25, 2009; "Iran May Be 'Struggling' with New Nuclear Machines," *Reuters*, February 28, 2012.

[98] For example, then-Atomic Energy Organization President Aghazadeh indicated in February 2009 that at least one new type of centrifuge would be installed in the "near future" (*Islamic Republic of Iran News Network*, February 25, 2009). Then-Atomic Energy Organization President Ali Akbar Salehi stated in a December 2009 interview that Iran hoped to have the new types of centrifuges operational by early 2011 ("Iran to Produce New Generation of Centrifuges - Nuclear Chief," *Fars News Agency*, December 18, 2009.)

[99] *Final Report of the Panel of Experts Established Pursuant to Resolution 1929 (2010)*, June 12, 2012.

Fordow Enrichment Facility[100]

In December 2011, Iran began enriching uranium up to 20% uranium-235 in the Fordow Fuel Enrichment Plan, according to IAEA reports. As of November 1, 2013, Iran was feeding uranium hexafluoride into four cascades (696 centrifuges) of IR-1 centrifuges.[101] As of November 1, 2013, Iran had installed a total of 2,710 IR-1 centrifuges in the facility. Tehran had planned to install a total of 16 cascades containing approximately 3,000 centrifuges. Tehran told the IAEA that the facility would be configured to produce both uranium enriched to 5% uranium-235 and 20% uranium-235. Iran also told the IAEA that "the facility could be reconfigured to contain centrifuges of more advanced types should Iran take a decision to use such centrifuges in the future."[102] Iran agreed under the JCPOA to convert the facility into "a nuclear, physics, and technology centre." The facility will not contain any nuclear material. Pursuant to this commitment, Iran has decreased the number of IR-1centrifuges to 1,044 and also removed all nuclear material from the facility. In addition, Iran has modified two cascades "for the production of stable isotopes" for medical and industrial uses.[103]

As noted, Iran revealed in September 2009 that it had been constructing the facility; Tehran provided some details that month about the facility to the IAEA. The United States had been "observing and analyzing the facility for several years," according to September 25, 2009, Obama Administration talking points, which added that "there was an accumulation of evidence" earlier in 2009 that the facility was intended for enriching uranium. Some of this evidence apparently indicated that "Iran was installing the infrastructure required for centrifuges earlier" in 2009. U.S. officials have not said exactly when Iran began work on the facility, which is "located in an underground tunnel complex on the grounds of an Islamic Revolutionary Guard Corps" base near the Iranian city of Qom. Nevertheless, the Atomic Energy Organization of Iran, rather than the Iranian military, is responsible for the development and management of the facility, according to September 2009 U.S. government talking points. According to a November 2009 report from former IAEA Director-General ElBaradei, Iran informed the IAEA that construction on the site began in the second half of 2007.[104] However, the agency has information that appears to contradict Tehran's claim and has asked Iran to provide more information about the facility's chronology.[105]

U.S. officials have suggested that the facility may have been part of a nuclear weapons program. President Obama stated on September 25, 2009, that "the size and configuration of this facility is inconsistent with a peaceful program." But the Administration's talking points were somewhat more vague, stating that the facility "is too small to be viable for production of fuel for a nuclear power reactor," although it "could be used" for centrifuge research and development or

[100] Unless otherwise noted, this section is based on a September 21, 2009, letter from Iran to the IAEA and September 25, 2009, background briefings from U.S. officials, along with associated Obama Administration talking points. See also CRS Report R43333, *Iran Nuclear Agreement*.

[101] GOV/2012/23.

[102] GOV/2009/74.

[103] GOV/INF/2016/1.

[104] GOV/2009/74.

[105] Majlis speaker Ali Larijani, who was formerly Iran's lead nuclear negotiator, indicated September 27, 2009, that Iran had been constructing the facility for approximately three years. ("Iran Speaker Says Country has Fully Mastered Nuclear Technology," *Islamic Republic News Agency*, September 27, 2009).

"configured to produce weapons-grade uranium." The facility "would be capable of producing approximately one weapon's worth" of HEU per year, according to the talking points.[106]

Iran's failure to inform the IAEA of the Fordow plant's existence until well after Tehran had begun constructing it raised concerns that the country may have had other covert nuclear facilities. A November 2009 IAEA Board of Governors resolution stated that Iran's declaration of the Fordow facility "reduces the level of confidence in the absence of other nuclear facilities and gives rise to questions about whether there are any other [undeclared] nuclear facilities under construction in Iran." Furthermore, UK Foreign Office Minister Alistair Burt told Parliament in February 2012 that the Fordow facility "which Iran initially kept secret from the IAEA, also raises our concerns that there may also be other, undeclared sites in Iran that could be engaged in work" related to nuclear weapons.[107]

Tehran's shifting explanations regarding the facility's purpose also raised concerns that Iran would use it in the future to produce fissile material for nuclear weapons. Iran's 2009 letter to the IAEA described the Fordow facility as a "new pilot fuel enrichment plant" that would produce uranium enriched to no higher than 5% uranium-235. Tehran subsequently changed the plant's stated purpose several times. For example, Tehran, as noted, later told the IAEA that the facility would be configured to produce both uranium enriched to 5% uranium-235 and 20% uranium-235. Apparently suggesting that Iran might later produce uranium containing higher levels of uranium-235, a U.S. official told the IAEA Board of Governors on March 8, 2012, that "[w]e cannot help but wonder ... whether Iran has finally informed us of the ultimate purpose of this facility."[108]

For its part, Iran has asserted that the facility is for peaceful purposes and that the government has acted in accordance with its international obligations. As noted, Tehran argued that it was producing enriched uranium containing up to 20% uranium-235 for use as fuel in research reactors, which will be used to produce isotopes for medical purposes. Regarding the facility's secret nature, Iranian officials argued that Tehran was not previously obligated to disclose it to the IAEA[109] and stated on several occasions that the facility was concealed in order to protect it from military attacks.[110] Moreover, Iran told the IAEA in 2009 that the Fordow facility was to serve as a "contingency enrichment plant, so that the enrichment activities shall not be suspended in the case of any military attack."[111] The Natanz commercial facility "was among the targets threatened with military attacks," Iran explained.[112] Iranian officials also stated during a June 2012 meeting with the P5+1 that the Fordow facility is "not a military base" and is "not located on a military base."[113]

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[106] Such estimates depend on several variables, including the number and type of centrifuges used, as well as the degree to which the uranium hexafluoride feedstock is enriched. This particular estimate appears to assume the use of 3,000 IR-1 centrifuges; the other assumed parameters are unclear. For more information on the facility's potential weapons-grade HEU production capability, see *Iran's Nuclear, Chemical and Biological Capabilities: A Net Assessment*, February 2011, p.67.

[107] "Written Answers to Questions," *Daily Hansard*, February 7, 2012.

[108] "U.S. Statement to the Board of Governors on Iran," March 8, 2012.

[109] For more information, see CRS Report R40094, *Iran's Nuclear Program: Tehran's Compliance with International Obligations*, by (name redacted)

[110] See, for example, "Iranian Nuclear Negotiator Says 5+1 Talks 'Positive'," *Islamic Republic of Iran News Network*, October 1, 2009.

[111] GOV/2009/74.

[112] *Ibid.*

[113] "Full Text of Iran's Proposals to Six World Powers in Moscow Talks," *Fars News Agency*, July 7, 2012.

Enriched Uranium Containing Up To 20 Percent Uranium-235

As noted, Iran argued that it was producing LEU containing nearly 20% uranium-235 for use in research reactors; as of January 20, 2014, when the JPA went into effect, Tehran had used the Natanz pilot facility and the Fordow facility to produce a total of 447.8 kilograms of uranium hexafluoride containing up to 20% uranium-235.[114] Iran's production of uranium enriched to this level has caused concern because such production requires approximately 90% of the effort necessary to produce weapons-grade HEU, which contains about 90% uranium-235.[115] This amount of material would, if it had been further enriched, have been sufficient for a nuclear weapon. Iran would need approximately 215 kilograms of uranium hexafluoride containing 20% uranium-235 in order to produce approximately 27.8 kilograms of uranium containing 90% uranium-235—a sufficient amount of weapons-grade HEU for a nuclear weapon.[116] This is a conservative estimate; the specific characteristics of Iran's enrichment facilities may necessitate using more than 215 kilograms of such material. Director of National Intelligence James Clapper suggested during a February 16, 2012, Senate Armed Services Committee hearing that "a number of factors" could impede Tehran's ability to produce weapons-grade HEU from uranium enriched to 20% uranium-235.[117]

As of January 20, 2014, approximately 160 kilograms of the LEU described above was in the form of uranium hexafluoride and, therefore, available to be further enriched in the near term.[118] Since that date, Iran has either converted much of that material for use as fuel in the Tehran Research Reactor, or prepared it for that purpose.[119] Iran diluted the rest of that stockpile so that it contained no more than 5% uranium-235. Behrouz Kamalvandi, Spokesman for the Iranian Atomic Energy Organization, said in February 2014 that Iran had "the necessary reservoirs of fuel for 5 years for the Tehran research reactor."[120]

JCPOA Research and Development Limits

The JCPOA contains a detailed description of centrifuge Research and Development (R&D) that Iran is permitted to conduct under the agreement. Iran is to conduct centrifuge R&D with uranium only at the Natanz pilot facility and will conduct mechanical testing of centrifuges only at the

[114] GOV/2014/10.

[115] Former IAEA Deputy Director General Olli Heinonen, "Dealing with a Nuclear Iran: Redlines and Deadlines," Center for Strategic and International Studies, February 6, 2013; U.S. Secretary of Energy Ernest Moniz, Senate Committee on Armed Services, "Impacts of the Joint Comprehensive Plan of Action (JPCOA) on U.S. Interests and the Military Balance in the Middle East," July 29, 2015.

[116] This number of nuclear weapons assumes that 25 kilograms of uranium-235 (approximately 27.8 kilograms of uranium containing 90 percent uranium-235) would be necessary for one HEU-based nuclear weapon. The IAEA term for this amount of uranium is "significant quantity," defined as the "approximate amount of nuclear material for which the possibility of manufacturing a nuclear explosive device cannot be excluded." Some types of weapons could be developed using less uranium-235.

[117] "Current and Future Worldwide Threats to the National Security of the United States," Senate Armed Services Committee, February 16, 2012.

[118] GOV/2014/10. In addition to the 43 kilograms of this material which is being prepared for use as fuel, Iran has altered another 1.6 kilograms of the material, which now contains less than 5% uranium-235.

[119] This process has generated scrap which contains LEU with up to 20% uranium-235. Iran also retains .6 kilograms of uranium hexafluoride containing up to 20% uranium-235, which "had been used as reference material for mass spectrometry" (*Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council resolutions in the Islamic Republic of Iran*, Report of the Director General, International Atomic Energy Agency, GOV/2015/34, May 29, 2015).

[120] Sara Massoumi, Hamed Shafiei, "20% Enrichment Is Not Iran's Need Today," *Iranian Diplomacy*, February 8th, 2014.

pilot facility and the Tehran Research Centre. Iran has submitted an "enrichment R&D plan" in January 2016 to the IAEA as part of Tehran's initial declaration for its Additional Protocol.[121] Iranian adherence to that plan is a JCPOA requirement.

Possible Future Enrichment Facilities

Iranian officials indicated in the past that Tehran intended to construct 10 additional centrifuge plants—a goal that many analysts argued was virtually unachievable. Then-President of Iran's Atomic Energy Organization Ali Akbar Salehi stated in 2009 that Iran is investigating locations for the sites (Salehi was President of the Organization from 2009-2010. He became President again in August 2013).[122] In 2012, then-Atomic Energy Organization President Abbasi argued that "mastering" centrifuge enrichment technology would enable Iran to "develop [centrifuge] sites in various locations to avoid any threat by foreign enemies." According to the JCPOA, Iran is to enrich uranium only at the Natanz commercial facility for 15 years.[123] Expiration of the JCPOA enrichment restrictions will be "followed by gradual evolution, at a reasonable pace" of Iran's enrichment program. According to the JCPOA, Iran's centrifuge-testing program may proceed under strict limits, which begin to ease approximately eight years after the beginning of the agreement's implementation. An Atomic Energy Organization spokesperson stated in January 2016 that Iran's nuclear program "will begin to accelerate from the 13th or 14th year onwards."[124] Iran plans to increase its enrichment capacity by approximately "20-fold" by the end of the 15th year, the spokesperson added.[125]

Inconsistent Progress

A senior U.S. intelligence official said in 2007 that a country needs to be able to "operate large numbers of centrifuges for long periods of time with very small failure rates" in order to be able to "make industrial quantities of enriched uranium."[126] Iran's record indicates that the country has not always met this standard. The 2007 National Intelligence Estimate stated that Iran still faced "significant technical problems operating" its centrifuges. Although a 2008 report to Congress submitted by the Deputy Director for National Intelligence described the amount of LEU that Iran produced in 2008 as a "significant improvement" over the amount it had produced during the previous year,[127] data from an August 2015 Institute for Science and International Security report indicates that the average per-centrifuge performance at that facility peaked in 2010 and has since fluctuated.[128]

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[121] *Verification and Monitoring in the Islamic Republic of Iran in Light of United Nations Security Council Resolution 2231 (2015),* Report by the Director General, GOV/2016/8, February 26, 2016.

[122] *Fars News Agency*, December 18, 2009.

[123] After 10 years Iran may produce enriched uranium at the pilot centrifuge facility as part of R&D work.

[124] Specifically, the JCPOA states that "Iran will commence, upon start of implementation of the JCPOA," testing of Iran's IR-6 and IR- 8 centrifuges "on single centrifuge machines and its intermediate cascades and will commence the testing of up to 30 centrifuges machines from one and a half years before the end of year 10. Iran will proceed from single centrifuges to small cascades to intermediate cascades in a logical sequence."

[125] Interview with Behruz Kamalvandi, January 11, 2016.

[126] Background Briefing with Senior Intelligence Officials, December 3, 2007.

[127] *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, Covering 1 January to 31 December 2008*.

[128] David Albright, Serena Kelleher-Vergantini, Andrea Stricker, and Daniel Schnur, *ISIS Analysis of the IAEA Iran Safeguards Report*, Institute for Science and International Security, August 27, 2015. Calculating the average performance of Iran's centrifuges became more difficult after November 2010, when the IAEA stopped reporting (continued...)

The extent to which Iran's progress is sustainable is open to question. Former Pakistani nuclear official Abdul Qadeer Khan described Pakistan's first-generation centrifuges as "unsuccessful" in a 1998 interview.[129] Furthermore, Mark Fitzpatrick of the International Institute for Strategic Studies observed that "[i]t can be years before it is clear whether an enrichment programme is working well," observing that centrifuges at a Japanese enrichment facility "started to crash seven years after installation."[130] And, as noted, Iran has had difficulty in developing and deploying more-advanced centrifuges. Nevertheless, historical experience indicates that sustained operation of gas centrifuges appears to be a manageable task for governments with even modest technical capabilities.[131] According to a U.S. Nuclear Regulatory Commission document, some centrifuges of simple design "have operated 30 years with a failure rate of less than one percent."[132] (See also "Effects of Sanctions and Sabotage on Iran's Enrichment Program.")

Uranium Conversion

As noted, uranium conversion is a process whereby uranium ore concentrate is converted into several compounds, including uranium hexafluoride—the feedstock for Iran's centrifuges. Iran produced approximately 541 metric tons of uranium hexafluoride between March 2004 and August 10, 2009 using both imported uranium ore concentrate and domestically-produced uranium ore concentrate.[133] Iran has not produced any uranium hexafluoride since August 2009, according to IAEA reports. Tehran has transferred domestically-produced uranium ore concentrate to the uranium conversion facility, but the government has told the IAEA that the material will be used to produce uranium dioxide.

According to a report from the Director of National Intelligence to Congress covering 2011, "Iran has almost exhausted" its supply of imported uranium ore concentrate.[134] Tehran has apparently not imported any more such material. According to the 2012 U.N. Panel of Experts report, "a number" of governments believed that Tehran was "seeking new sources of uranium ore to supply its enrichment efforts;" the report added that "the Panel is not aware of any confirmed cases of actual transfers."[135] British Foreign and Commonwealth Office official Tobias Ellwood informed Parliament in June 2015 that the British government was "not aware of" any recent reports that Iran had attempted to purchase foreign uranium.[136] Former State Department official Richard

(...continued)

information about the Natanz commercial facility's average product enrichment level.

[129] "A Talk with A.Q. Khan: Pakistan's Top Nuclear Scientist Talks About Nuclear Weapons," *Jane's Foreign Report,* July 24, 1998.

[130] Mark Fitzpatrick, *The Iranian Nuclear Crisis: Avoiding Worst-Case Outcomes*, Adelphi Paper 398, International Institute for Strategic Studies, May 2008, p. 50.

[131] R. Scott Kemp, "The Nonproliferation Emperor Has No Clothes: The Gas Centrifuge, Supply-Side Controls, and the Future of Nuclear Proliferation," *International Security*, Spring 2014, Vol. 38, No. 4, pp. 39-78.

[132] USNRC Technical Training Center: Uranium Enrichment Processes, Module 4.0 of the Uranium Enrichment Processes Directed Self-Study Course 9/08 (Rev 3), Directed Self Study. The document appears to have been published in 2008.

[133] Based on data from GOV/2009/74. Iran imported 531 metric tons of uranium ore concentrate in 1982, according to *Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran*, Report by the Director General, GOV/2003/75, November 10, 2003.

[134] *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, Covering 1 January to 31 December 2011*.

[135] *Panel of Experts,* 2012.

[136] Iran: Nuclear Weapons: Written Question-1913. Answered by Mr Tobias Ellwood on June 15, 2015.

Nephew wrote in September 2015 that there had "not been any verified transfer of uranium to Iran aside from fuel for the Bushehr power reactor."[137] In late December 2015, Iran imported between 200 and 220 metric tons of uranium ore concentrate in exchange for LEU that Iran shipped to Russia in order to reduce its stockpile to JCPOA-required levels.[138]

Prior to 2009, Tehran apparently improved its ability to produce centrifuge feedstock of sufficient purity for light-water reactor fuel; a 2010 IAEA report indicates that Iran is purifying its centrifuge feedstock. [139] [140] The 2012 U.N. Panel of Experts report concluded that, based on data from Amano's February 2012 report, Iran had "an ample supply of uranium hexafluoride to maintain current levels of enrichment for the foreseeable future."[141] Whether Iran is currently able to produce feedstock pure enough for weapons-grade HEU is unclear, however.

Plutonium

Iran acknowledged to the IAEA in 2003 that it had conducted plutonium-separation experiments—an admission which contributed to suspicions that Iran could have a program to produce plutonium for nuclear weapons. The IAEA, however, continued to investigate the matter, and ElBaradei reported in August 2007 that the agency had resolved its questions about Iran's plutonium activities.[142] As noted above, Iran has said that it does not plan to engage in reprocessing, and IAEA Director-General Amano's November 2011 report described an "absence of any indicators that Iran is currently considering reprocessing irradiated nuclear fuel to extract plutonium."[143] Amano's November 2015 report states that the agency could "confirm that there are no ongoing reprocessing related activities" at the Iranian facilities to which the Agency has access.[144]

The JCPOA prohibits Iran from reprocessing spent reactor fuel, except to produce "radio-isotopes for medical and peaceful industrial purposes." The JCPOA text states that Iran "does not intend" to engage in reprocessing after the 15-year period expires and specifies Iran's intention to "ship out all spent fuel for all future and present nuclear power and research reactors, for further treatment or disposition as provided for in relevant contracts to be concluded consistent with national laws with the recipient party."

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[137] Richard Nephew, "How the Iran Deal Prevents a Covert Nuclear Weapons Program," *Arms Control Today*, September 2015.

[138] Interview with Behruz Kamalvandi, January 11, 2016. "Atomic Chief: Iran Completes Swap of Surplus Enriched Uranium With Russia," *Vision of the Islamic Republic of Iran Network*," December 29, 2015; Secretary of State John Kerry," Arms Control and International Security: An Update on Progress Toward Implementation Day of the JCPOA," December 28, 2015.

[139] IISS Strategic Comments, "Nuclear Iran: How Close Is It?," September 2007; Paul Kerr, "Iran Continues Security Council Defiance," *Arms Control Today*, June 2007; analyst interview with State Department official October 28, 2008.

[140] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2010/28, May 31, 2010. A footnote in the report states that some enriched uranium hexafluoride "was present in the feed purification cylinder."

[141] *Panel of Experts,* 2012..

[142] *Implementation of the NPT Safeguards Agreement in the Islamic Republic of Iran*, Report by the Director General, GOV/2007/48, August 30, 2007.

[143] GOV/2011/65.

[144] *Ibid.*

Arak Reactor

Iran says that its heavy-water reactor, which is being constructed at Arak, is intended for the production of medical isotopes and various other purposes. According to a 2008 presentation by Ambassador Soltanieh, the reactor is to substitute for the "outdated" Tehran Research Reactor (TRR), which has been in operation since 1967.[145] As noted, Iran has since decided to re-fuel the TRR. According to a 2012 report from Iran's Atomic Energy Organization, the reactor has several objectives:

- A suitable replacement for the aging Tehran Research Reactor using local engineers and scientist [sic] with the least dependency to foreign countries;
- Medical, industrial and research radioisotope production of [sic] the country;
- Performing research in the fields of neutron physics, reactor chemistry, thermal-hydraulics, and health physics;
- Obtaining technological and scientific experience in design and construction of nuclear reactors using local experts within the country;
- Training of specialists in the nuclear field; and
- Enhancing the technological levels of the local industries in design and manufacturing of various components such as reactor vessels, heat exchangers, pumps, etc. using nuclear standards.[146]

Iran told the IAEA in 2012 that the reactor was scheduled to begin operating during the second half of 2013.[147] The project was about 75% complete as of July 2011.[148] Iran suspended several aspects of the reactor's construction pursuant to the 2013 Joint Plan of Action.[149]

The originally-designed Arak reactor was a proliferation concern because its spent fuel would have contained plutonium better suited for nuclear weapons than the plutonium produced by light-water moderated reactors, such as the TRR and Bushehr reactor. The Arak reactor, if it had been completed, could have produced enough plutonium for between one and two nuclear weapons per year.[150] In addition, Iran would have been able to operate the reactor with natural uranium and, therefore, would not have been dependent on supplies of enriched uranium. The JCPOA commits Iran to redesign and rebuild the Arak reactor based on a design agreed to by the P5+1 so that the reactor will not produce weapons-grade plutonium. Tehran is "trying to complete the project in five years," an AEOI spokesperson said in January 2016.[151] Iran is to export the spent fuel from this reactor and all other nuclear reactors. The JCPOA also requires Tehran to render the Arak reactor's original core inoperable; Iran has met this requirement.[152] In addition,

[145] "Iran's Exclusively Peaceful Nuclear Programs and Activities," Briefing for NGOs, May 5, 2008.

[146] *Nuclear Industry in Iran: An Overview on Iran's Activities and Achievements in Nuclear Technology*, Atomic Energy Organization of Iran, 2012, p. 29.

[147] GOV/2012/23.

[148] *Nuclear Industry in Iran*, p.29.

[149] Iran pledged to refrain from commissioning the reactor, transferring fuel or heavy water to the reactor site, testing and producing additional reactor fuel, and installing remaining reactor components.

[150] Colin Kahl, Deputy Assistant to the President and National Security Adviser to the Vice President, "Arms Control Association Annual Meeting: Unprecedented Challenges for Nonproliferation and Disarmament," May 14, 2015.

[151] Interview with Behruz Kamalvandi, January 11, 2016.

[152] GOV/INF/2016/1.

the JCPOA requires Iran to refrain from building heavy water-moderated reactors for 15 years, and Tehran has pledged to refrain from constructing any such reactors indefinitely.

According to IAEA reports and Iranian officials, Iran began to operate its heavy-water production plant located near Arak in August 2006.[153] A May 2016 report from Amano indicates that he the plant, which is to produce heavy water for the reactor and deuterated solvents, is operating.[154] Pursuant to the JCPOA, Tehran has committed to refrain from accumulating heavy water "beyond Iran's needs;" Iran is to "sell any remaining heavy water on the international market for 15 years."

Bushehr Reactor

Iran is also beginning to operate a 1,000-megawatt nuclear power reactor located near the city of Bushehr moderated by light water. The original German contractor, which began constructing the reactor in 1975, abandoned the project following Iran's 1979 revolution. Russia agreed in 1995 to complete the reactor, but the project subsequently encountered repeated delays; both Russian and Iranian officials attributed those delays to technical issues. In February 2005, Moscow and Tehran concluded an agreement stating that Russia would supply fuel for the reactor for 10 years. Atomstroyexport sent the first shipment of LEU fuel to Iran on December 16, 2007, and the reactor received the last shipment near the end of January 2008. The fuel, which is under IAEA seal, will contain no more than 3.62% uranium-235, according to an Atomstroyexport spokesperson.[155] The fuel has since been loaded into the reactor but its operation has fluctuated, according to reports from Amano. For example, an August 2014 IAEA inspection revealed that the reactor "was operating at 100% of its nominal power"[156] and agency inspectors observed in February 2015 that the reactor "was operating at 70% of its nominal power."[157] Moreover, the reactor was "shut down for refueling" during a November 2015 inspection.[158]

Before 2002, the United States had previously urged Moscow to end the project, citing concerns that it could aid an Iranian nuclear weapons program by providing the country with access to nuclear technology and expertise.[159] However, U.S. officials said in 2002 that Washington would

[153] " 'Peaceful' " Iran Has a Transparent Nuclear Program: Ahmadinejad; Arak Heavy Water Plant Launched," *Mehr News Agency*, August 26, 2006; "Iran's Heavy Water Research Reactor Project on Track, Says Official," *Fars News Agency*, August 26, 2006. A 2005 IAEA report (GOV/2005/67) describes the plant as "currently being commissioned;" a 2007 IAEA report (GOV/2007/8) states that the plant is operational.

[154] GOV/2016/23; *Nuclear Industry in Iran*, p.27.

[155] "Atomstroyexport Completes Latest Shipment of Fuel to Bushehr Nuclear Plant," *Interfax*, December 28, 2007.

[156] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2014/43, September 5, 2014.

[157] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, Report by the Director General, GOV/2015/15, February 19, 2015.

[158] GOV/2015/65.

[159] For example, then- Deputy Assistant Secretary of Defense Marshall Billingslea testified before the Senate July 29, 2002, that the United States was "concerned that the Bushehr nuclear power project is, in reality, a pretext for the creation of an infrastructure designed to help Tehran acquire atomic weapons." Similar concerns are expressed in a 2005 State Department report (Adherence to and Compliance with Arms Control, Nonproliferation, and Disarmament Agreements and Commitments, U.S. Department of State, August 2005, p.77.) Then-Under Secretary of State for International Security and Arms Control John Bolton told the House International Relations Committee in June 2003 that Iran could build "over 80 nuclear weapons" if it had access to sufficient fuel, operated the reactor for five to six years, and chose to withdraw from the NPT. During a June 12, 2008, House Foreign Affairs Committee hearing, then-Acting Under Secretary of State for Arms Control and International Security John Rood agreed with a Department of Energy assessment that the reactor's spent fuel would contain enough plutonium for between 50 and 60 nuclear weapons. These estimates assume that Iran possesses a reprocessing facility, which the country does not possess.

drop these public objections if Russia took steps to mitigate the project's proliferation risks; the 2005 deal requires Iran to return the spent nuclear fuel to Russia.[160] This measure is designed to ensure that Tehran will not separate plutonium from the spent fuel. Moscow also argues that the reactor will not pose a proliferation risk because it will operate under IAEA safeguards. It is worth noting that light-water reactors are generally regarded as more proliferation-resistant than other types of reactors. Although the U.N. Security Council resolutions restricted the supply of nuclear-related goods to Iran, they did permit the export of nuclear equipment and fuel related to light-water reactors. Experts have expressed strong doubts regarding Iran's ability to produce fuel for the reactor.[161] According to a July 2014 Iranian government report, Russia and Iran may renew the fuel supply agreement, but are also "engaged in negotiations ... to engage in cooperative arrangements for the domestic manufacturing of fuel for the facility after the expiration of the current contract."[162]

Possible Future Reactors

Iran and Russia reached agreement in March 2014 for the construction of two additional light water nuclear power reactors in Bushehr.[163] These plants were to have been completed by March 2016, but were delayed because of unspecified disagreements with Russia, Vice President Salehi said in an April 9, 2016, interview. [164] The reactors' construction "will start once we reach a consensus with Russian experts," he added. Iran is also "negotiating with China for building two 100 megawatt power plants," Salehi stated in a July 2015 speech.[165]

Fuel Manufacturing Facilities

Iran's fuel manufacturing plant was to produce fuel for the Arak and Darkhovin reactors.[166] The plant started the process of producing fuel for the pre-JCPOA Arak reactor.[167] Iran's Fuel Plate Fabrication Plant has produced fuel for the Tehran Research Reactor.[168]

Uranium Mines

Iran has a uranium mill and a uranium mine located at a site called Bandar Abbas, which is also sometimes referred to as Gchine. Iran also has a uranium mine at a site called Saghand and an associated uranium mill called the Ardakan Yellowcake Production Plant. Iranian officials acknowledge that the country's uranium deposits are insufficient for its planned nuclear power

[160] Estimates for the length of time the spent fuel must stay in Iran to cool range from two to five years. See Paul Kerr, "Iran, Russia Reach Nuclear Agreement," *Arms Control Today*, April 2005.

[161] See, for example, Robert Einhorn, "Will Iran Play Ball in Nuke Talks?," *The National Interest*, January 14, 2015.

[162] *What Are Iran's "Practical Needs"?*, NuclearEnergy.ir, July 2014.

[163] GOV/2016/8; "Official: Iran Starts Construction of 2 More N. Power Plants in Bushehr," *FARS News Agency*, December 29, 2014.

[164] "Atomic Chief Gives TV Interview on Iran's Nuclear Activities Iran's Nuclear Chie[f]," *Vision of the Islamic Republic of Iran Network 2*, April 9, 2016.

[165] "Excerpts of the Speech Presented by H.E Dr. A.A.Salehi, President's Deputy and Head of AEOI in the Presence of Organization's Personnel," July 20, 2015. Available at http://www.aeoi.org.ir/Portal/Home/ShowPage.aspx?Object=NEWS&CategoryID=3fe2bc57-c1a6-47dc-9d1d-e1290fe3ad77&WebPartID=774bd8ac-b7a7-49d5-9dde-2197faa15e57&ID=2c12026b-06ae-4064-85c8-54c334b536e8

[166] "Aqazadeh: Iran Heralds Peaceful Nuclear Program," *Islamic Republic News Agency*, April 8, 2008.

[167] GOV/2015/65.

[168] *Ibid.*

program.[169] These reserves are sufficient, however, to produce 250-300 nuclear weapons, according to a past U.S. estimate.[170]

Effects of Sanctions and Sabotage on Iran's Enrichment Program

The international community has employed sanctions and, apparently, sabotage to impede Iran's nuclear program.

Sanctions

Iran has, in recent years, tried to improve its capabilities to produce materials and components for its centrifuge program, according to former IAEA Deputy Director General Olli Heinonen.[171] Some Iranian officials have claimed that the country can manufacture centrifuges on its own. For example, then-Iranian Ambassador to the IAEA Ali Asghar Soltanieh said in 2012 that Iran "has 'fully mastered' the nuclear energy technology and can produce all the 90 pieces of a centrifuge machine on its own and without foreign assistance."[172] However, a 2014 U.N. Panel of Experts report observed that the "quality of such [Iranian-produced] equipment is not known."[173] Furthermore, other Iranian officials have suggested that Tehran is not yet able to produce all of the necessary centrifuge components. Then- President of Iran's Atomic Energy Organization Abbasi stated during a 2012 television broadcast that "Iran could not claim that it did not need other countries" for its enrichment program, adding that "domestic production of all items was not economically viable."[174] Atomic Energy Organization of Iran Director Salehi stated in 2014 that Iran was purchasing some items for its nuclear program "from some developing and growing Eastern countries."[175] Moreover, Principal Deputy Assistant Secretary of State for International Security and Nonproliferation Vann Van Diepen said that Iran in 2014 was still attempting to "procure items" for the nuclear program.[176]

Nevertheless, according to the 2014 Panel of Experts report, several governments told the panel that, since mid-2013, there had been a "been a decrease in the number of detected [Iranian] attempts ... to procure items for prohibited programmes, and related seizures."[177] A 2015 Panel report states that the experts had not "identified cases of procurement for activities prohibited" by

[169] Installation of centrifuges continues in Natanz - Iran nuclear official," *Iranian Students News Agency*, April 17, 2007; Thomas W. Wood, Matthew D. Milazzo, Barbara A. Reichmuth, and Jeffrey Bedell, "The Economics Of Energy Independence For Iran," *Nonproliferation Review*, Vol. 14, No. 1, March 2007.

[170] Paul Kerr, "Iran Nuclear Abilities Limited," *Arms Control Today*, September 2005.

[171] Analyst interview, January 18, 2012.

[172] "Nuclear Official Stresses Iran's Domestic Capability to Produce Centrifuge Machines," *FARS News Agency*, December 3, 2012.

[173] *Final Report of the Panel of Experts Established Pursuant to Resolution 1929 (2010)*, June 11, 2014.

[174] "Nuclear Chief Says West Aware of Significance of Iran Achievements," *Vision of the Islamic Republic of Iran Network 2*, February 15, 2012.

[175] "Some in East Colluding with West in Iran Nuclear Sabotage: AEOI," *Press TV*, August 25, 2014.

[176] William Maclean, "Iran Pursuing Banned Items for Nuclear, Missile Work: U.S. Official," *Reuters*, March 16, 2014.

[177] *Panel of Experts*, 2014.

Security Council resolutions in force at the time.[178] No governments reported any such cases, the report adds.

According to various sources, international sanctions have made it difficult for Iran to obtain components and materials for its centrifuge program. For example, the UN Panel of Experts 2011 report stated that "sanctions are constraining Iran's procurement of items related to prohibited nuclear and ballistic missile activity and thus slowing development of these programmes."[179] Similarly, the 2012 U.N. Panel of Experts report observed that "[s]anctions are slowing the procurement by the Islamic Republic of Iran of some critical items required for its prohibited nuclear programme."[180]A June 2013 Panel report suggested that this condition still existed, arguing that "Iran's reliance on procurement abroad continues to provide the international community with opportunities to limit Iran's ability to maintain and expand certain activities."[181] Then-UK Foreign Secretary William Hague wrote in 2013 that "[w]e judge that sanctions have been effective in slowing the nuclear programme to some degree."[182]

U.S. officials have also argued that the sanctions have impeded Iran's ability to acquire technology for its nuclear programs. Then-State Department Special Advisor for Nonproliferation and Arms Control Robert Einhorn told a Washington audience in 2011 that "[w]e believe Iran has had difficulty in acquiring some key technologies and we judge this has had an effect of slowing some of its programs."[183] Similarly, then-National Security Adviser Tom Donilon argued in 2011 that "[s]anctions and export control efforts have made it more difficult and costly for Iran to acquire key materials and equipment for its enrichment program, including items that Iran can't produce itself."[184]

However, the extent to which sanctions have slowed Tehran's program is unclear. Donilon also cited "mistakes and difficulties in Iran," as obstacles to the program's progress. Former IAEA Deputy Director General Heinonen stated that "[w]e do not know" whether Iran's delays in deploying advanced centrifuges are attributable to "lack of raw materials or design problems," according to a 2012 press report.[185] Furthermore, reports from the Office of the Director of National Intelligence covering 2009, 2010, and 2011 stated that "some obstacles slowed" the progress of Iran's nuclear program during those years, but the report did not name those obstacles.[186]

[178] *Final Report of the Panel of Experts Established Pursuant to Resolution 1929 (2010)*, June 2, 2015.

[179] *Panel of Experts Established Pursuant to Resolution 1929 (2010): Final Report*, June 2011.

[180] *Panel of Experts*, 2012.

[181] *Final report of the Panel of Experts Established Pursuant to Resolution 1929 (2010)*, June 5, 2013.

[182] Letter to Richard M. Ottaway MP, May 14, 2013.

[183] Robert J. Einhorn, "The Impact of Sanctions on Iran's Nuclear Program," Arms Control Association, March 9, 2011.

[184] Tom Donilon, "Iran and International Pressure: an Assessment Of Multilateral Effort to Impede Iran's Nuclear Program," The Brookings Institution, November 22, 2011.

[185] "Iran May Be 'Struggling' with New Nuclear Machines," *Reuters*, February 28, 2012.

[186] *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, Covering 1 January to 31 December 2009; Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, Covering 1 January to 31 December 2010; Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, Covering 1 January to 31 December 2011*.

Sabotage

There have been allegations of efforts by the United States and other governments, including Israel's, to sabotage Iran's centrifuge program, but the extent to which any of these efforts have affected Tehran's nuclear program is unclear. The *New York Times* reported in 2009 that such efforts have included "undermin[ing] electrical systems, computer systems and other networks on which Iran relies," according to unnamed senior U.S. and foreign government officials.[187] One effort involved foreign intelligence services sabotaging "individual power units that Iran bought in Turkey" for Tehran's centrifuge program. "A number of centrifuges blew up," according to the *Times*.[188] Western governments have reportedly made other efforts to sabotage centrifuge components destined for Iran, according to some non-governmental experts.[189] Iranian officials have asserted that Western countries have tampered with components in transit to Iran's enrichment facilities, directly sabotaged those facilities, and conducted espionage in the country.[190] Additionally, *New York Times* reporter James Risen wrote in 2006 that, according to unnamed U.S. officials, the United States engaged in a covert operation to provide Iran with flawed blueprints for a device designed to trigger a nuclear explosion.[191]

The United States and Israel have reportedly executed cyber attacks on Iran's nuclear facilities. Perhaps the best known of these utilized the Stuxnet computer worm, which was discovered in 2010 and probably developed by a government to attack Iran's enrichment facilities.[192] Some governments have reportedly assassinated Iranians associated with Iran's nuclear program.[193] The United States also may have obtained information from Iranian officials who defected as part of a CIA program to induce them to do so.[194]

[187] David E. Sanger, "U.S. Rejected Aid for Israeli Raid on Nuclear Site," *New York Times*, January 11, 2009.

[188] David E. Sanger and William J. Broad, "U.S. Sees an Opportunity to Press Iran on Nuclear Fuel," *New York Times*, January 3, 2010. Iranian officials alluded to this incident, according to a January 2007 Iranian press report (*Ayande-ye Now*, January 6, 2007).

[189] James Blitz, Roula Khalaf, and Daniel Dombey, "Suggestions of Iran Nuclear Sabotage," *Financial Times*, July 22, 2010.

[190] "Iran Atomic Energy Officials Discuss 'Thwarted' Nuclear 'Sabotage' Attempts," *Tehran Hamshahri Online*, September 6, 2014.

[191] James Risen, *State of War: The Secret History of the CIA and the Bush Administration* (New York: Free Press), 2006.

[192] David Albright, Paul Brannan, Andrea Stricker, Christina Walrond, and Houston Wood, *Preventing Iran From Getting Nuclear Weapons: Constraining Its Future Nuclear Options*, Institute for Science and International Security, March 5, 2012; R Scott Kemp, "Worm Holes - Virus Attacks Iran's Enrichment Operation," *Jane's Intelligence Review*, September 15, 2011; David E. Sanger, "Obama Order Sped Up Wave of Cyberattacks Against Iran," *New York Times*, June 1, 2012; Ellen Nakashima, Greg Miller, Julie Tate, "U.S. and Israel Created 'Flame'," *Washington Post*, June 20, 2012. For more information about Stuxnet, see CRS Report R41524, *The Stuxnet Computer Worm: Harbinger of an Emerging Warfare Capability*, by (name redacted), (name redacted), and (name redacted) . See also, Geoff McDonald, Liam O. Murchu, Stephen Doherty, Eric Chien, *Stuxnet 0.5: The Missing Link*, Symantec Security Response, February 26, 2013; and Ralph Langner, *To Kill a Centrifuge: A Technical Analysis of What Stuxnet's Creators Tried to Achieve*, The Langner Group, November 2013.

[193] See, for example, Ulrike Putz, "Sabotaging Iran's Nuclear Program," *Der Spiegel*, August 2, 2011; Artin Afkhami, "Tehran Abuzz as Book Says Israel Killed 5 Scientists," *New York Times*, July 11, 2012.

[194] Greg Miller, "CIA Has Recruited Iranians to Defect; The Secret Effort Aims to Undermine Tehran's Nuclear Program," *Los Angeles Times*, December 9, 2007.

Nuclear Weapon Development Capabilities

Statements from the U.S. intelligence community indicate that Iran has the technical capability to produce nuclear weapons. For example, the 2007 NIE assessed that "Iran has the scientific, technical and industrial capacity eventually to produce nuclear weapons if it decides to do so."[195] More recently, Director of National Intelligence Clapper stated during a February 2016 Senate Armed Services Committee hearing that Iran "does not face any insurmountable technical barriers to producing a nuclear weapon."[196]

Obtaining fissile material is widely regarded as the most difficult task in building nuclear weapons. As noted, Iran is enriching uranium, but whether and to what extent Tehran has taken the other steps necessary for producing a nuclear weapon is unclear. A 2008 report from former IAEA Director-General ElBaradei points out that the IAEA, with the exception of a document related to uranium metal, has "no information ... on the actual design or manufacture by Iran" of components, nuclear or otherwise, for nuclear weapons.[197] However, according to IAEA Director-General Amano's November 2011 report, the IAEA has "credible" information that Iran has carried out activities "relevant to the development of a nuclear explosive device."[198] These include acquisition of "nuclear weapons development information and documentation" and work to develop "an indigenous design of a nuclear weapon including the testing of components." Although some of these activities have civilian applications, "others are specific to nuclear weapons," the report notes.[199] Most of the report provides additional details about Iranian activities applicable to nuclear weapons development that were described in previous IAEA reports, although it does contain some previously unreported material.[200] A 2012 Department of Defense report described Amano's report as containing "extensive evidence of past and possibly ongoing Iranian nuclear weapons-related research and development work."[201] (See **Appendix B** for more details about the IAEA's information regarding suspected military aspects of Iran's nuclear program.)

Amano's November 2011 report states that, according to information available to the IAEA, Iranian activities related to building a nuclear explosive device "took place under a structured programme" prior to the end of 2003. That program, however, "was stopped rather abruptly pursuant to a 'halt order' instruction issued in late 2003 by senior Iranian officials," the report says. The weapons-related activities were consolidated under the "AMAD Plan" and "appear to have been conducted during 2002 and 2003." Nevertheless, "[t]here are also indications that some activities relevant to the development of a nuclear explosive device continued after 2003, and that

[195] *Iran: Nuclear Intentions and Capabilities*, November 2007.

[196] *Statement for the Record Worldwide Threat Assessment of the US Intelligence Community*, Senate Armed Services Committee, February 9, 2016.

[197] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007),1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2008/59, November 19, 2008.

[198] GOV/2011/65.

[199] An annex to the report details these activities and provides a detailed explanation of the suspected weapons program's organizational structure.

[200] For example, the IAEA had previously reported documentation of an undisclosed Iranian uranium conversion project and an undisclosed missile re-entry vehicle program. However, the November report describes documents obtained by the IAEA after May 2008 which "established a connection" between the two programs. Similarly, the annex also describes information provided by an unnamed government which contains additional details about Iranian experiments with high explosives.

[201] Department of Defense, *Annual Report on Military Power of Iran*, April 2012.

some may still be ongoing," according to the report. According to an August 2014 State Department announcement, Iran established the Organization of Defensive Innovation and Research (SPND), which "is primarily responsible for research in the field of nuclear weapons development," in 2011. The SPND "took over some of the activities related to Iran's undeclared nuclear program," the announcement said.[202] According to a 2012 Israeli intelligence report, the SPND

> was established for the purposes of preserving the technological ability and the joint organizational framework of Iranian scientists in the area of R&D of nuclear weapons, and for the purposes of retaining the skills of the scientists. This is [to] allow renewal of the activity necessary to produce weapon immediately when the Iranian leadership decides to do so.[203]

The report also indicates that Iran had not restarted the nuclear weapons program.

Amano's December 2, 2015, report assesses that Iran conducted "a range of activities relevant to the development of a nuclear explosive device ... prior to the end of 2003 as a coordinated effort," the report says, adding that "some [nuclear weapons-related] activities took place after 2003," but "were not part of a coordinated effort." The report concludes that "these activities did not advance beyond feasibility and scientific studies, and the acquisition of certain relevant technical competencies and capabilities." The IAEA "has no credible indications of activities in Iran relevant to the development of a nuclear explosive device after 2009,"the report explains.[204]

According to some non-governmental organization reports, the IAEA has assessed that Iran "has sufficient information to be able to design and produce a workable implosion nuclear device based upon HEU as the fission fuel."[205] However, these reports cite information from an internal 2009 IAEA document which ElBaradei has described as

> a rolling text complied by the Agency's Department of Safeguards that included all the various pieces of information that had come in from different intelligence organizations, most of which IAEA inspectors had been unable to verify or authenticate ... by definition, it was a series of best guesses.[206]

The IAEA Deputy Director General for Safeguards at the time had neither "assessed" nor "signed off on" the document, ElBaradei added.

For its part, the U.S. government assesses that Iran has not mastered "all the necessary technologies" for building a nuclear weapon, a senior Administration official stated during a November 8, 2011, briefing about Amano's November 2011 report.[207] During the same briefing, a senior Administration official explained that "the fact that some activities have apparently continued after the full-scale program was shut down in 2003 suggests that there's been some advancement" in Iran's ability to develop nuclear weapons, but "since it appears to be relatively

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[202] "Additional Sanctions Imposed by the Department of State Targeting Iranian Proliferators," August 29, 2014. Amano's November 2011 report also mentioned the SPND.

[203] Report 9342, Iran/Nuclear/Program Status, October 22, 2012.

[204] GOV/2015/68.

[205] *Excerpts from Internal IAEA Document on Alleged Iranian Nuclear Weaponization*, Institute for Science and International Security, October 2, 2009. Colin H. Kahl, Melissa G. Dalton, and Matthew Irvine, *Risk and Rivalry Iran, Israel and the Bomb*, Center for a New American Security, June 2012.

[206] Mohamed ElBaradei, *The Age of Deception: Nuclear Diplomacy in Treacherous Times*, (New York, Metropolitan Books, Henry Holt and Company), 2011, pp. 290.

[207] "Press Briefing by Senior Administration Officials on IAEA Report on Iran's Nuclear Activities," November 8, 2011.

uncoordinated and sporadic activity ... the advancement probably hasn't been that dramatic." Perhaps reinforcing this point, Director Clapper stated during the February 2012 Senate Armed Services Committee hearing that "there are certain things" that Iran has not yet done to develop a nuclear weapon, but he did not elaborate. Ambassador Stephen D. Mull, Coordinator for Implementation of the JCPOA, told a Washington audience on January 21, 2016, that "there was a portion of the Iranian Government working in a very organized, systematic way to develop the capability to build a nuclear weapon. We don't know to the extent to which that knowledge has been tested or even survived."[208]

Amano's November 2011 report states that, according to a member of a "clandestine nuclear supply network" run by former Pakistani nuclear official Abdul Qadeer Khan, Iran "had been provided with nuclear explosive design information." However, this information may not be sufficient to produce a nuclear weapon. Although Khan's network supplied Libya with "documents related to the design and fabrication of a nuclear explosive device," according to the IAEA,[209] these documents lacked "important parts" for making a nuclear weapon, according to ElBaradei.[210] In addition to the documents supplied to Tripoli, members of the Khan network also had computer files containing "drawings for the components of two smaller, more advanced nuclear weapons."[211] However, according to former IAEA Deputy Director-General Olli Heinonen, these "detailed designs" were not "complete sets" of weapons design information. Other members of the network could have possessed more complete nuclear weapons designs, he said.[212]

Timelines

A senior intelligence official explained during a December 2007 press briefing that the "acquisition of fissile material ... remains the governing element in any timelines" regarding Iran's production of a "nuclear device."[213] The 2007 NIE argued that "centrifuge enrichment is how Iran probably could first produce enough fissile material for a weapon" and added that "the earliest possible date Iran would be technically capable of producing enough HEU for a weapon is late 2009."[214] However, it was "very unlikely" that Iran would attain such a capability by that date, the estimate says, adding that "Iran probably would be technically capable of producing

[208] "Implementation of the Joint Comprehensive Plan of Action," Washington Foreign Press Center, January 21, 2016.

[209] *Implementation of the NPT Safeguards Agreement in the Socialist People's Libyan Arab Jamahiriya*, GOV/2008/39, September 12, 2008.

[210] Mohamed ElBaradei, *The Age of Deception*, p.155. The International Institute for Strategic Studies described the design as "95% complete" (*Nuclear Black Markets: Pakistan, A.Q. Khan and the Rise of Proliferation Networks*, (London: The International Institute for Strategic Studies), 2007, p. 79). Khan told a former member of his network that the plans that he had provided to Libya were "for a non-working nuclear device" (Extract from the Statement of Sayed Abu Tahir Bin Bukhary, June 7, 2006, *Annexure L in Plea and Sentence Agreement, State vs. Geiges, Wisser, and Krisch Engineering*, September 2007). A report from Pakistan's Inter-Services Intelligence organization published in September 2011 argued that neither the technical assistance nor centrifuge components provided by the Khan network were sufficient "for the establishment of a small pilot [centrifuge] plant or to produce nuclear weapons." ("The A.Q. Khan Report by Pakistan ISI," September 15, 2011.)

[211] David Albright, *Peddling Peril: How the Secret Nuclear Trade Arms America's Enemies*, The Institute for Science and International Security, 2010. p.151.

[212] Interview with CRS analyst, August 4, 2011.

[213] "Unclassified Key Judgments of the National Intelligence Estimate: Iran: Nuclear Intentions and Capabilities," Background Briefing with Senior Intelligence Officials, December 3, 2007.

[214] This time frame describes the point at which Iran could have enough HEU for a weapon, rather than when Iran could start producing HEU.

enough HEU for a weapon sometime during the 2010-2015 time frame." But the State Department Bureau for Intelligence and Research, the estimate says, judged that Tehran "is unlikely to achieve this capability before 2013"[215] and all intelligence agencies recognized "the possibility that this capability may not be attained until *after* 2015."[216]

27.8 kilograms of uranium containing 90% uranium-235 is a frequently-cited benchmark for determining the minimum sufficient amount of weapons-grade HEU for a nuclear weapon, but the amount assumed by U.S. government estimates is unclear. Tehran would likely need to produce more uranium-235 in order to produce its first nuclear weapon; according to a 2011 International Institute for Strategic Studies report, "the fabrication of an initial bomb would involve an amount of unavoidable wastage." Then-Deputy Assistant Secretary of Defense Colin Kahl explained during a November 15, 2011, hearing that "the time to actually complete a testable [Iranian nuclear] device could shrink over time."

Then-Secretary of Defense Leon Panetta told *60 Minutes* in 2012 that, if Iran were to decide to build a nuclear weapon, "it would probably take them about a year to be able to produce a bomb and then possibly another one to two years in order to put it on a deliverable vehicle of some sort in order to deliver that weapon."[217] Although, as noted, the United States estimates that Iran's Fordow enrichment facility "would be capable of producing approximately one weapon's worth" of HEU per year, whether and how that assessment factors into the U.S. timelines for Iranian nuclear weapons development is unclear.[218] Then-Under Secretary of State for Political Affairs Wendy Sherman explained during an October 3, 2013, Senate Foreign Relations Committee hearing that Iran would need as much as one year to produce a nuclear weapon if the government made the decision to do so.[219] At the time, Tehran would have needed two to three months to produce enough weapons-grade HEU for a nuclear weapon.[220] Iran's December 28, 2015, shipment of LEU to Russia lengthened this time to one year, according to February 9, 2016, Congressional testimony from Director of National Intelligence Clapper.[221]

Declared Versus Undeclared Nuclear Facilities

The U.S. estimates described above apparently assume that Iran would use its declared nuclear facilities to produce fissile material for a weapon. However, the 2007 NIE states that Iran "probably would use covert facilities—rather than its declared nuclear sites—for the production of highly enriched uranium for a weapon." Similarly, a CIA report covering 2004 concluded that "inspections and safeguards will most likely prevent Tehran from using facilities declared to the

[215] In responses to Questions for the Record from the Senate Select Committee on Intelligence, which were made public in August 2009, the Director for National Intelligence stated that the Bureau continues to stand by this estimate.

[216] The time frame described in the 2007 NIE is the same as one described in a 2005 NIE.

[217] Transcript of remarks by Secretary Panetta from CBS's *60 Minutes* interview, January 29, 2012.

[218] See "Fordow Enrichment Facility" section.

[219] This estimate assumes the necessary time to produce a sufficient amount of weapons-grade HEU and complete the remaining steps necessary for an implosion-style nuclear explosive device suitable for explosive testing (conversation with U.S. official, July 21, 2015); "Reversing Iran's Nuclear Program," Senate Foreign Relations Committee, October 3, 2013.

[220] The White House. "Parameters for a Joint Comprehensive Plan of Action Regarding the Islamic Republic of Iran's Nuclear Program." April 2, 2015.

[221] *Statement for the Record Worldwide Threat Assessment of the US Intelligence Community*, Senate Armed Services Committee, February 9, 2016.

IAEA directly for its weapons program as long as Iran remains a party to the NPT."[222] Director Clapper echoed this assessment in a March 2015 interview.[223]

Iran would probably prefer to avoid using its safeguarded facilities partly because the IAEA would likely detect an Iranian attempt to use them for producing weapons-grade HEU. According to former Deputy Assistant Secretary Kahl, Tehran "is unlikely to dash for a bomb in the near future because IAEA inspectors would probably detect Iranian efforts to divert low-enriched uranium and enrich it to weapons-grade level at declared facilities."[224] Similarly, then-Deputy Assistant Secretary of Defense for Media Operations John Kirby told reporters on December 21, 2011, that, were Iran to begin producing a nuclear weapon, IAEA inspectors would likely give sufficient warning for the United States to take action. Former IAEA Deputy Director-General Olli Heinonen observed in 2010 that Iran would probably be caught if it attempted to divert more than "small quantities" of nuclear material from its safeguarded nuclear facilities.[225] It would be extremely difficult to reconfigure the cascades in the Natanz facility without detection[226] and, in any case, IAEA inspectors measure the isotopic content of enriched uranium and would thereby detect Iranian production of weapons-grade HEU. More recently, Clapper testified that the JCPOA

> has also enhanced the transparency of Iran's nuclear activities ... [a]s a result, the international community is well postured to quickly detect changes to Iran's declared nuclear facilities designed to shorten the time Iran would need to produce fissile material.[227]

Although Iran could eject IAEA inspectors and/or withdraw from the NPT, such a move would be "an incredibly provocative action and very risky for Iran to undertake," then-Department of State Special Advisor Einhorn argued in 2011, adding that Iran is unlikely to take such a risk because its operating first-generation centrifuges are inefficient.[228] Such an action would also be virtually unprecedented.[229]

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[222] *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions*, January 1-December 31, 2004.

[223] PBS "Charlie Rose" Interview with James Clapper, Director of National Security, March 3, 2015.

[224] Colin Kahl, "Before Attacking Iran, Israel Should Learn From Its 1981 Strike On Iraq," *The Washington Post*, March 2, 2012.

[225] Heinonen described "small quantities" as "one gram or a hundred grams"—far less than the amount necessary for a nuclear weapon. Arms Control Association, "The Status of Iran's Nuclear and Missile Programs," Transcript, November 22, 2010. The Verification Research, Training, and Information Centre assessed in 2009 that "any diversion of more than 48 grams of low enriched uranium would raise the alarm and trigger an in-depth [IAEA] investigation" (Andreas Persbo, *Safeguards in Iran: Prospects and Challenges*, presentation given to "Prospects for Dialogue in the Middle East," British Pugwash, April 30, 2009). See also "Senior Administration Official Holds A Background Briefing Previewing Iran P5+1 Talks," November 6, 2013; and Colin H. Kahl, "Not Time to Attack Iran: Why War Should Be a Last Resort," *Foreign Affairs*, January 17, 2012. Then- IAEA Deputy Director General for Safeguards Herman Nackaerts stated in July 2013 that the IAEA "would know within a week," if Iran were to use its safeguarded facilities to produce weapons-grade HEU (Barbara Slavin, "Tight IAEA Inspection Regime Hampers Iran's Nuclear Breakout," *Al-Monitor*, July 22, 2013).

[226] For more details about cascade configuration, see Houston G. Wood, Alexander Glaser, and R. Scott Kemp, "The Gas Centrifuge and Nuclear Weapons Proliferation," *Physics Today*, September 2008; International Institute for Strategic Studies, *Iran's Strategic Weapons Programmes: A Net Assessment*, (UK: Routledge, 2005), pp. 53-54.

[227] *Statement for the Record Worldwide Threat Assessment of the US Intelligence Community*, February 9, 2016.

[228] Einhorn, March 9, 2011.

[229] No state that has been found in good standing with the IAEA has ever used this tactic. North Korea restarted its nuclear weapons program, which includes previously-monitored facilities, after announcing its withdrawal from the NPT in 2003, but the IAEA has never completed an assessment of that country's nuclear activities.

A senior intelligence official explained in December 2007[230] that Iran could use knowledge gained from its Natanz facilities at covert enrichment facilities; according to the NIE, a "growing amount of intelligence indicates Iran was engaged in covert uranium conversion and uranium enrichment activity," but Tehran probably stopped those efforts in 2003. U.S. officials have argued that Iran currently does not appear to have any nuclear facilities of which the United States is unaware. CIA Director John Brennan stated during a March 2015 interview that the United States has "a good understanding of what the Iranian nuclear program entails."[231] During a July 31, 2015, press briefing about possible Iranian undeclared nuclear facilities, U.S. Secretary of Energy Ernest Moniz stated that "we feel pretty confident that we know their current configuration." U.S. officials have expressed confidence in the ability of U.S. intelligence to detect Iranian covert nuclear facilities.[232]

Does Iran Have a Nuclear Weapons Program?

In addition to the possible nuclear weapons-related activities discussed above, Iran has continued to develop ballistic missiles, which could potentially be used to deliver nuclear weapons. It is worth noting, however, that then-Director of National Intelligence Dennis Blair indicated during a 2009 Senate Armed Services Committee hearing that Iran's missile developments do not necessarily indicate that the government is also pursuing nuclear weapons, explaining that "I don't think those missile developments ... prejudice the nuclear weapons decision one way or another. I believe those are separate decisions."[233] Iran is developing missiles and space launch vehicles "for multiple purposes," he added. Similarly, in a June 2015 statement to Parliament, British Foreign and Commonwealth Office official Tobias Ellwood stated that "we are not aware of any current links between Iran's ballistic missile programme and nuclear programme."[234]

In any case, Tehran's nuclear program raised concerns for various other reasons. First, Iran was secretive about the program. For example, Tehran hindered the IAEA investigation by failing to disclose numerous nuclear activities, destroying evidence, and making false statements to the agency.[235] Moreover, although Iran's cooperation with the agency improved, the IAEA still repeatedly criticized Tehran for failing to cooperate fully with the agency's investigation of certain issues concerning Iran's nuclear program.[236]

Second, many observers have questioned Iran's need for nuclear power, given the country's extensive oil and gas reserves. The fact that Tehran resumed its nuclear program during its 1980-88 war with Iraq has also cast doubt on the energy rationale. Furthermore, many countries with

[230] Background Briefing with Senior Intelligence Officials, December 3, 2007.

[231] "Exclusive: CIA Director John Brennan Provides Insight into Agency Overhaul to Face Modern Threats," *Fox News Sunday*, March 22, 2015.

[232] "Exclusive: CIA Director John Brennan Provides Insight into Agency Overhaul to Face Modern Threats," Fox News Sunday, March 22, 2015. Conversation with U.S. official, October 25, 2013. Tom Donilon, Former National Security Adviser, "Iran and International Pressure: An Assessment of Multilateral Effort to Impede Iran's Nuclear Program," The Brookings Institution, November 22, 2011.

[233] "The Current and Future Worldwide Threats to the National Security of the United States," Senate Armed Services Committee Hearing, March 10, 2009.

[234] Iran: Nuclear Weapons: Written Question-1860. Answered by Mr. Tobias Ellwood on June 16, 2015.

[235] For example, Iran sanitized a facility where Iranian scientists had enriched uranium, falsely told the IAEA that it had not enriched uranium, and falsely claimed that it had not procured any foreign components for one of its centrifuge programs.

[236] As noted, the IAEA has concluded its investigation of the outstanding issues concerning Iran's nuclear program.

nuclear power reactors purchase nuclear fuel from foreign suppliers – indeed, Russia has provided fuel for the Bushehr reactor—a fact that calls into question Iran's need for an indigenous enrichment capability. Moreover, Iranian officials acknowledge that Iran lacks sufficient uranium deposits for its planned nuclear power program.[237]

Iran's stated rationale for its Arak reactor has also been met with some skepticism. Tehran says it needs the reactor to produce medical isotopes and to replace the Tehran Research Reactor (TRR). However, that reactor is capable of producing such isotopes and has unused capacity. Furthermore, as noted, Iran expressed the desire to obtain more fuel for the TRR. In addition, non-proliferation experts have argued that a new heavy-water reactor would be unnecessary for producing such isotopes.[238]

However, Iran maintains that its nuclear program has always been exclusively for peaceful purposes; as noted, the Iranian government says that it plans to expand its reliance on nuclear power in order to generate electricity. Some experts have documented Tehran's projected difficulty in exporting oil and natural gas without additional foreign investment in its energy infrastructure.[239] Iran has explained its covert nuclear procurement efforts by arguing that it has been forced to conceal these efforts in order to counter Western efforts to deny it nuclear technology—a claim that appears to be supported by a 1997 CIA report.[240]

Tehran argues that it cannot depend on foreign suppliers for such fuel because such suppliers have been unreliable in the past.[241] At least one expert has described Iran's inability to obtain nuclear fuel from an international enrichment consortium called Eurodif; during the 1970s, Iran had reached an agreement with Eurodif that entitled Iran to enriched uranium from the consortium in exchange for a loan.[242] Former Atomic Energy Organization President Aghazadeh has also argued that, although Iran does not need to produce fuel for the Bushehr reactor, the Natanz facility needed to be completed to provide fuel for the planned Darkhovin reactor.[243]

Other factors also suggest that Iran may not have an active nuclear weapons program. First, as noted, the IAEA has resolved the outstanding issues described in the August 2007 Iran-IAEA work plan. The agency has not discovered significant undeclared Iranian nuclear activities for a number of years. Second, Tehran, beginning in 2003, has been willing to disclose previously

[237] *Iranian Students News Agency*, April 17, 2007. Wood, et al, *Nonproliferation Review*, March 2007.

[238] Robert J. Einhorn, "Iran's Heavy-Water Reactor: A Plutonium Bomb Factory," November 9, 2006, available at http://www.armscontrol.org/pressroom/2006/20061109_Einhorn.asp?print.

[239] See, for example, *U.S.-Iranian Engagement: The View from Tehran*, International Crisis Group, June 2, 2009; Roger Stern, "The Iranian Petroleum Crisis and United States National Security," *Proceedings of the National Academy of Sciences of America*, January 2007; and George Perkovich and Silvia Manzanero, "Plan B: Using Sanctions to End Iran's Nuclear Program," *Arms Control Today*, May 2004. A 1975 U.S. government report stated that "Iran has decided now to introduce nuclear power to prepare against the time – about 15 years in the future – when Iranian oil production is expected to begin to decline sharply." ("Report of the NSSM 219 Working Group Nuclear Cooperation Agreement with Iran," April 1975).

[240] CIA, *Report of Proliferation-Related Acquisition in 1997*. The report says that Iran had responded to "Western counterproliferation efforts by relying more on legitimate commercial firms as procurement fronts and by developing more convoluted procurement networks."

[241] For an official Iranian perspective on the issue, see *The Root Cause of Iran's Confidence Deficit vis a vis Some Western Countries on Assurances of Nuclear Fuel Supply*, INFCIRC/785, March 2, 2010. Iranian officials argued for an independent fuel production capability during the 1970s; see U.S. Embassy Tehran Airgram A-76 to State Department, 1976.

[242] Oliver Meier, "Iran and Foreign Enrichment: A Troubled Model," *Arms Control Today*, January/February 2006.

[243] "Iran to Follow Nuclear Timetable Regardless of IAEA Reports – Official," *Islamic Republic of Iran News Network*, February 25, 2009.

undeclared nuclear activities to the IAEA. Third, Iran made important changes to the administration of its nuclear program in the second half of 2003—changes that produced greater openness with the IAEA and may have indicated a decision to stop a nuclear weapons program.[244]

Fourth, as noted above, Iranian officials have stated numerous times that Tehran is not seeking nuclear weapons, partly for religious reasons—indeed, Khamenei has issued a fatwa declaring that "the production, stockpiling, and use of nuclear weapons are forbidden under Islam," according to Iranian officials.[245] A change in this stance could damage Iranian religious leaders' credibility. In 2013, an Iranian Foreign Ministry spokesperson described the fatwa as the "operational instruction" for Iran's government.[246] Mark Fitzpatrick of the International Institute for Strategic Studies has argued that "given the pervasive religiosity of the regime, it is unlikely that Iran's supreme leader would be secretly endorsing military activity in explicit contradiction of his own religious edict."[247]

Fifth, Iranian officials have made several arguments that nuclear weapons would not improve the country's security. They argue that Iran would not be able to compete with the nuclear arsenals of larger countries, such as the United States.[248] Moreover, the Iranian government has asserted that "Iran today is the strongest country in its immediate neighborhood. It does not need nuclear weapons to protect its regional interests."[249] The U.S.-led spring 2003 invasion of Iraq which overthrew Iraqi leader Saddam Hussein and thereby eliminated a key rival of Iran, may also have induced Tehran to decide that it did not need nuclear weapons. The government has also argued that a nuclear weapons program "would be prohibitively expensive, draining the limited economic resources of the country."[250]

In any case, since Iran has implemented its JCPOA commitments, which, as noted, include significant limits on Iran's nuclear program and transparency requirements with respect to that program, U.S. officials have argued that the Iranian nuclear program poses a less-severe proliferation threat. For example, Secretary of Defense Ashton Carter testified in March 2016 that

[244] This argument is explained in more detail in Paul Kerr, "Divided From Within," *Bulletin of the Atomic Scientists*, November/December 2006. For an in-depth discussion of Iran's nuclear decision-making process, see Abbas William Samii, "The Iranian Nuclear Issue and Informal Networks," *Naval War College Review*, Winter 2006, and Chen Kane, *Nuclear Decision-Making in Iran: A Rare Glimpse*, Middle East Brief, Brandeis University: Crown Center for Middle East Studies, May 2006.

[245] "Iran's Statement at IAEA Emergency Meeting," *Mehr News Agency*, August 10, 2005. See also Statement by H.E. Dr. M. Javad Zarif, Permanent Representative of the Islamic Republic of Iran Before the Security Council, December 23, 2006. Khamene'i issued a fatwa as early as 2003 against nuclear weapons, according to Iranian officials ("Iran: Rowhani Says Khamene'i Considers Attempts to Access Nuclear Weapons 'Religiously Illegal'," *Islamic Republic News Agency*, October 25, 2003).

[246] "Leader's Fatwa on Nuclear Weapons Binding for Iran: Foreign Ministry," *Islamic Republic of Iran Broadcasting*, January 16, 2013. Iran's current Foreign Minister Zarif indicated in a 1999 journal article that Iran had produced chemical weapons, but the country's "religious leadership found it very difficult to condone the use of these weapons, even as reprisal." Iran later ceased producing the weapons, he wrote (Mohammad Javad Zarif and Mohammad Reza Alborzi, "Weapons of Mass Destruction in Iran's Security Paradigm: The Case of Chemical Weapons," *The Iranian Journal of International Affairs*, Vol. XI, No.4, Winter 1999).

[247] *The Iranian Nuclear Crisis*, p. 13.

[248] "Interview with Iran's Ambassador to IAEA," June 29, 2008.

[249] Iran's Permanent Mission to United Nations in New York, "An Unnecessary Crisis: Setting the Record Straight about Iran's Nuclear Program," Published as advertisement in *New York Times*, November 18, 2005.

[250] *Ibid*.

the agreement "places significant limitations on Iran that will effectively cut off its pathways to the fissile material for a nuclear bomb."[251]

Government Estimates

Since at least 2007, the U.S. intelligence community has issued unclassified assessments that Iran has not decided whether to develop nuclear weapons. According to the 2007 NIE, "Iranian military entities were working under government direction to develop nuclear weapons" until fall 2003, after which Iran halted its nuclear weapons program "primarily in response to international pressure." The NIE defines "nuclear weapons program" as "Iran's nuclear weapon design and weaponization work and covert uranium conversion-related and uranium enrichment-related work." The NIE adds that the intelligence community also assessed "with moderate-to-high confidence that Tehran at a minimum is keeping open the option to develop nuclear weapons." The NIE also states that, because of "intelligence gaps," the Department of Energy and the National Intelligence Council assessed "with only moderate confidence that the halt to those activities represents a halt to Iran's entire nuclear weapons program." The NIE added that "[s]ince fall 2003, Iran has been conducting research and development projects with commercial and conventional military applications—some of which would also be of limited use for nuclear weapons."

The NIE also states that "Tehran's decision to halt its nuclear weapons program suggests it is less determined to develop nuclear weapons than we have been judging since 2005."[252] The change in assessments, a senior intelligence official said in December 2007, was the result of "new information which caused us to challenge our assessments in their own right, and illuminated previous information for us to be able to see it perhaps differently than we saw before, or to make sense of other data points that didn't seem to self-connect previously."[253] According to press accounts, this information included various written and oral communications among Iranian officials which indicated that the program had been halted.[254] As noted, the United States may also have obtained information from Iranian officials who defected as part of a CIA program to induce them to do so,[255] as well as from penetration of Iran's computer networks.[256] Additionally, the NIE also incorporated open-source information, such as photographs of the Natanz facility that became available after members of the press toured the facility.

[251] Statement before Senate Committee on Armed Services, March 17, 2016.

[252] Although the 2005 NIE stated that "Iran currently is determined to develop nuclear weapons despite its international obligations and international pressure," that assessment was somewhat qualified. Titled "Iran's Nuclear Program: At A Crossroads," the estimate stated that Iran was not "immovable" on the question of pursuing a nuclear weapons program and also addressed the possibility that Tehran may not have had such a program. Moreover, the word "determined" was used in lieu of "pursuing" a nuclear weapon because the authors believed the latter to be a stronger term. The NIE was issued as a Memorandum to Holders of NIE 2001-15HC, "Iran's Nuclear Weapons Program: Multifaceted and Poised to Succeed, But When?"

[253] Background Briefing with Senior Intelligence Officials, December 3, 2007.

[254] Dafna Linzer and Joby Warrick, "U.S. Finds that Iran Halted Nuclear Arms Bid in 2003," *Washington Post,* December 4, 2007; Greg Miller, "Iran's Nuclear Ambitions on Hold, U.S. Agencies Conclude," *Los Angeles Times*, December 4, 2007; David E. Sanger and Steven Lee Myers, "Details in Military Notes Led to Shift on Iran, U.S. Says," *New York Times*, December 6, 2007; Peter Baker and Dafna Linzer, "Diving Deep, Unearthing a Surprise; How a Search for Iran's Nuclear Arms Program Turned Up an Unexpected Conclusion," *Washington Post,* December 8, 2007.

[255] Miller, *Los Angeles Times*, December 9, 2007.

[256] David Sanger and William Broad, "U.S. and Allies Press Iran over Nuclear Plant 'Deception'," *The New York Times*, September 26, 2009.

According to the 2007 NIE, the intelligence community assessed "with moderate-to-high confidence that Iran[did] not have a nuclear weapon." The community assessed "with low confidence that Iran probably [had] imported at least some weapons-usable fissile material," but still judged "with moderate-to-high confidence" that Tehran still lacked sufficient fissile material for a nuclear weapon.

On several occasions, the U.S. intelligence community has reaffirmed the 2007 NIE's assessment that Iran halted its nuclear weapons program but is keeping its options open.[257] The late-September 2009 revelation of the Fordow facility increased suspicions that Iran may have restarted its nuclear weapons program; as noted, some U.S. officials indicated that the facility was likely intended for a nuclear weapons program. Nevertheless, Administration talking points made public September 25, 2009, stated that the intelligence community still assessed that "Iran halted its nuclear weapons program in 2003." More recently, Director of National Intelligence Clapper testified in February 2016 that

> [w]e continue to assess that Iran's overarching strategic goals of enhancing its security, prestige, and regional influence have led it to pursue capabilities to meet its nuclear energy and technology goals and give it the ability to build missile-deliverable nuclear weapons, if it chooses to do so. Its pursuit of these goals will dictate its level of adherence to the JCPOA over time. We do not know whether Iran will eventually decide to build nuclear weapons."[258]

A decision to produce nuclear weapons "will be made by the Supreme Leader," Clapper stated in April 2013.[259]

The November 2011 report from IAEA Director-General Amano appears to support the U.S. assessment.[260] As noted, the report states that Iranian activities related to building a nuclear explosive device "took place under a structured programme," but senior Iranian officials ordered a halt to the program in late 2003. Echoing the judgment of the 2007 NIE, Amano's report mentions "indications that some activities relevant to the development of a nuclear explosive device continued after 2003," adding that some such activities "may still be ongoing." Most of the activities listed in the report occurred before the end of 2003. During a briefing about Amano's report, a senior Administration official described Iran's post-2003 weapons-related work as "a much less coordinated ... more sporadic set of research activities," some of which "are sort of related to nuclear weapons development."[261] As noted, an April 2012 Department of Defense report described Amano's report as containing "extensive evidence of past and possibly ongoing Iranian nuclear weapons-related research and development work."[262] Amano's December 2, 2015, report assesses that "before the end of 2003, an organizational structure was in place in Iran suitable for the coordination of a range of activities relevant to the development of a nuclear explosive device." Some Iranian nuclear weapons-related activities "took place after 2003," the

[257] See, for example, February 12, 2009, testimony before the Senate Intelligence Committee by Director of National Intelligence Dennis Blair; "Annual Threat Assessment of the Intelligence Community for the Senate Intelligence Committee," February 12, 2009; and March 10, 2009, testimony before the Senate Armed Services Committee by Director of the Defense Intelligence Agency Michael Maples.

[258] *Statement for the Record Worldwide Threat Assessment of the US Intelligence Community*, Senate Armed Services Committee, February 9, 2016.

[259] "Hearing on Current and Future Worldwide Threats," Senate Committee on Armed Services, April 18, 2013.

[260] GOV/2011/65.

[261] "Press Briefing by Senior Administration Officials on IAEA Report on Iran's Nuclear Activities," November 8, 2011.

[262] *Annual Report on Military Power of Iran*, April 2012.

report adds, noting that these activities "were not part of a coordinated effort." The IAEA "has no credible indications of activities in Iran relevant to the development of a nuclear explosive device after 2009," the report explains.[263] (See also "Nuclear Weapon Development Capabilities").

Some foreign intelligence agencies apparently concur with the U.S. assessment that Iran has not yet decided to build nuclear weapons. Director of the French General Directorate of External Security Erard Corbin de Mangoux stated in an interview published in 2010 that "[w]e do not yet know whether Tehran's objective is to enable itself to acquire such a capability (so-called 'threshold status') or actually to possess it."[264] In 2012, Israeli Foreign Minister Avigdor Lieberman appeared to confirm reports that Israeli intelligence shares this U.S. assessment.[265] Moreover, according to a 2012 Israeli intelligence report, "until 2003," Iran had a "set nuclear program ... for R&D of nuclear weapons."[266] However, the report indicates that Iran had not restarted the nuclear weapons program. German intelligence assessments have also reportedly concurred with this assessment.[267]

Living with Risk

Other findings of the NIE indicate that the international community may, for the foreseeable future, have to accept some risk that Iran will develop nuclear weapons. According to the 2007 NIE, "only an Iranian political decision to abandon a nuclear weapons objective would plausibly keep Iran from eventually producing nuclear weapons—and such a decision is inherently reversible." As noted, the U.S. intelligence community assesses that Iran has the capacity to produce nuclear weapons at some point. This is not to say that an Iranian nuclear weapons capability is inevitable; as noted above, Iran does not yet have such a capability. But Tehran adherence to the JCPOA is probably necessary to provide the international community with confidence that it is not pursuing a nuclear weapon.

Other Constraints on Nuclear Weapons Ambitions[268]

Although the production of fissile material is widely considered to be the most difficult step in nuclear weapons development, Iran would, even with the ability to produce weapons-grade HEU, still face challenges in producing nuclear weapons, such as developing a workable physics package and effective delivery vehicles. A 1978 CIA report points out that there is a

> great difference between the development and testing of a simple nuclear device and the development of a nuclear weapons system, which would include both relatively sophisticated nuclear designs and an appropriate delivery system.[269]

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[263] GOV/2015/68.

[264] Isabelle Lasserre, "Intelligence and the New Threats," *Politique Internationale*, January 1-March 31, 2010.

[265] "Israeli Foreign Minister Says Iran Nuclear Programme 'of Military Nature,'" *Voice of Israel*, March 19, 2012. The reports appeared in James Risen, "U.S. Faces a Tricky Task in Assessment of Data on Iran," *New York Times*, March 17, 2012, and Amy Teibel, "Israelis Agree Iran Hasn't Decided on Atom Bomb," *The Associated Press*, March 18, 2012.

[266] Report 9342, Iran/Nuclear/Program Status, October 22, 2012.

[267] " 'Iran Striving for Nuclear Bomb'—Security Sources: Political Decision Still Pending," *Main Frankfurter Allgemeine*, July 1, 2011.

[268] For more detail about nuclear weapons development, see "Appendix B. Nuclear Weapons Development" in CRS Report R43333, *Iran Nuclear Agreement*.

[269] "RE: Pakistan Strong Motivation to Develop Their Nuclear Capability," Central Intelligence Agency, April 26, 1978. For a more detailed discussion, see Office of Technology Assessment, *Technologies Underlying Weapons of*
(continued...)

Moreover, Iran would face significant challenges if it were to attempt developing and producing HEU-based nuclear weapons covertly, although, as noted, covert production would probably be Tehran's preferred option. Covert centrifuge facilities are notoriously difficult for intelligence agencies to detect,[270] but Iran may well not be able to complete a covert centrifuge facility without detection. A 2005 International Institute for Strategic Studies report concluded that "an Iranian planner would have little basis for confidence that significant nuclear facilities could be kept hidden."[271] Tehran would need to hide a number of activities, including uranium conversion, the movement of uranium from mines, and the movement of centrifuge feedstock.[272] Alternatively, Iran could import uranium ore or centrifuge feedstock, but would also need to do so covertly.

The difficulty of the above task becomes clearer when one considers that foreign intelligence agencies apparently possess a significant amount of information about the Iran's enrichment program. First, both the Natanz and Fordow facilities were discovered by foreign governments before they became operational. Second, the development of the Stuxnet computer worm, discussed above, indicates that at least one foreign government possesses a large amount of information about Iran's centrifuge program which could not have been obtained via IAEA reporting, according to some experts.[273] As noted, U.S. officials have expressed confidence in the ability of U.S. intelligence to detect Iranian covert nuclear facilities.

It is also worth noting that Iran could produce only fairly simple nuclear weapons, which are not deliverable by longer-range missiles, without conducting explosive nuclear tests. Such tests, many analysts argue, would likely be detected.[274] It is also worth noting that moving from the production of a simple nuclear weapon to more sophisticated nuclear weapons could take several additional years.[275]

(...continued)

Mass Destruction (OTA-BP-ISC-115), December 1993.

[270] International Institute for Strategic Studies, February 2011, p.68. See also, David Albright, Paul Brannan, and Jacqueline Shire, *Can Military Strikes Destroy Iran's Gas Centrifuge Program? Probably Not*., Institute for Science and International Security, August 7, 2008; and Kemp, *International Security*, Spring 2014.

[271] International Institute for Strategic Studies, *Iran's Strategic Weapons Programmes: A Net Assessment*, (UK: Routledge, 2005).

[272] The 2005 IISS report also explains that concealing a plutonium-based nuclear weapons program would be even more difficult (pp. 62-63).

[273] David Albright, Paul Brannan, Andrea Stricker, Christina Walrond, and Houston Wood, *Preventing Iran From Getting Nuclear Weapons: Constraining Its Future Nuclear Options*, Institute for Science and International Security, March 5, 2012; R Scott Kemp, "Worm Holes - Virus Attacks Iran's Enrichment Operation," *Jane's Intelligence Review*, September 15, 2011.

[274] For a detailed discussion of this issue, see (name redacted), s tatement before the House Committee on Oversight and Government Reform, Subcommittee on National Security and Foreign Affairs, March 5, 2008. Iran is a party to the Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water, also known as the Limited Test Ban Treaty. Iran has signed, but not ratified, the Comprehensive Nuclear-Test-Ban Treaty, which has not entered into force.

[275] *Iran's Nuclear and Missile Potential: A Joint Threat Assessment by U.S. and Russian Technical Experts*, EastWest Institute, May 2009. pp. 5-6.

Appendix A. Multilateral Diplomacy Concerning Iran's Nuclear Program

In fall 2002, the IAEA began to investigate Iran's nuclear activities at Natanz and Arak; inspectors visited the sites the following February. The IAEA board adopted its first resolution, which called on Tehran to increase its cooperation with the agency's investigation and to suspend its uranium enrichment activities, in September 2003. The next month, Iran concluded an agreement with France, Germany, and the United Kingdom, collectively known as the "E3," to suspend its enrichment activities, sign and implement an Additional Protocol to its IAEA safeguards agreement, and comply fully with the IAEA's investigation.[276] As a result, the IAEA board decided to refrain from referring the matter to the U.N. Security Council, despite U.S. advocacy for such a referral.[277] Statements from current and former Iranian officials indicate that, during fall 2003, Tehran feared that the United States might use Security Council referral as a means to undertake military action or other coercive measures against Iran.[278]

The IAEA's investigation, as well as information Tehran provided after the October 2003 agreement, ultimately revealed that Iran had engaged in a variety of clandestine nuclear-related activities, some of which violated Iran's safeguards agreement. These included plutonium separation experiments, uranium enrichment and conversion experiments, and importing various uranium compounds.

After October 2003, Iran continued some of its enrichment-related activities, but Tehran and the E3 agreed in November 2004 to a more detailed suspension agreement. During negotiations between fall 2003 and summer 2005, both Iran and the E3 offered a number of proposals, although the two sides never reached agreement.[279] According to one former British official involved in the negotiations, a chief obstacle was E3 opposition to a 2005 Iranian proposal that would have included a limited Iranian enrichment program.[280] A former Iranian official argued that the perceived lack of success of Iranian officials who had participated in negotiations with the E3 discredited those officials in the eyes of other Iranian officials.[281]

The United States differed with several aspects of the E3 negotiations during this time. For example, the Bush administration opposed an E3 request to ease sanctions on certain US. goods.[282] The United States also persuaded the E3 to refrain from agreeing to any arrangement

[276] The text of the agreement is available at http://www.iaea.org/NewsCenter/Focus/IaeaIran/statement_iran21102003.shtml. Iran signed its Additional Protocol in December 2003, but has not ratified it.

[277] "Ex-chief Negotiator Says Iran Leaders Decided to Suspend Nuclear Enrichment," *Aftab-e Yazd*, April 7, 2009; John Bolton, *Surrender Is Not an Option: Defending America at the United Nations and Abroad*, (New York: Threshold Editions), 2008, p. 139; Christopher Ford, "A New Paradigm: Shattering Obsolete Thinking on Arms Control and Nonproliferation," *Arms Control Today*, November 2008. For more details about noncompliance with IAEA safeguards agreements and Security Council referral, see CRS Report R40094, *Iran's Nuclear Program: Tehran's Compliance with International Obligations*, by (name redacted)

[278] *Aftab-e Yazd*, April 7, 2009; Mehdi Mohammadi,"Nuclear Case From Beginning to End in Interview with Dr. Hasan Rowhani (Part 1): We Are Testing Europe," *Keyhan*, July 23, 2005; David Patrikarakos, *Nuclear Iran: The Birth of an Atomic State*, (New York: I.B. Tauris), 2012, p.181; Seyed Hossein Mousavian, *The Iranian Nuclear Crisis: A Memoir*, (Washington, DC: Carnegie Endowment for International Peace), 2012, p. 76.

[279] These proposals are available at http://www.armscontrol.org/factsheets/Iran_Nuclear_Proposals.

[280] Peter Jenkins, "Did Hassan Rouhani Dupe Europe in 2003?," *LobeLog*, June 25, 2013.

[281] Mousavian, 2012, pp. 200, 209, 267, 280.

[282] Jack Straw, *Last Man Standing: Memoirs of a Political Survivor*, (London: MacMillan), 2012, p. 453.

with Iran which included even a limited Iranian enrichment program, according to accounts from E3 officials directly involved in the diplomacy.[283] Former President George W. Bush has written that the United States' "ultimate goal" was "stopping Iranian enrichment."[284]

Iran resumed uranium conversion in August 2005 under the leadership of President Ahmadinejad, who had been elected two months earlier. . On September 24, 2005, the IAEA Board of Governors adopted a resolution that, for the first time, found Iran to be in noncompliance with its IAEA safeguards agreement. The board, however, did not refer Iran to the Security Council, choosing instead to give Tehran additional time to comply with the board's demands. Iran announced in January 2006 that it would resume research and development on its centrifuges at Natanz. In response, the IAEA board adopted a resolution on February 4, 2006, that referred the matter to the Security Council. Two days later, Tehran announced that it would stop implementing its Additional Protocol.

In June 2006, China, France, Germany, Russia, the United Kingdom, and the United States, collectively known as the "P5+1," presented a proposal to Iran that offered a variety of incentives in return for Tehran taking several steps to assuage international concerns about its enrichment and heavy-water programs.[285] The proposal called on the government to address the IAEA's "outstanding concerns ... through full cooperation" with the agency's ongoing investigation of Tehran's nuclear programs, "suspend all enrichment-related and reprocessing activities," and resume implementing its Additional Protocol.

Then-European Union High Representative for Common Foreign and Security Policy Javier Solana presented a revised version of the 2006 offer to Iran in June 2008.[286] Representatives from the P5+1 discussed the new proposal with Iranian officials the next month. Iran provided a follow-up response in August 2008, but the six countries deemed it unsatisfactory.[287] Tehran told the IAEA that it would implement its Additional Protocol "if the nuclear file" were "returned from the Security Council" to the agency.[288] It is unclear how the council could have met this condition. The 2006 offer's requirements were also included in several U.N. Security Council resolutions, including Resolution 1929, which was adopted on June 9, 2010.[289]

[283] Richard Dalton, "Iran Is not in Breach of International Law," *The Guardian*, June 9, 2011; Francois Nicoullaud, former French Ambassador to Iran, quoted in Patrikarakos 2012, p. 194.

[284] George W. Bush, *Decision Points*, (New York: Crown Publishing), 2010, p. 416.

[285] The proposal text is available at http://armscontrol.org/pdf/20060606_Iran_P5+1_Proposal.pdf. Prior to late May 2006, the United States refused to participate in direct talks with Iran about its nuclear program. In March 2005, Washington had offered some limited incentives for Iran to cooperate with the E3. (See Kerr, *Arms Control Today*, June 2006). For more information about the state of international diplomacy with Iran, see CRS Report RL32048, *Iran: Politics, Gulf Security, and U.S. Policy*, by (name redacted) .

[286] The revised proposal text is available at http://www.auswaertiges-amt.de/diplo/de/Aussenpolitik/Themen/Abruestung/IranNukes/Angebot-e33-080614.pdf.

[287] Iran had also presented a proposal to the P5+1 in May 2008. See Peter Crail, "Proposals Offered on Iranian Nuclear Program," *Arms Control Today*, May 2008. The proposal text is available at http://www.iaea.org/Publications/Documents/Infcircs/2008/infcirc729.pdf.

[288] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007) and 1803 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2008/4, February 22, 2008.

[289] The resolution text is available at http://www.iaea.org/newscenter/focus/iaeairan/unsc_res1929-2010.pdf. The resolutions also required Iran to suspend work on its heavy water-related projects.

Iran issued another proposal in early September 2009 which described a number of economic and security issues as potential topics for discussion but only obliquely mentioned nuclear issues and did not explicitly mention Iran's nuclear program.[290]

Tehran Research Reactor Discussions[291]

After an October 1, 2009, meeting in Geneva with the P5+1 and High Representative Solana, Iranian officials repeatedly stated that Tehran wanted future discussions about its September 2009 proposal. Nevertheless, during that meeting, Iranian officials agreed in principle to a proposal that would provide LEU fuel containing about 20% uranium-235 for Iran's U.S.-supplied Tehran Research Reactor (TRR), which produces medical isotopes and operates under IAEA safeguards. Iran asked the IAEA in a June 2, 2009, letter to provide fresh fuel for its U.S-supplied TRR. Initially fueled by U.S.-supplied HEU, the reactor was converted to use LEU fuel in 1994 after Argentina agreed to supply the reactor with such fuel in 1987.[292] The reactor is currently running on the Argentinean-supplied fuel, which contains about 20% uranium-235. Subsequent to Iran's June 2009 request, the United States and Russia presented a proposal to the IAEA (which the agency conveyed to Iran) for providing fuel for the reactor.

According to the proposal, Iran would have transferred approximately 1,200 kilograms of its low-enriched uranium hexafluoride to Russia, which would have either enriched the uranium to about 20% uranium-235 or produced such LEU from Russian-origin uranium. Russia would then have transferred the low-enriched uranium hexafluoride to France for fabrication into fuel assemblies. Finally, Paris would have transferred the assemblies to Russia for shipment to Iran. France would have delivered the fuel within about one year.[293] Iran had, as of October 30, 2009, produced 1,763 kilograms of low-enriched uranium hexafluoride containing less than 5% uranium-235.[294]

Beginning on October 19, 2009, Iranian officials met with officials from the IAEA, France, Russia, and the United States to discuss details of implementing the proposal, such as the fuel price, contract elements, and a timetable for shipping the fuel. Two days later, then-IAEA Director-General ElBaradei announced the conclusion of a "draft agreement," which was drafted by the IAEA. Although Iran, France, Russia, and the United States held further discussions regarding the proposal's implementation, they did not reach agreement with Tehran. Iran resisted transferring all 1,200 kilograms of low-enriched uranium hexafluoride out of the country before receiving the reactor fuel, arguing that the proposal needed more credible assurances that the fuel would actually be delivered. During the last few months of 2009, Iranian officials did suggest different compromises, such as shipping its low-enriched uranium hexafluoride out of the country

[290] The proposal text may be found at http://documents.propublica.org/iran-nuclear-program-proposal#p=1.

[291] Unless otherwise noted, this section is based on an October 1, 2009, background briefing by senior U.S. officials; ElBaradei's remarks during an October 4, 2009, press conference; an October 13, 2009, French Foreign Ministry briefing; an analyst interview with a U.S. official; Mark Hibbs, "Six Nations Might Place Conditions on Reactor Fuel Supply to Iran," *Nuclear Fuel*, October 5, 2009; "Iran to Provide 20 % Fuel if Probable Deal with West Fails: AEOI," *Iranian Students News Agency*, October 10, 2009; and "Iran Foreign Ministry Spokesman's Weekly News Conference," *Iranian News Network Channel*, October 12, 2009.

[292] This information is contained in a February 18, 2010, letter from Iran to the IAEA (GOV/INF/2010/5).

[293] These details appeared in a June 2010 letter from France, Russia, and the United States to the IAEA. The text appears in "Text: Powers Dismiss Iran Fuel Offer Before U.N. Vote," *Reuters*, June 9, 2010.

[294] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, Report by the Director General, GOV/2009/74, November 16, 2009.

in phases or simultaneously exchanging that material for the TRR fuel on an Iranian island or in a third country, but these proposals were not accepted by the United States, France, and Russia.[295]

Further details about the French, Russian, and U.S. proposals later became public.[296] For example, the IAEA had agreed to take formal custody of any Iranian low-enriched uranium hexafluoride transferred pursuant to a TRR agreement. Additionally, France, Russia, and the United States had agreed to a "legally binding Project and Supply Agreement"; agreed to "support technical assistance through the IAEA to ensure" that the TRR would operate safely; and expressed support for allowing Iran to transfer its low-enriched uranium hexafluoride to a third country, which would hold that material in escrow until the TRR fuel was fabricated. The United States also offered "substantial political assurances that the agreement would be fulfilled." An April 20, 2010, letter from President Obama to then-President Brazilian President Luis Inácio Lula da Silva stated that the United States had expressed its willingness to "potentially even play a more direct role in the fuel production process," but did not elaborate.

Notably, the October 2009 IAEA draft did not include an explicit prohibition on Iranian production of uranium enriched to about 20% uranium-235. Instead, the agreement's proponents thought that the supply of fuel for the TRR would obviate the need for Tehran to produce the fuel on its own.[297] The escrow proposal described in the previous paragraph was not contained in the October 2009 IAEA draft.[298] Whether the other provisions described above were explicitly contained in that draft is unclear because there is no public official copy of it.

Following a November 20, 2009, meeting, the P5+1 issued a joint statement expressing disappointment with Tehran's failure to respond positively to the TRR proposal. "We have agreed to remain in contact and expect a further meeting soon to complete our assessment of the situation and to decide on our next steps," the statement said. Although some subsequent Iranian statements suggested that Iran was still open to some version of the IAEA proposal,[299] Tehran never officially accepted it. Although, as discussed below, Iran has manufactured fuel for the reactor, whether Iran can produce sufficient amounts of acceptable-quality fuel is unclear.[300]

Following a May 17, 2010, meeting of Iranian President Ahmadinejad, Turkish Prime Minister Recep Tayyip Erdogan, and Brazilian President Lula, Iran did accept a proposal, known as the Tehran Declaration, for supplying the TRR with fuel.[301] Iran conveyed its acceptance of the declaration in a May 24, 2010, letter to the IAEA. The Tehran Declaration contained some of the same elements as the October 2009 IAEA draft proposal and other elements described in a February 12, 2010, letter to the IAEA. For example, the declaration stated that Iran would be willing to "deposit" 1,200 kilograms of LEU in Turkey. Iran would deposit the fuel, which would be subject to IAEA monitoring in Turkey, "not later than one month" after reaching an agreement regarding the details of the exchange with France, Russia, the United States, and the IAEA.

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[295] See, for example, "Iran Says It Would Swap Nuclear Material With West in Turkey," *The Associated Press*, December 26, 2009; "Mottaki: Iran Ready for Simultaneous N. Fuel Swap," *Fars News Agency*, December 26, 2009.

[296] These details are contained in an official February 12, 2010, letter from those three governments to IAEA Director-General Amano.

[297] *Ibid.*

[298] Analyst interview with knowledgeable U.S. official, June 16, 2010.

[299] See, for example, Iran's February 18, 2010, letter to the IAEA.

[300] David Albright and Jacqueline Shire, *Iran's Recent Statements about Production of Fuel for the Tehran Research Reactor: A Quick Review*, Institute for Science and International Security, February 8, 2010.

[301] The text is available at http://www.brasil.gov.br/news/history/2010/05/17/joint-declaration-by-iran-turkey-and-brazil?set_language=en.

However, unlike the IAEA draft proposal, the declaration did not mention an ultimate destination for the LEU to be deposited in Turkey. As noted, Tehran had resisted transferring all 1,200 kilograms of LEU out of the country before receiving fuel for the TRR.

IAEA Director-General Amano told the agency's Board of Governors on June 7, 2010, that he had "immediately conveyed Iran's letter" to France, Russia, and the United States "and asked for their views." Those three governments responded to the IAEA two days later with letters and a joint paper titled "Concerns about the Joint Declaration Conveyed by Iran to the IAEA."[302] The paper conveyed several reservations about the Tehran Declaration, but did not reject it outright. One reason for the U.S. refusal to accept the proposal was fear that the proposal would disrupt efforts to persuade the Security Council to adopt a resolution imposing additional sanctions on Iran (the council adopted Resolution 1929 in June 2010).[303]

Further Talks

Iran and the P5+1 met in December 2010 and January 2011, but the two meetings, held in Geneva and Istanbul, respectively, produced no results. In April 2012, the two sides resumed talks in Istanbul. Since then, Iran and the P5+1 have held two rounds of talks—a May meeting in Baghdad and a June meeting in Moscow. Additionally, the two sides held expert-level discussions in Istanbul in July 2012.

Following the April 2012 talks, the P5+1 stated that the process of inducing Iranian compliance with "all its international obligations" would be "guided by the principle of the step-by-step approach and reciprocity."[304] The P5+1 presented their proposal the next month during the Baghdad meeting. The six governments demanded that Tehran end its production of enriched uranium containing approximately 20% uranium-235; ship to a third country Iran's stockpile of uranium enriched to this level (this uranium would be under IAEA monitoring); halt enriching uranium, as well as installing centrifuges and centrifuge components, at the Fordow facility; and cooperate fully with the IAEA's investigation. Then-European Union High Representative Catherine Ashton for Common Foreign and Security Policy stated on May 24, 2012, that the P5+1 "put ideas on the table on reciprocal steps we would be prepared to take." These included

- refraining from imposing new sanctions on Iran;
- facilitating Iranian access to spare aircraft parts, as well as safety and repair inspections;
- providing fuel for the TRR;
- supporting IAEA technical cooperation regarding the TRR's safety;
- providing medical isotopes to Tehran;

[302] The text appears in "Text: Powers Dismiss Iran Fuel Offer Before U.N. Vote," *Reuters*, June 9, 2010.

[303] Hillary Rodham Clinton, *Hard Choices*, (New York: Simon & Shuster), 2014, p. 361-63.

[304] This paragraph is based on the following sources: Kelsey Davenport, "Iran, P5+1 Move to Technical Talks," *Arms Control Today*, July/August 2012; Kelsey Davenport, "P5+1 and Iran Claim Progress in Talks," *Arms Control Today*, June 2012; Kelsey Davenport, *History of Official Proposals on the Iranian Nuclear Issue*, Arms Control Association, August 2012; *The P5+1, Iran and the Perils of Nuclear Brinkmanship*, International Crisis Group Middle East Briefing, June 15, 2012; "Text of statement by EU's Ashton After Iran Talks," *Reuters*, May 24, 2012; Jay Solomon, "Iran, U.S. Agree Only to Resume Their Talks Next Month," *Wall Street Journal*, May 24, 2012; Paul Richter, "Iran, World Powers Clash At Latest Talks; Tehran Says The Six Nations Haven't Given It A 'Balanced' Offer On Its Nuclear Program," *Los Angeles Times*, May 24, 2012; "Full Text of Iran's Proposals to Six World Powers in Moscow Talks," *Fars News Agency*, July 7, 2012.

- potentially reviewing suspended IAEA technical cooperation projects with Iran;[305] and
- cooperating on Tehran's acquisition of a light-water reactor for producing radioisotopes.

The two sides again held talks in February 2013. Technical experts from the P5+1 and Iran met the next month, and another round of talks at the political director level took place in April 2013. Following the June 2013 election of Iranian President Hassan Rouhani, many observers expressed optimism that these negotiations would produce an agreement. After Rouhani took office in August 2013, Iran and the P5+1 met twice later that year (once in October and once in November). The two sides met again on November 20, 2013 and agreed to an accord called the Joint Plan of Action (JPA) on November 24. This agreement set out an approach toward reaching a long-term comprehensive solution to international concerns regarding Iran's nuclear program. The two sides began implementing the JPA on January 20, 2014. The P5+1 and Iran reached a framework of a Joint Comprehensive Plan of Action (JCPOA) on April 2, 2015, and finalized the JCPOA on July 14, 2015.

[305] These are apparently the same technical cooperation projects which the IAEA Board of Governors suspended in 2007.

Appendix B. Possible Military Dimensions of Iran's Nuclear Program

Then-International Atomic Energy Agency (IAEA) Director-General Mohamed ElBaradei told the agency's Board of Governors on June 2, 2008, that questions regarding "possible military dimensions" to Iran's nuclear program constituted the "one remaining major issue" concerning the IAEA's investigation of the program. A November 2011 report by current IAEA Director-General Yukiya Amano to the IAEA board contains the most detailed account to date of the IAEA's evidence regarding Iran's suspected nuclear weapons-related activities.[306] Unless otherwise noted, this appendix is based on Amano's November 2011 report.

The IAEA has "credible" information that Iran has carried out activities "relevant to the development of a nuclear explosive device." Although some of these activities have civilian applications, "others are specific to nuclear weapons," the report notes. Most of these activities were conducted before the end of 2003, though some may have continued. The Iranian government managed these activities via a program structure which included "senior Iranian figures." Amano's report contains a detailed description of the program's structure, which was set up in the late 1980s. The program's activities were managed via an institution called the Physics Research Center and overseen by an Iranian Ministry of Defense entity. About a decade later, the center's activities were consolidated under a new entity called the AMAD Plan. After the Iranian regime halted the AMAD Plan's work in 2003, "staff remained in place to record and document the achievements of their respective projects," according to information provided to the IAEA by unnamed governments. Later, "equipment and work places were either cleaned or disposed of so that there would be little to identify the sensitive nature of the work which had been undertaken." The IAEA has "other information" from governments which "indicates that some activities previously carried out under the AMAD Plan were resumed later." Some of these activities "would be highly relevant to a nuclear weapon programme." A December 2015 report from Amano assesses that, although some Iranian nuclear weapons-related activities "took place after 2003," these activities "were not part of a coordinated effort."[307] The IAEA "has no credible indications of activities in Iran relevant to the development of a nuclear explosive device after 2009,"the report explains.[308]

The IAEA has information that the AMAD Plan either obtained or attempted to obtain dual-use "equipment, materials and services which ... would be useful in the development of a nuclear explosive device." Additionally, the program may have conducted studies on uranium conversion, missile reentry vehicles for delivering nuclear warheads, and conventional explosives used in nuclear weapons.

Nuclear Explosive Device Components

The IAEA has information indicating that Iran may have conducted work on components for nuclear weapons. Iran possesses a document "describing the procedures" for reducing uranium hexafluoride to uranium metal, as well as "machining ... enriched uranium metal into hemispheres," which are "components of nuclear weapons."[309] Tehran has previously told the

[306] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions in the Islamic Republic of Iran*, GOV/2011/65, November 8, 2011.

[307] GOV/2015/68.

[308] *Ibid.*

[309] *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737* (continued...)

IAEA that it was offered equipment for casting uranium but never actually received it.[310] Moreover, a member of a clandestine nuclear supply network run by former Pakistani nuclear official Abdul Qadeer Khan told the IAEA that Iran "had been provided with nuclear explosive design information." However, this information may not be sufficient to produce a nuclear weapon. (See "Nuclear Weapon Development Capabilities.") The IAEA has also received information from an unnamed government that Iran carried out "preparatory work, not involving nuclear material, for the fabrication of natural and high enriched uranium metal components for a nuclear explosive device."

As noted, the AMAD Plan may have conducted studies on conventional explosives used in nuclear weapons. Implosion-type nuclear explosive devices use conventional explosives to compress a core of highly-enriched uranium or plutonium in order to start a nuclear chain reaction. Specifically, Iran developed detonators which have limited non-nuclear applications, but also could be used in a nuclear explosive device. Tehran also may have experimented with a multipoint initiation system which could be used in conjunction with the detonators. Additionally, Iran may have conducted high explosive testing, possibly in association with nuclear materials, at a military site (see "Parchin" below). Iran also may have worked on neutron initiators, which are used in implosion-type nuclear weapons.

Re-Entry Vehicle

As noted, the IAEA suspects that the AMAD Plan conducted studies on missile reentry vehicles for delivering nuclear warheads. Iran may have conducted "engineering studies to examine" integrating a payload into the re-entry vehicle of Iran's Shahab-3 ballistic missile. Although these activities "may be relevant to the development of a non-nuclear payload, they are highly relevant to a nuclear weapon programme." Iran also may have conducted work on a "prototype firing system" that would enable a missile's nuclear payload "to explode both in the air above a target, or upon impact of the re-entry vehicle with the ground."

Parchin

Parchin is an Iranian military site.[311] The Institute for Science and International Security described the complex in a 2004 report as "a huge site dedicated to the research, development, and production of ammunition, rockets, and high explosives," adding that the site "is owned by Iran's military industry and has hundreds of buildings and test sites."[312] IAEA inspectors previously investigated the Parchin site after receiving "information ... from a Member State in the early 2000s alleging that Iran was conducting high explosive testing, possibly in association with nuclear materials."[313] Such testing could contribute to the development of implosion-type

(...continued)

(2006), 1747 (2007), and 1803 (2008) in the Islamic Republic of Iran, Report by the Director General, GOV/2008/15, May 26, 2008.

[310] According to Iran, its nuclear suppliers, many of whom were affiliated with the Khan network, provided the document in 1987 at their own initiative, rather than at Tehran's request. Islamabad has confirmed to the IAEA that "an identical document exists" in Pakistan.

[311] Then-Iranian Ambassador to the IAEA Ali Asghar Soltanieh described Parchin as "a military site" in a March 2012 statement. (Statement by H.E. Ambassador Soltanieh Resident Representative of the Islamic Republic of Iran to the IAEA Before the IAEA Board of Governors, March 8, 2012). Similarly, the IAEA described Parchin as a "military complex" (GOV/2011/65).

[312] David Albright and Corey Hinderstein, *Parchin: Possible Nuclear Weapons-Related Site in Iran*, Institute for Science and International Security, September 15, 2004.

[313] GOV/2011/65.

nuclear explosive devices. IAEA inspectors visited the site twice in 2005, but "did not uncover anything of relevance."

Parchin is not under IAEA safeguards. However, the IAEA wanted Tehran to respond to information which the agency obtained from unnamed governments indicating that "Iran constructed a large explosives containment vessel" in 2000 at Parchin "in which to conduct hydrodynamic experiments."[314] Such experiments are conducted to validate the design of an implosion-type nuclear weapon and are "strong indicators of possible weapon development." The report does not say whether Iran actually conducted these experiments at Parchin. The inspectors in 2005 did not visit "the location now believed to contain the building which houses the explosives chamber."[315] The agency requested access to this latter building in February 2012, but Iran did not provide such access until September 2015. At that time, IAEA officials "did not observe a chamber or any associated equipment inside the building." Iranian officials told their IAEA counterparts in October 2015 that the building in question "had always been used for the storage of chemical material for the production of explosives," but the "information available" to the IAEA, "does not support Iran's statements on the purpose of the building."[316]

Other Issues

The IAEA has asked Tehran about other indications, some of which do not appear in Amano's November 2011 report, suggesting that the country may have pursued nuclear weapons.[317] These include

- "information about a high level meeting in 1984 on reviving Iran's pre-revolution nuclear programme";
- "the scope of a visit by officials" associated with Iran's Atomic Energy Organization "to a nuclear installation in Pakistan in 1987";
- information on 1993 meetings between Iranian officials and members of a clandestine procurement network run by former Pakistani nuclear official Abdul Qadeer Khan;
- information about work done in 2000 which apparently related to reprocessing;
- Iranian scientists' mathematical research with nuclear weapons applications; and
- information indicating that Iran "may have planned and undertaken preparatory experimentation which would be useful were Iran to carry out a test of a nuclear explosive device."

[314] *Ibid*. The report also notes that the IAEA "has obtained commercial satellite images that are consistent with this information. From independent evidence ... the Agency has been able to confirm the date of construction of the cylinder and some of its design features."

[315] GOV/2011/65.

[316] *Final Assessment on Past and Present Outstanding Issues Regarding Iran's Nuclear Programme*, GOV/2015/68, December 2, 2015.

[317] The first four items are discussed in GOV/2008/15. The last two items are in GOV/2011/65.

Appendix C. Iranian Centrifuge Workshops and Related Entities

This appendix lists Iranian entities which appear to have manufactured centrifuges or related components. It also includes some entities which appear to have conducted work closely related to these activities. The appendix excludes entities which have only been identified as involved in procuring materials or components for Iran's centrifuge program. This list is probably not exhaustive and at least some of the publicly available information about Iran's centrifuge workshops may be outdated. International Atomic Energy Agency (IAEA) inspectors had access to Iranian centrifuge workshops until early 2006 in order to verify the October 2003 agreement under which Iran suspended its enrichment program. However, the agency's knowledge of Iran's workshops deteriorated after Iran ended this access in early 2006. Since then, Iran may well have moved centrifuge-related work to other locations[318] and has likely built more such workshops.[319] Iran has provided the IAEA with access to some centrifuge workshops pursuant to the November 2013 Framework for Cooperation, the Joint Plan of Action, and the Joint Comprehensive Plan of Action.

Kalaye Electric

U.N. Security Council Resolution 1737 describes Kalaye Electric, which is located in Tehran, as a "provider" to Iran's pilot centrifuge facility located at Natanz. According to an August 2008 Institute for Science and International Security (ISIS) report, the Atomic Energy Organization of Iran (AEOI) controls the country's centrifuge program, but the program "is operated by the Kalaye Electric Company."[320] The report states that

> Even today, the centrifuge program still acquires vacuum pumps and much of its measuring equipment via illicit trade with foreign suppliers. Work at Kalaye Electric is aimed at creating an indigenous capability to make this equipment and reduce its dependence on smuggling, which has become more difficult under increased economic sanctions. However, it is unknown which Iranian facilities would make vacuum or measuring equipment.

A December 2011 European Union Council regulation describes several entities as current suppliers to Kalaye Electric, suggesting that the company was involved in Iran's centrifuge program at that time.[321]

[318] A former top Middle East intelligence analyst at the Department of State expressed concern in 2006 that Tehran could be moving some components related to its nuclear program. See Paul Kerr, "News Analysis: IAEA Limits Leave Iran Intel Gaps," *Arms Control Today*, October 2006.

[319] A U.S. official told CRS in April 2011 that there "could be lots of workshops" in Iran. And a former U.S. government official with direct experience on the issue told CRS in February 2012 that Iran's centrifuge production is widely distributed and that the number of workshops probably multiplied "many times" since 2005 because of an increase in Iranian contractors and subcontractors working on the program.

[320] David Albright, Paul Brannan, and Jacqueline Shire, *Can Military Strikes Destroy Iran's Gas Centrifuge Program? Probably Not*, Institute for Science and International Security, August 7, 2008.

[321] *Council Implementing Regulation (EU) No 503/2011 Implementing Regulation (EU) No 961/2010 on Restrictive Measures Against Iran*, May 23, 2011.

7th of Tir

Resolution 1737 describes this entity, which is located in Esfahan, as "directly involved" in Iran's nuclear program. 7th of Tir was involved in manufacturing centrifuge components, according to the ISIS report, which added that Iran moved "the key centrifuge manufacturing equipment and components to Natanz and other AEOI sites" when the IAEA began monitoring the 2003 suspension agreement. Whether and to what extent the facility is still involved in manufacturing centrifuge components is unknown, the report says.

Farayand Technique

Resolution 1737 describes this entity, which is located in Esfahan, as "involved in" Iran's centrifuge program. The facility was involved in "making and assembling" centrifuge components, according to the 2008 ISIS report. According to a 2010 European Council regulation, another entity, called the Iran Centrifuge Technology Company, "has taken over the activities of Farayand Technique," which include "manufactur[ing] uranium enrichment centrifuge parts."[322]

Iran Centrifuge Technology Company

As noted, this entity, which is apparently located in Esfahan, took over "the activities of Farayand Technique," which have included "manufactur[ing] uranium enrichment centrifuge parts," according to the 2010 European Council regulation.[323]

Pars Trash

Resolution 1737 describes this Tehran-based entity as "involved in" Iran's centrifuge program. According to the ISIS report, the company manufactured centrifuge components. The report does not say whether Pars Trash is still involved in Iran's centrifuge program.

Kaveh Cutting Tools Company

This entity, according to the 2008 ISIS report, manufactured centrifuge components. The company is "part of" Khorasan Metallurgy Industries, the ISIS report says. Both of these entities are located in Mashad. Khorasan Metallurgy Industries is "involved in the production of centrifuge components," according to the 2010 European Council regulation.

Khorasan Metallurgy Industries

This entity, which is located in Mashad, has been "involved in the production of centrifuge components," according to the 2010 European Council regulation.

Sanam Electronic Industry Group

Located in Tehran, this entity was, according to ISIS, "involved in making centrifuge components."

Abzar Boresh Kaveh Company

U.N. Security Council Resolution 1803 describes this company as "[i]nvolved in the production of centrifuge components."

Parto Sanat Company

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[322] *Council Regulation (EU) No 961/2010 on Restrictive Measures Against Iran and Repealing Regulation (EC) No 423/2007*, October 25, 2010.

[323] *Ibid.*

The 2010 European Council regulation describes this company, which is located in Tehran, as a "[m]anufacturer of frequency changers ... capable of developing/modifying imported foreign frequency changers in a way that makes them usable in gas centrifuge enrichment."

Eyvaz Technic

The 2011 European Council regulation states that, as recently as 2011, this Tehran-based company supplied equipment relevant to centrifuge operations to Iran's Natanz and Fordow centrifuge facilities.

Ghani Sazi Uranium Company

According to the 2011 European Council regulation, this company, which is located in Tehran, had "production contracts" with Kalaye Electric and Iran Centrifuge Technology Company.

Iran Pooya

The 2011 European Council regulation describes this Tehran-based entity as "a major manufacturer of aluminium cylinders for centrifuges whose customers" included the AEOI and Iran Centrifuge Technology Company.

Mohandesi Toseh Sokht Atomi Company

The 2011 European Council regulation describes this company, which is located in Tehran, as "contracted to" Kalaye Electric "to provide design and engineering services across the nuclear fuel cycle."

Saman Nasb Zayendeh Rood

The 2011 European Council regulation describes this company, which is located in Esfahan, as a "[c]onstruction contractor that has installed piping and associated support equipment at the uranium enrichment site at Natanz." The company "has dealt specifically with centrifuge piping," according to the regulation.

Jelvesazan Company

This company, located in Esfahan, was a possible supplier of vacuum pumps to the Iran Centrifuge Technology Company, according to a December 2012 European Council regulation.[324]

Iran Aluminium Company

According to the December 2012 European Council regulation, this company, located in Arak, was a supplier to the Iran Centrifuge Technology Company as of mid-2012.

Simatec Development Company

The December 2012 European Council regulation identified this company, apparently located in Tehran, as a supplier of inverters for centrifuges to the Kalaye Electric Company.

Sharif University of Technology

This university, located in Tehran, has provided laboratories for use by the entity Kalaye Electric Company and the Iran Centrifuge Technology Company, according to the December 2012 European Council regulation.

Zirconium Production Plant

[324] *Council Implementing Regulation (EU) No 1264/2012 Implementing Regulation (EU) No 267/2012 Concerning Restrictive Measures Against Iran*, December 21, 2012.

A 2012 report from the AEOI identified this plant, located in Esfahan, as a "provider of pipes and aluminum sheets used in different parts of centrifuge machines."[325]

Aluminat

This Tehran-based company had a contract in 2012 to supply aluminum to the Iran Centrifuge Technology Company, according to the December 2012 European Council regulation.

Pishro Systems Research Company

This company, according to a 2013 State Department announcement, was "responsible for research and development efforts across the breadth of Iran's nuclear program," including Iran's enrichment program.[326] The company "likely has or will have a facility" in Tehran, the State Department said.

[325] *Nuclear Industry in Iran: An Overview on Iran's Activities and Achievements in Nuclear Technology*, Atomic Energy Organization of Iran, 2012, p. 19.

[326] Patrick Ventrell, "State Department Actions Targeting Iran's Nuclear Enrichment and Proliferation Program," May 9, 2013.

Appendix D. Post-2003 Suppliers to Iran's Uranium Enrichment Program

Iran has obtained components, expertise, and material for its nuclear program from a variety of foreign sources. Tehran sought assistance for the program from the Russian and Chinese governments,[327] but also obtained relevant components, expertise, and material via deceptive procurement techniques.[328] Perhaps Iran's best-known source was a clandestine procurement network run by former Pakistani nuclear official Abdul Qadeer Khan. This network began supplying Iran's centrifuge program in 1987,[329] but U.S. and Pakistani officials have characterized the network as defunct since Pakistan publicly revealed the network in early 2004.[330]

It is worth noting that, according to former Deputy Director General of the International Atomic Energy Agency (IAEA) Olli Heinonen,[331] the IAEA has not determined the source of material that Iran obtained for its advanced centrifuges; CRS has not found additional information on this subject.

Methodology

Because the original Khan network appears to be defunct, this appendix focuses on post-2003 suppliers to Iran's enrichment program. To obtain the information for this appendix, CRS reviewed official U.S. government reports,[332] as well as lists of entities sanctioned by the United States and the European Union since early 2004.[333] CRS also reviewed public information from the Department of Justice, reports from a U.N. Panel of Experts, and selected non-governmental reports.[334] In order to identify suppliers germane to this appendix, CRS excluded Iranian entities or nationals, Iranian ships under foreign flags, and entities associated with the Khan network.

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[327] A Russian entity agreed during the 1990s to provide Iran with a centrifuge facility but later canceled the transaction. See Robert J. Einhorn and Gary Samore, "Ending Russian Assistance to Iran's Nuclear Bomb," *Survival*, Summer 2002. The United States dissuaded China in 1997 from supplying Iran with a uranium conversion facility, although Iran did receive blueprints for the facility. See *Report of Proliferation-Related Acquisition in 1997*, and *Implementation of the NPT Safeguards Agreement and Relevant Provisions of Security Council Resolutions 1737 (2006) and 1747 (2007) in the Islamic Republic of Iran*, Report by the Director General, GOV 2007/58, November 15, 2007.

[328] According to *Report of Proliferation-Related Acquisition in 1997*, "Tehran is attempting to acquire fissile material and technology for weapons development and has set up an elaborate system of military and civilian organizations to support its effort."

[329] Iran began obtaining centrifuge-related technology from non-Khan network sources in 1985. See David Albright, *Peddling Peril: How the Secret Nuclear Trade Arms America's Enemies* (New York: Free Press), 2010, pp. 70-73.

[330] For more information, see CRS Report RL34248, *Pakistan's Nuclear Weapons*, by (name redacted) and (name redacted) .

[331] Analyst interview January 18, 2012.

[332] State Department reports to Congress covering 2004 through 2008 (submitted pursuant to Section 1308 of the Foreign Relations Authorization Act for Fiscal Year 2003; CRS does not have the report covering 2006); State Department reports reviewing countries' compliance with international arms control and nonproliferation agreements covering between 2004-2010 and December 31, 2008; and intelligence community reports mandated by section 721 of the Intelligence Authorization Act for Fiscal Year 1997 covering 2004-2010.

[333] Specially Designated Nationals List and lists of entities sanctioned pursuant to several nonproliferation laws (available at http://www.state.gov/t/isn/c15231.htm).

[334] *Panel of Experts Established Pursuant to Resolution 1929 (2010): Final Report*, June 2011; *Final Report of the Panel of Experts Established Pursuant to Resolution 1929 (2010)*, June 12, 2012.

This methodology has limitations. Official reports generally do not provide enough information to identify specific suppliers to Iran's enrichment program and Federal Register announcements of the imposition of sanctions generally do not explain the specific transactions which warranted the sanctions.[335] Even if official reports do identify suppliers to Iran's *nuclear* program, they often do not say whether the entities were supplying Iran's *enrichment* program. For example, an October 2008 Justice Department fact sheet stated that the sales director of a California-based corporation attempted to export illegally to Iran "machinery and software to measure the tensile strength of steel," explaining that these items "can make a contribution to nuclear activities of concern." The fact sheet, however, did not provide additional information and neither 2007 testimony from a Department of Commerce official nor a 2008 Commerce Department announcement explained whether the exports were intended for Iran's enrichment program.[336] Similarly, a 2008 report from the Czech Republic's Security Information Service stated that an Iranian company "subject to sanctions because of its involvement in the Iranian nuclear program" attempted to acquire "specific machinery" from a Czech supplier, but the report did not specify further.[337]

Suppliers to Iran's Enrichment Program

The information reviewed for this appendix indicates that Iranian-owned entities were using deceptive means in attempts to acquire enrichment technology from foreign entities.[338] However, the sources described above contain no evidence that foreign governments are currently supplying Iran's enrichment program. According to a 2009 State Department report, "all major suppliers, apart from Russia which is providing assistance to Iran's Bushehr Nuclear Power Plant, have agreed not to provide nuclear technology to Iran."[339] Additionally, State Department reports covering countries' compliance with international nonproliferation agreements between 2004 and 2010 indicate that the Chinese government is not involved in supplying Iran's suspected nuclear weapons program.[340]

Chinese Entities

Robert J. Einhorn, then- State Department Special Advisor for Nonproliferation and Arms Control, stated in March 2011 that the United States continued "to have concerns about the transfer of proliferation-sensitive equipment and materials to Iran by Chinese companies."[341]

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[335] CRS checked the lists of sanctioned entities against news reports and other sources in order to obtain additional information.

[336] Statement of Mark Foulon, Acting Under Secretary of Commerce for Industry and Security, Before Committee on Banking, Housing, and Urban Affairs, March 21, 2007; Order Denying Export Privileges, Bureau of Industry and Security, January 25, 2008.

[337] Annual Report of the Security Information Service (BIS) for 2008.

[338] The extent to which these attempts have been successful is unclear.

[339] *Report on the Proliferation of Missiles and Essential Components of Nuclear, Biological, Chemical and Radiological Weapons. Report Submitted to the Congress Pursuant to Section 1308 of the Foreign Relations Act for Fiscal Year 2003*. January 2008-December 2008. Previous official statements from the United States and the United Kingdom appear to support this statement with respect to Russia. John Rood, then-Acting Under Secretary of State for Arms Control and International Security, stated during a June 12, 2008, House Committee on Foreign Affairs hearing that the Bush Administration did not believe there was "ongoing Russian nuclear assistance [to Iran] outside of the Bushehr project" that would cause concern. Similarly, the UK Foreign and Commonwealth Office stated in August 2007 that the "Russian relationship with Iran in connection with Bushehr is now the only significant foreign relationship Iran has in the nuclear field," adding that "[e]arlier plans for a wider Russian relationship with Iran on nuclear matters ... have been shelved."

[340] The reports covering 2011-15 do not address this issue.

[341] Robert J. Einhorn, "The Impact of Sanctions on Iran's Nuclear Program," Arms Control Association, March 9, (continued...)

Similarly, the State Department compliance reports mentioned above indicate that unspecified non-Chinese entities have attempted to acquire "nuclear-related" materials and equipment from Chinese entities. Furthermore, a CIA report covering 2007 stated that "private Chinese businesses continue to sell materials, manufacturing equipment, and components suitable for use in ballistic missile, chemical weapon and nuclear weapon programs to North Korea, Iran and Pakistan."[342] The report did not specify further.[343] It is worth noting that Chinese entities may be supplying Iran with enrichment-related equipment obtained from Western suppliers. According to court documents made public in July 2012, an Iranian national attempted to obtain U.S.-origin components for Iran's enrichment program using entities in China and the Philippines.[344]

Other Suppliers

Iran has reportedly established front companies in Turkey in order to obtain nuclear-related items. Notably, Turkish entities were involved with the Khan network.[345] Iranian entities have also attempted to obtain nuclear-related items from companies in the Czech Republic, according to reports from that government's Security Information Service.[346]

Iran has also attempted to obtain enrichment-related equipment from U.S. suppliers. For example, according to a January 2012 Justice Department fact sheet, a man was sentenced in 2010 for attempting in March 2009 to export pressure transducers to Iran via Canada and the United Arab Emirates; he had purchased the items in the United States.[347] "Pressure transducers have applications in the production of enriched uranium," according to the fact sheet. Also, the Justice Department announced in January 2016 that a Chinese citizen was sentenced in the United States for exporting U.S. -origin pressure transducers to Iran from 2009 to 2012.[348] Additionally, a California-based firm exported "vacuum pumps and pump-related equipment to Iran through a free trade zone located in the United Arab Emirates [UAE]" between December 2007 and November 2008. This equipment has "a number of applications, including in the enrichment of uranium," according to the Justice Department fact sheet. In July 2013, an Iranian national pleaded guilty to arranging the illegal export of carbon fiber in 2008 to an Iranian entity. The individuals obtained the material from a U.S. supplier and shipped it to Iran via Europe and the

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2011.

[342] Director of Central Intelligence, *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, 1 January through 30 June 2007*, Washington, DC.

[343] For non-official reports on Chinese suppliers to Iran's enrichment program, see also, John Pomfret, "Chinese Firms Bypass Sanctions on Iran, U.S. Says," *The Washington Post*, October 18, 2010; and *Chinese Firms Continue to Evade Iran Sanctions*, Institute for Science and International Security, October 19, 2010.

[344] United States District Court for the District of Columbia, Grand Jury Indictment: *United States of America v. Parviz Khaki and Zongcheng Yi*, May 7, 2012, unsealed July 12, 2012.

[345] Aaron Stein, "Front Companies Use Turkey for Iran's Nuclear Programme," *Southeast European Times*, November 6, 2011; Andrea Stricker, *United States Indicts Man behind Alleged Multi-Million Dollar Iranian Smuggling Network*, Institute for Science and International Security, February 11, 2011.

[346] Annual Reports of the Security Information Service (BIS) for 2004 and 2008. Available at http://www.bis.cz/annual-report.html.

[347] *Summary of Major U.S. Export Enforcement and Embargo-Related Criminal Prosecutions: 2007 to the Present*.

[348] "Extradited Chinese National Sentenced to Nine Years for Providing U.S. Goods to Iran to Support its Nuclear Program," Department of Justice January 27, 2016.

United Arab Emirates. Carbon fiber "has nuclear applications in uranium enrichment as well applications in missiles," according to an October 2014 Justice Department fact sheet.[349]

Furthermore, declassified documents from the Canada Services Border Agency state that Iranian entities were attempting to acquire items from Canada for Iran's nuclear program, though the documents do not specifically mention Tehran's enrichment program.[350] The documents also state that "Iranian procurement agents have ... been able to export items [from Canada]," international sanctions notwithstanding. The documents, however, do not specify whether exported items were destined for Iran's nuclear program. Moreover, as noted, court documents made public in July 2012 state that an Iranian national attempted to obtain U.S.-origin components via Canada for Iran's enrichment program.

Entities in the UAE were part of the Khan network and have been cited as shippers for enrichment-related technology to Iran. Einhorn described the UAE in March 2011 as a "trans-shipment hub for Iran," but added that the UAE "has also taken strong steps in recent months to curtail illicit Iranian activities."[351] A 2011 European Council regulation identified two UAE entities, Modern Technologies FZC and Qualitest FZE, as "[i]nvolved in procurement of components for [the] Iranian nuclear programme," although the regulation did not specify whether the components were for uranium enrichment.[352]

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[349] *Summary of Major U.S. Export Enforcement, Economic Espionage, Trade Secret and Embargo-Related Criminal Cases* (January 2008 to the present: updated October 22, 2014).

[350] The Canadian press reported on the documents in August 2012 (Lee Berthiaume, "Canadian Goods Destined for Iran's Nuclear Program Slip Through: Documents," *Postmedia News*, August 22, 2012). One document is dated October 28, 2011. The other document is undated, but appears to have been created in 2011 or 2012.

[351] Einhorn, March 9, 2011. For more information, see CRS Report R40344, *The United Arab Emirates Nuclear Program and Proposed U.S. Nuclear Cooperation*, by (name redacted) and (name redacted) .

[352] *Council Implementing Regulation (EU) No 503/2011 of 23 May 2011 implementing Regulation (EU) No 961/2010 on restrictive measures against Iran*.