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Iran and Nuclear Weapons Production

Background

Iran's nuclear program has generated widespread concern that Tehran is pursuing nuclear weapons. According to U.S. intelligence assessments, Tehran has the capacity to produce nuclear weapons at some point, but has halted its nuclear weapons program and has not mastered all of the necessary technologies for building such weapons. (For additional information, see CRS Report RL34544, *Iran's Nuclear Program: Status*, by Paul K. Kerr.)

Since the early 2000s, Tehran's construction of gas centrifuge uranium enrichment facilities has been the main source of proliferation concern. Gas centrifuges enrich uranium by spinning uranium hexafluoride (UF6) gas at high speeds to increase the concentration of the uranium-235 (u-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. Tehran asserts that its enrichment program is meant to produce fuel for peaceful nuclear reactors.

The 2015 Joint Comprehensive Plan of Action (JCPOA) requires Iran to implement various restrictions on its nuclear program, as well as to accept specific monitoring and reporting requirements. (For additional information, see CRS Report R43333, *Iran Nuclear Agreement and U.S. Exit*, by Paul K. Kerr and Kenneth Katzman.)

Following this decision, Iran stopped implementing much of this agreement, as well as JCPOA-required International Atomic Energy Agency (IAEA) monitoring. Then-President Donald Trump announced in May 2018 that the United States was ending U.S. participation in the JCPOA; beginning in July 2019, the IAEA verified that some of Iran's nuclear activities were exceeding JCPOA-mandated limits. Tehran's subsequent expansion of the country's enrichment program has decreased the amount of time needed for Iran to produce enough weapons-grade HEU for a nuclear weapon—an action frequently termed "breakout."

According to official U.S. assessments, Iran halted its nuclear weapons program in late 2003 and has not resumed it. For example, the CIA has no evidence that Iranian Supreme Leader Ayatollah Ali Khamene'i "has made a decision to move to weaponize," CIA Director William Burns said stated during a December 2021 *Wall Street Journal* interview. This program's goal, according to U.S. officials, was to develop an implosion-style nuclear weapon for Iran's Shahab-3 ballistic missile.

The U.S. government assessed prior to the JCPOA that Tehran had not mastered all of the necessary technologies for building a nuclear weapon. Apparently confirming persisting gaps in Iran's nuclear weapons knowledge, the 2022 U.S. Intelligence Community Annual Threat Assessment observes that "Iran is not currently undertaking the key nuclear weapons-development activities ... necessary to produce a nuclear device." An April 2022 State Department report contains a similar conclusion.

The JCPOA-mandated restrictions on Iran's nuclear program and Iran-specific monitoring and reporting requirements both supplement Tehran's obligations pursuant to the government's comprehensive IAEA safeguards agreement. Such agreements empower the agency to detect the diversion of nuclear material from peaceful purposes, as well as to detect undeclared nuclear activities and material. These agreements also require governments to declare their entire inventory of certain nuclear materials, as well as related facilities. Safeguards include agency inspections and monitoring of declared nuclear facilities. (For more information, see CRS Report R40094, *Iran's Nuclear Program: Tehran's Compliance with International Obligations*, by Paul K. Kerr.)

Prior and subsequent to the JCPOA's January 2016 implementation, IAEA and U.S. officials expressed confidence in the ability of both the IAEA and the U.S. intelligence community to detect an Iranian breakout attempt using either Tehran's IAEA-monitored facilities or clandestine facilities. (See CRS Report R43333.)

Estimated Nuclear Weapons Development Timelines

U.S. estimates concerning Iranian nuclear weapon development account for the time necessary to produce a sufficient amount of weapons-grade HEU and also complete the remaining steps necessary for an implosion-style nuclear device suitable for explosive testing.

Fissile Material Production

The time needed to produce enough weapons-grade HEU for a nuclear weapon is a function of a nuclear program's enrichment capacity, as well as the mass and u-235 content of the UF6 stockpile fed into the enrichment process. LEU used in nuclear power reactors typically contains less than 5% u-235; research reactor fuel can be made using enriched uranium containing 20% u-235; HEU used in nuclear weapons typically contains about 90% u-235.

The JCPOA mandates restrictions on Iran's declared enrichment capacity and requires that Iran's enriched uranium stockpile must not exceed 300 kilograms of UF6 containing 3.67% u-235 "or the equivalent in other chemical forms." This quantity of uranium hexafluoride "corresponds to 202.8 kg of uranium," according to the IAEA.

The aforementioned JCPOA restrictions constrained Iran's nuclear program so that Tehran, using its declared enrichment facilities, would, for at least 10 years, have needed a minimum of one year to produce enough

weapons-grade HEU for one nuclear weapon. The JCPOA does not explicitly mandate such a timeline.

Iran's number of installed centrifuges, the mass and u-235 concentration of Tehran's enriched uranium stockpile, and number of enrichment locations currently exceed JCPOA-mandated limits. Tehran is also conducting JCPOA-prohibited research and development, illicit uranium metal production, and centrifuge manufacturing and installation.

A March 2022 IAEA report estimates Tehran's total enriched uranium stockpile to be 3197.1 kilograms of uranium. This amount includes batches of enriched uranium containing up to 5% u-235, up to 20% u-235, and up to 60% u-235, respectively. Iran has enough fissile material that, if further enriched, would be sufficient for several nuclear weapons, according to U.S. officials.

According to an April 2021 State Department report, "Iran's expansion of uranium enrichment activities ... allow [sic] Iran to enrich more uranium more quickly and to higher levels." The U.S. government estimates that Iran would currently need as little as one week to produce enough weapons-grade HEU for one nuclear weapon, according to a State Department official in March 2022.

If Tehran were to resume implementing its current JCPOA obligations, this fissile material production timeline would increase, but would be less than one year, according to State Department officials. This estimate reflects Iran's recent accumulation of knowledge gained by operating centrifuges that are more sophisticated. Former National Intelligence Council official Eric Brewer noted in an October 2021 Center for Strategic and International Studies publication that, absent this experience, Iran would probably have used less efficient, first-generation centrifuges for a breakout attempt.

Even with a breakout timeline of less than one year, Iran would be "unlikely" to make such an attempt, Brewer wrote, arguing that the JCPOA monitoring provisions "would almost certainly" enable the United States to detect such a move.

JCPOA restrictions on Iran's enrichment capacity, as well as the mass and u-235 content of the UF6 stockpile, begin to expire in January 2026. At that point, the breakout timeline would begin to decrease.

Weaponization

At the time when the JCPOA negotiations concluded, the U.S. intelligence community assessed that Iran would have needed one year to complete the necessary steps for producing a nuclear weapon that do not involve fissile material production. This estimate assumed that Iran could complete fissile material production and weaponization in parallel, which meant that Iran would have needed about one year to produce a nuclear weapon.

The U.S. intelligence community assesses that Iran has not resumed work on its weaponization research. A State Department official told CRS in a March 2022 email that Iran would need approximately one year to complete the necessary weaponization steps. This timeline "takes into consideration assessed knowledge gaps and reflects" the intelligence community's "view of Iran's fastest reasonable path to overcome them," the official added.

An implosion-style nuclear explosive device, according to the Office of Technology Assessment, uses "a shell of chemical high-explosive surrounding the nuclear material ... designed (for example, by being detonated nearly simultaneously at multiple points) to rapidly and uniformly compress the nuclear material to form a supercritical mass" necessary for a sustained nuclear chain reaction.

IAEA reports suggest that Iran does not yet have a viable nuclear weapon design or a suitable explosive detonation system. Tehran may also need additional experience in producing uranium metal; weapons-grade HEU metal for use in a nuclear weapon is first "cast and machined into suitable components for a nuclear core."

Discussion

The aforementioned one-year fissile-material breakout estimate assumes that Iran would use its declared nuclear facilities to produce fissile material for a weapon. But the breakout concept does not accurately measure Tehran's nuclear weapons capability.

The U.S. government continues to assess that Iran is more likely to use covert, rather than declared, facilities to produce the requisite fissile material. Neither the U.S. government nor the IAEA have publicly described any evidence that Iran is conducting such activities. Former National Nuclear Security Administration official Corey Hinderstein, who was involved in JCPOA implementation, wrote in a January 2020 *Defense One* article that producing fissile material in such a manner would require more time than executing a breakout scenario. As noted, IAEA and U.S. officials have expressed confidence in the ability of both the IAEA and the U.S. intelligence community to detect an Iranian covert breakout effort.

The breakout timeline was an unclassified proxy measure of Iranian nuclear weapons capabilities. A State Department official described the breakout "concept" in a September 2021 email as "a useful metric to help quantify" U.S. negotiating goals and as "a useful analytic framework to structure the negotiation of technical measures related to enrichment." The timeline was also "helpful in explaining the deal and selling it politically," the official noted, adding that the timeline has "become an important political yardstick" for evaluating the agreement's merits.

In a February 2022 *Bulletin of the Atomic Scientists* article, Jon Wolfsthal, a National Security Council official during the Obama Administration, explained that the "one-year breakout timeline" was "based on how much time that JCPOA members believed it would take to generate an international response to any Iranian move to build weapons."

Former State Department official Robert Einhorn discussed this point in a 2021 United Nations Institute for Disarmament Research report. The Obama Administration, according to Einhorn, argued that stopping Iran from developing nuclear weapons required preventing Tehran "from having the fissile material production infrastructure" to break out "in less time than it would take the international community to intervene to block it."

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