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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 only 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 more information, see CRS Report R40094, *Iran's Nuclear Program: Tehran's Compliance with International Obligations*, by Paul K. Kerr.)

Then-President Donald Trump announced in May 2018 that the United States was ending U.S. participation in the JCPOA. Over time, Iran subsequently stopped implementing much of this agreement, as well as JCPOA-required International Atomic Energy Agency (IAEA) monitoring. 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. This program's goal, according to U.S. officials and the IAEA, was to develop an implosion-style nuclear weapon for Iran's Shahab-3 ballistic missile. Iran has not made a decision to develop nuclear weapons, according to several 2024 public U.S. intelligence assessments.

The U.S. government assessed prior to the JCPOA that Iran had not mastered all of the necessary technologies for building a nuclear weapon. However, Tehran may now be conducting work on such technologies. The 2024 U.S. Intelligence Community Annual Threat Assessment published by the Office of the Director of National

Intelligence (ODNI) observes that "Iran is not currently undertaking the key nuclear weapons-development activities necessary to produce a testable nuclear device." But this phrase is absent from July and November 2024 ODNI assessments of Tehran's nuclear program.

The JCPOA-mandated restrictions on Iran's nuclear program, as well as the agreement's 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.

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 R40094). More recently, an ODNI spokesperson indicated that the U.S. intelligence community is capable of detecting Iranian efforts to build a nuclear weapon, the *Wall Street Journal* reported on August 9, 2024.

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.

Such a device, according to the Office of Technology Assessment, uses "a shell of chemical high-explosive surrounding the nuclear material ... to rapidly and uniformly compress the nuclear material to form a supercritical mass" necessary for a sustained nuclear chain reaction.

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 agreement does not explicitly mandate such a timeline. The timeline would begin to decrease after 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.

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, as well as centrifuge manufacturing and installation. A November 2024 ODNI report explains that Iran has enough fissile material that, if further enriched, would be sufficient for “more than a dozen nuclear weapons.”

According to the July 2024 ODNI report, “Tehran has the infrastructure and experience to quickly produce weapons-grade uranium.” The U.S. government estimates that Iran would 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. CIA Director William Burns stated during an October 7, 2024, event that Iran could produce this amount of HEU in “a week or a little more.”

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.

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.

Until recently, the U.S. intelligence community assessed that Iran had not resumed work on its weaponization research. A State Department official told CRS in an April 2022 email that Iran would need approximately one year to complete the necessary weaponization steps. This timeline took “into consideration assessed knowledge gaps” and reflected the intelligence community’s “view of Iran’s fastest reasonable path to overcome them,” the official added.

The current assessed timeline appears to be unclear. Chairman of the Joint Chiefs of Staff Mark Milley testified in March 2023 that Iran would need “several months to produce an actual nuclear weapon,” but he did not explain the assumptions underlying this estimate. As noted, a 2024 ODNI report indicates that Iran may have resumed work on its weaponization research.

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 has long assessed that Iran is more likely to use covert, rather than declared, facilities to produce the requisite fissile material; whether this is still the U.S. assessment is unclear. Neither the U.S. government nor the IAEA have publicly described any evidence that Iran is conducting covert nuclear 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.

During JCPOA negotiations, 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 goal was meant to provide enough time “to generate an international response to any Iranian move to build weapons.”

The Obama Administration, former State Department official Robert Einhorn wrote in a 2021 United Nations Institute for Disarmament Research report, 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.”

Paul K. Kerr, Specialist in Nonproliferation

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