

Enriching uranium is the key factor in how quickly Iran could produce a nuclear weapon. Here's where it stands today

July 20 2022, by Gary Samore



A cascade of gas centrifuges at a U.S. enrichment plant in Piketon, Ohio, in 1984. Iran is using similar technology to enrich uranium. Credit: [U.S. Department of Energy](#)

Iran's nuclear program was a major topic in President Joe Biden's July 13–16, 2022 trip to the Middle East. The most challenging part of producing nuclear weapons is making the material that fuels them, and Iran is known to have produced uranium that is near-weapons grade.

The Conversation asked Brandeis University professor [Gary Samore](#), who worked on nuclear arms control and nonproliferation in the U.S. government for over 20 years, to explain why [uranium enrichment](#) is central to Iran's nuclear ambitions and where the Iranian effort stands now.

What does it mean to enrich uranium?

Natural uranium contains two main isotopes, or forms whose atoms contain the same number of protons but different numbers of neutrons. It's about 99.3% uranium-238 and 0.7% uranium-235. The uranium-235 isotope can be used to generate [nuclear power](#) for peaceful purposes, or nuclear explosives for military purposes.

Enrichment is the process of separating out and increasing the concentration of U-235 to higher levels above natural uranium. Generally speaking, lower levels of enriched uranium, such as uranium with 5% U-235, are commonly used for nuclear reactor fuel. Higher levels of enrichment, such as 90% U-235, are most desirable for nuclear weapons.

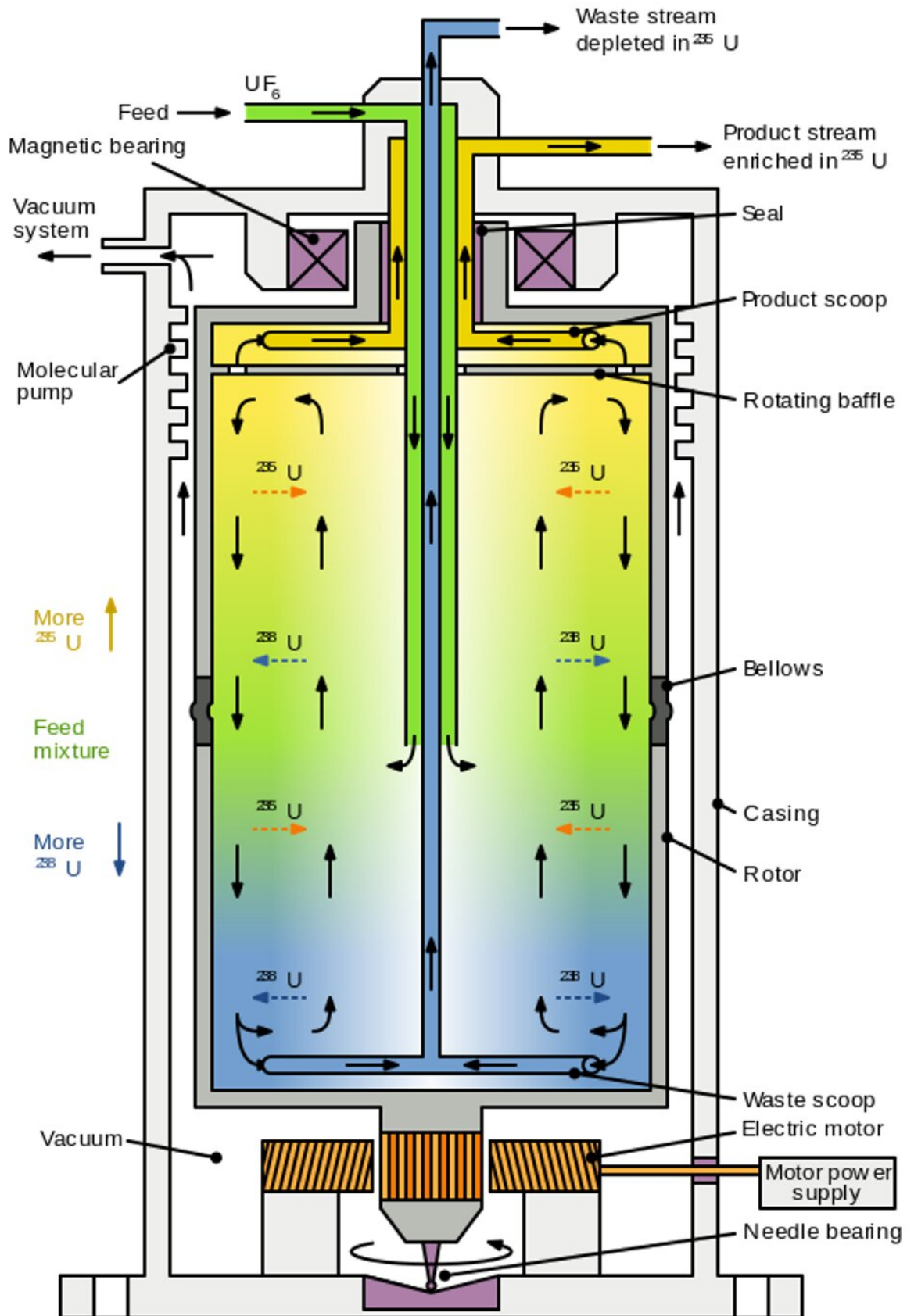
For military purposes, why are higher levels of enrichment important?

The higher the level of enrichment, the smaller the amount of nuclear material necessary to produce a nuclear weapon.

The [International Atomic Energy Agency](#) identifies 25 kilograms (55 pounds) of 90% enriched uranium as a "significant quantity" necessary for a simple nuclear weapon. But larger amounts of lower-enriched uranium can also work.

For example, the "[Little Boy](#)" [atomic bomb](#) that the U.S. dropped on Hiroshima, Japan, in 1945 used about 64 kilograms of uranium (141 pounds) enriched to [an average of 80% U-235](#).

From a nuclear weapons design standpoint, smaller amounts of higher-enriched nuclear material are more desirable because that reduces the size and weight of the nuclear weapon and makes it easier to deliver. As a result, modern [nuclear weapons](#) based on uranium typically use uranium enriched to 90% to 93% U-235, which is known as weapons-grade uranium, for the primary fuel.



A gas centrifuge separates uranium-235 atoms, which can sustain a nuclear chain reaction, from much more abundant atoms of uranium-238, which cannot. As the centrifuge rotates at high speed, uranium hexafluoride gas is pumped into it. The heavier U-238 molecules move toward the outer edge, and the lighter U-235 molecules move toward the center. The ‘product stream’ of gas enriched in U-235 is pumped through many more centrifuges, increasing the concentration of U-235 at each stage. Credit: Inductiveload/Wikipedia

What had Iran achieved prior to the 2015 nuclear deal?

The [2015 nuclear deal](#) between Iran, the U.S. China, France, the United Kingdom, Russia and Germany put significant restrictions on Iran's nuclear program, in return for relief from a number of international sanctions. When the deal was adopted, Iran had mastered the basic technology for enriching uranium with gas centrifuges—cylinders that spin uranium in gas form at very high speeds to separate the heavier U-238 isotope from the lighter U-235 isotope.

At its two principal enrichment facilities, [Natanz](#) and [Fordow](#), Iran was operating about 18,000 first-generation IR-1 centrifuges and about 1,000 second-generation IR-2 centrifuges. It had also accumulated a stockpile of roughly 7,000 kilograms (about 15,430 pounds) of low-enriched uranium (under 5%) and about 200 kilograms (440 pounds) of 20% enrichment uranium.

Based on these capabilities, Iran's "[breakout time](#)" to produce about 25 kilograms (55 pounds) of 90% enriched uranium—enough for a single [nuclear weapon](#)—was estimated to be one or two months.

Breakout time is not intended to suggest that Iran would necessarily

decide to produce weapons-grade uranium at these inspected facilities, because the risk of detection and of potential negative international reaction is very high.

President Biden arrived in Israel, nearly 50 years after his first trip as a senator, on Wednesday to open his Middle East visit to focus on slowing down Iran's nuclear program, getting oil to American gas pumps and improving relations with Saudi Arabia. <https://t.co/om6Pw4udVx> pic.twitter.com/0jrnRP93p

— The New York Times (@nytimes) [July 13, 2022](#)

How did the nuclear deal constrain Iran's activities?

The 2015 nuclear deal put physical constraints on Iran's enrichment program for 10 to 15 years, including the number and type of centrifuges Iran could operate, the size of its stockpile of low-enriched uranium and its maximum enrichment level.

For 15 years, no enrichment would take place at Fordow, and Iran's stockpile of low-enriched uranium would be limited to 300 kilograms (660 pounds) at a maximum enrichment level of 3.67%. And for 10 years, its centrifuges would be limited to about 6,000 IR-1 centrifuges at Natanz.

In order to meet these physical limits, Iran [shipped out to Russia](#) most of its stockpile of low-enriched uranium and its entire stockpile of 20% enriched uranium. It also [dismantled for storage inside Iran](#) most of its IR-1 centrifuges and all of its more advanced IR-2 centrifuges. As a consequence of these limits, Iran's "breakout time" was extended from a month or two before the deal to about one year after the deal.

After year 10 of the deal, however, Iran was allowed to start replacing its

IR-1 centrifuges at Natanz with more advanced models, which it was permitted to continue to research and develop during the first decade of the deal. As these more powerful advanced centrifuges were installed, breakout time would probably have shrunk to about a few months by year 15 of the deal.

As part of the deal, Iran also agreed to enhanced international inspections and monitoring of its nuclear facilities.

What has Iran done since President Trump withdrew the U.S. from the nuclear deal in 2018?

Since the U.S. [withdrew from the nuclear deal](#), Iran has gradually exceeded the agreement's limits. It has increased its stockpile of 5% enriched uranium; resumed producing 20% enriched uranium; initiated production of 60% enriched uranium, resumed enrichment at Fordow; and manufactured and installed advanced centrifuges at both Natanz and Fordow.

Iran has also begun to restrict international monitoring of its nuclear facilities. In June 2022, for example, Iran announced that it was disconnecting cameras installed under the 2015 [nuclear deal](#) to monitor its nuclear facilities.

As of May 2022, the International Atomic Energy Agency estimated that Iran had about 1,000 kilograms (2,200 pounds) of 5% enriched uranium, about 240 kilograms (530 pounds) of 20% enriched uranium and [40 kilograms \(88 pounds\) of 60% enriched uranium](#).

As a result of this growing stockpile of enriched uranium and the use of advanced centrifuges, Iran's estimated breakout time has been reduced to a few weeks. So far, however, Iran has not decided to begin production

of weapons-grade (90%) enriched uranium, even though it is technically capable of doing so.

Most likely, Iran is behaving cautiously because its leaders are concerned that producing weapons-grade [uranium](#) would trigger a strong international reaction, which could range from additional sanctions to military attack.

This article is republished from [The Conversation](#) under a Creative Commons license. Read the [original article](#).

Provided by The Conversation

Citation: Enriching uranium is the key factor in how quickly Iran could produce a nuclear weapon. Here's where it stands today (2022, July 20) retrieved 27 April 2024 from <https://phys.org/news/2022-07-enriching-uranium-key-factor-quickly.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.