

# Restoring the JCPOA's Nuclear Limits

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A year after former U.S. President Donald Trump withdrew the United States from the 2015 nuclear deal, known as the Joint Comprehensive Plan of Action (JCPOA), and reimposed sanctions on Iran in violation of the deal, Iran began to breach limits under the accord.

Iranian officials maintain that Iran will reverse its activities that violate the JCPOA and return to full compliance if the other parties to the deal meet their obligations under the accord. Iran's violations of the JCPOA are largely reversible and could likely be undone within 3 months with sufficient political will.

However, several of Iran's escalatory breaches have resulted in its acquisition of new knowledge and expertise that cannot be reversed. Also, Iran's decision to suspend implementation of the additional protocol and other JCPOA-specific safeguards measures could create gaps in the International Atomic Energy Agency (IAEA)'s monitoring, if Tehran chooses to not share recorded data with the agency upon restoration of the accord, even if Iran otherwise returns to full compliance with the JCPOA.

The following is a summary of the steps necessary to rectify Iran's current breaches of the JCPOA. The steps are listed in the order of Iran's violations of the JCPOA, beginning with its first breach in May 2019.

## 1. Restoring the stockpile limits on enriched uranium and heavy water

*Background:* Iran announced in May 2019 that it would no longer observe the JCPOA-imposed stockpile limits of 300 kilograms of uranium hexafluoride (UF<sub>6</sub>) gas (202 kilograms of uranium by weight) enriched 3.67 percent and 130 metric tons of heavy water. The IAEA confirmed that Iran breached the 300-kilogram limit on July 1, 2019 and the heavy water limit in November 2019. As of November 2021, Iran's stockpile of uranium gas enriched up to 5 percent was about 2,182 kilograms (measured by uranium weight)—roughly 11 times the cap. According to the IAEA's November 2021 report, Iran has also produced 113.8

kilograms of uranium enriched up to 20 percent, and 17.7 kilograms of uranium enriched up to 60 percent. While Iran's heavy water stockpile has exceeded the 130 metric ton cap, the IAEA measured the stockpile at 131.4 metric tons in February 2021. The IAEA has not had access to Iran's heavy water production since February 23, 2021, when Tehran restricted IAEA access under the December 2020 nuclear law. In September 2021, the IAEA noted that there were indications that Iran's heavy water production plant continued to operate after June 24.

*Restoring Compliance:* Iran can reverse its stockpile violations quite quickly. Tehran can either ship out enriched uranium in excess of the 300-kilogram limit of 3.67 percent gas or blend it down to natural levels. Excess heavy water could be used, shipped abroad for storage, or sold, all of which Iran has done in the past to stay below the cap. To help facilitate Iran's return to compliance, the Biden administration should issue sanctions waivers allowing Tehran to export excess uranium and heavy water. These waivers were revoked by the Trump administration. The United States could also offer to purchase a quantity of heavy water for U.S. applications. The Obama administration did this in the past after deeming Iran's heavy water of sufficient quality for U.S. purposes.

## 2. Restoring the limit on uranium enrichment to no more than 3.67 percent uranium-235

*Background:* Iran announced in July 2019 that it would begin enriching uranium up to 4.5 percent, which was immediately confirmed by the IAEA. On Jan. 4, 2021, the agency confirmed that Iran began enriching uranium to 20 percent [uranium-235], and to 60 percent in April 2021

(see below for details). Iran enriched to 20 percent, which constitutes about 90 percent of the effort necessary to enrich to weapons grade levels, prior to negotiations on the JCPOA.

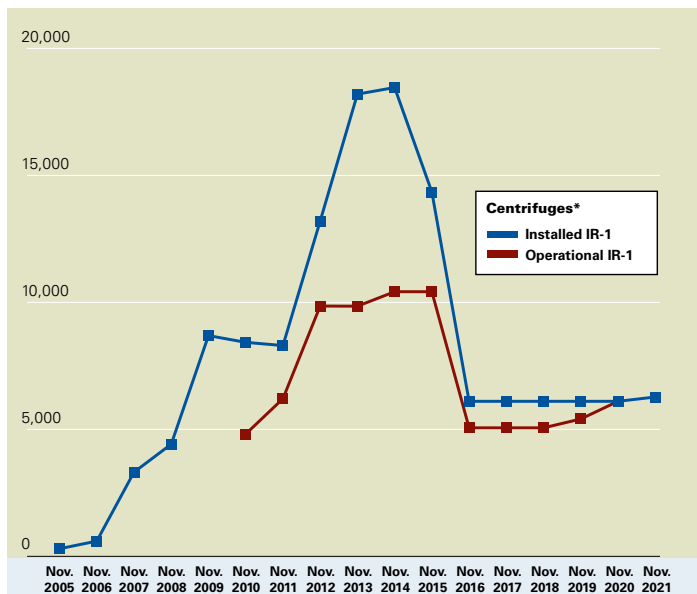
*Restoring Compliance:* Iran will need to halt enrichment to levels above 3.67 percent uranium-235 and recalibrate its centrifuges that were being used to enrich above that level. Given that Iran’s enrichment is monitored in real time using online enrichment monitors (OLEMs), the IAEA will be able to quickly confirm when Iran halts enrichment above the JCPOA limit. As noted above, material produced above the JCPOA’s limits can be blended down or shipped out.

Iran justifies its enrichment to 20 percent as necessary to produce uranium fuel for its Tehran Research Reactor (TRR), which produces medical isotopes. The United States should re-issue sanctions waivers that the Trump administration let lapse to allow Iran to import the necessary fuel for the TRR, removing the justification that 20 percent enrichment is necessary.

### 3. Returning to compliance with advanced centrifuge limits

*Background:* Iran announced in September 2019 that it would no longer be bound by any research and development limitations on advanced centrifuges imposed by the JCPOA. The deal’s restrictions include a 10-year prohibition on producing enriched uranium using

#### Capping Iran’s Deployment of Centrifuges



\*Iran is permitted to enrich uranium using 5,060 IR-1 centrifuges for 10 years. This chart does not reflect the advanced-model IR-2m, IR-4, and IR-6 centrifuges Iran has tested, operated, and used for the production of enriched uranium in breach of the accord since 2019. Source: IAEA, JCPOA

advanced machines and caps on the number and type of advanced centrifuges that Iran can install and operate for testing its designs. Since announcing this breach, Iran has installed full cascades of IR-2, IR-4, and IR-6 machines and is using them to enrich uranium. Iran has also introduced new advanced centrifuges not covered by the JCPOA.

The nuclear deal does permit Iran to design new centrifuge machines, but Tehran must receive approval from the Joint Commission before beginning testing. In what would be a further violation of research limits, a December 2020 nuclear law (see details below) calls for Iranian authorities to install 1,000 IR-2m centrifuges and 1,000 IR-6 centrifuges in 2021. According to the IAEA’s November 2021 report, Iran is operating six cascades of IR-2m centrifuges (1,044 machines) and two cascades of IR-4s (348 machines) at the main enrichment hall at Natanz. Iran also installed 189 IR-6 machines at Fordow, arranged in two cascades of 166 and 23 machines, and plans to install up to eight total cascades.

*Returning to compliance:* To return to compliance with the accord’s limits, Iran will need to dismantle and store under IAEA seal the advanced machines that it installed and is operating outside of the JCPOA’s parameters. It will also need to provide the IAEA with information about the new advanced centrifuges using an agreed-upon template designed by the JCPOA’s Joint Commission. The Joint Commission may also consider when and if Iran will be able to conduct any mechanical testing using those machines, as allowed by the JCPOA.

While the machines can be dismantled and stored relatively easily, the knowledge Iran has gained about the performance and capacity of its advanced machines is not reversible. This knowledge might have a slight impact on the overall breakout time of 12 months when the deal is fully implemented, but the IAEA would immediately detect any attempt to remove and reinstall the advanced machines. Iran’s testing of so many separate centrifuges design also suggests that the country has not established a designated successor for future enrichment when the JCPOA’s limits on enriching using IR-1s expire. The knowledge gained about advanced centrifuge performance could, however, be taken into account as the U.S. devises its plans for follow-up negotiations on a longer-term nuclear framework.

### 4. Halting uranium enrichment at Fordow

*Background:* In November 2019, Iran announced it would start enriching uranium up to 4.5 percent at Fordow. Iran continues to enrich uranium at Fordow and, in January

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2021, resumed enrichment to 20 percent at the facility. A November 2021 IAEA report confirmed that Iran continued to enrich to 20 percent, using 1,045 IR-1 centrifuges and 189 IR-6 centrifuges. Under the JCPOA, Iran is permitted to keep 1,044 IR-1 centrifuges at Fordow, but the deal prohibits from any uranium-related activities at the site for 15 years. As a result of Iran's decision to resume uranium enrichment at Fordow, efforts to convert the facility to a medical isotope research and development facility as required by the JCPOA, stalled.

*Returning to compliance:* To reverse this violation, Iran will need to halt production of enriched uranium using centrifuges at Fordow and remove all uranium from the facility. Iran will also need to remove the piping for the interconnected cascades that it is using for 20 percent enrichment, as that design is prohibited by the JCPOA. Iran may also choose to remove and store centrifuges that had been used for enrichment and replace them with excess IR-1s currently under storage that are not contaminated with uranium for isotope research and production, which is the intended use of Fordow for 15 years under the JCPOA.

### **Planned and In-Progress Iranian JCPOA Violations**

In an effort to put pressure on the United States and other JCPOA parties to deliver on sanctions relief envisioned by the JCPOA and respond to the assassination of Iranian nuclear scientist Mohsen Fakrizadeh, the Iranian government enacted a law in late December 2020 requiring the Atomic Energy Organization of Iran (AEOI) to take a number of steps to further breach the accord in 2021.

- **Limits on Uranium Enrichment (in progress and discussed above)**

*Background:* Iran is required to produce 120 kilograms of uranium enriched to 20 percent uranium-235 on an annual basis under the December 2020 law. The IAEA confirmed that Iran began enriching to this level at Fordow on Jan. 4, 2021. Iran notified the IAEA of its intentions to increase enrichment levels at that site prior to doing so.

*Restoring compliance:* Iran could either ship out or blend down its uranium enriched above 3.67 percent uranium-235 and reconfigure the centrifuges being used for enrichment to that level.

- **Limits on Iran's Use of Advanced Centrifuges (in progress and discussed above)**

*Background:* The nuclear law requires Iran to install and operate 1,000 IR-2m centrifuges within three months of the legislation's enactment (late-March 2021) and install 1,000 IR-6 centrifuges by the end of 2021. The IAEA confirmed that Iran had installed 1,044 IR-2m centrifuges at Natanz as of November 2021. Iran also installed 189 IR-6 centrifuges at Fordow, arranged into two cascades of 166 and 23 machines, and plans to install a total of eight IR-6 cascades.

*Restoring compliance:* Iran would need to dismantle and store under IAEA seal the excess advanced centrifuges. While Iran will have gained some knowledge about producing and operating these machines, it does not significantly impact the country's breakout or proliferation risk, given the relatively small number of centrifuges in question and the IAEA's ability to immediately detect any attempt to access and install the machines.

- **Restrictions on Iran's Implementation of the Additional Protocol and JCPOA-Specific Verification Measures (planned)**

*Background:* Iran suspended implementation of the additional protocol to its safeguards agreement and the JCPOA-specific verification mechanisms in February 2021, in accordance with the nuclear law. Iran continues to implement its comprehensive safeguards agreement (CSA), which is required by the nuclear Nonproliferation Treaty (NPT). Iran also continues to record and collect necessary monitoring information for the IAEA, per a Feb. 2021 agreement, and will transmit that data to the agency upon restoration of the JCPOA and after sanctions relief is granted.

*Restoring Compliance:* Iran can notify the IAEA of its intention to adhere to the additional protocol and the JCPOA required verification mechanisms to restore full implementation of the deal's monitoring mechanisms. While more intrusive inspections could resume quickly after Iran notifies the IAEA, the time required to return to full compliance with these obligations may depend on whether, and how quickly, Iran transmits recorded data to the IAEA, and the extent to which the IAEA can re-construct a narrative of Iran's nuclear activities during that time based on the data provided.

The reversibility of this violation also depends on the length of time that Iran is in violation of the obligations and Iran's willingness to take additional steps/provide information to fill in any gaps that may emerge from the breaks in monitoring. If the measures are suspended for too long, or if Iran chooses to cease the recording and collection of data for the IAEA, or chooses not to transmit it to the agency upon

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restoration of the JCPOA, it may create gaps in knowledge that could complicate the IAEA's task of determining if Iran's nuclear materials remain in peaceful purposes and increase speculation about illicit nuclear activities.

- **Uranium Metal Production (planned)**

*Background:* The December 2020 law requires the AEOI to “inaugurate the metallic uranium factory” at the Isfahan Fuel Fabrication Plant within five months, or by late May 2021. Iran notified the IAEA of its intentions to begin installing and designing equipment and its plans for producing a new uranium metal fuel for the Tehran Research Reactor, which produces medical isotopes. The IAEA verified that Iran produced 2.42 kilograms of natural uranium metal on May 18, 2021. From that, Iran used 0.85 kilograms to produce 0.54 kilograms of uranium in the form of uranium silicide. On October 25, the agency verified that Iran had produced two batches of uranium silicide containing 0.43 kilograms of uranium enriched up to 20 percent. The Agency's Nov. 17 report confirmed that Iran had completed the four-stage process to produce new fuel for the Tehran Research Reactor and that it had manufactured two fuel plates using uranium silicide containing 0.25 kilograms of uranium enriched up to 20 percent. Iran has produced 17 fuel assemblies for the Tehran Research Reactor, four of which have already been transferred to the reactor, according to the IAEA.

*Restoring Compliance:* Iran may have produced a limited amount of uranium metal in the past as part of its pre-2003 nuclear weapons program, but it does not appear to have

significant experience with the process. Evidence from the IAEA's investigations and the material Israel stole from Iran suggest that Iran conducted experiments on producing metal using surrogate materials and was in the process of constructing a uranium metal production facility, but the decision was made to abandon it. The IAEA also had evidence that Iran received a document on how to produce uranium metal in shapes relevant to weapons development from the AQ Khan network. While Iran could quickly uninstall any equipment put in place for this project and ship out any uranium metal produced, the knowledge gained is irreversible and relevant if Iran decided to pursue nuclear weapons in the future.

- **Work on a New Heavy Water Reactor (planned)**

*Background:* Iran announced plans to build a new heavy water reactor based on the original design of the unfinished heavy-water reactor at Arak. As originally designed, that reactor would have produced enough plutonium annually that, when separated, would be enough for two nuclear weapons. Iran is prohibited from building new heavy water reactors for 15 years under the JCPOA and from separating plutonium for the same time period.

*Restoring Compliance:* While the AEOI has submitted plans for the reactor, construction has not yet begun, making the decision easy to reverse. Even if Iran were to take steps to begin constructing the reactor, it could be dismantled quickly, or the unfinished reactor monitored to ensure Iran does not continue any building activities until the 15-year ban on heavy-water reactors expires.