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Iran's Uranium Enrichment Program: November 2020 Update

One of the most worrisome aspects of centrifuge enrichment plants is that even if they are configured to produce only low enriched uranium, they can easily be used to produce the highly enriched uranium (HEU) required for nuclear weapons using a batch recycling process. In a prior paper, I described how Iran could carry out this process in its current centrifuge enrichment facilities by sending the 4.5% enriched uranium that it is currently producing back through the cascade three more times.[2] In the first step, the enrichment would be increased to 23.7%, the second step to 67.1% and the third step to 93.1%.[3] Only minor modifications to the centrifuge plant are needed to carry out this process.

This prior analysis showed that *given a sufficiently large* stockpile of 4.5% enriched uranium, Iran could produce enough HEU for a nuclear weapon in just two to two and one half months.[4] The analysis showed that Iran would need about 1,845 kilograms of 4.5% enriched uranium to be able to produce enough HEU for a nuclear weapon (20 kilograms of uranium enriched to 93.1%). However according to reporting by the International Atomic Energy Agency (IAEA) as of February 20, 2020, Iran only had a stockpile of 537.8 kilograms of 4.5% enriched uranium. At its then production rate of 4.5% enriched uranium, Iran would not reach the total of 1,845 kilograms of 4.5% enriched uranium for about eleven months from February 2020, that is January 2021.

On November 11, 2020, the International Atomic Energy Agency (IAEA) published its latest safeguards update on Iran's nuclear program.[5] This update reported that Iran's total stockpile of 4.5% enriched uranium as of November 2, 2020, was 1,535 kilograms. This is an increase of 283 kilograms since the IAEA's last inventory on August 25, 2020. Iran's current rate of increase (4.1 kilograms per day) is slightly greater than the rate for most of 2020. At the current rate of increase Iran will reach a total of 1,845 kilograms at about the same time as I calculated in my April analysis, which is mid-January 2021, little more than one month from now.

Note that since it would take Iran two to two and a half months to then process this 4.5% enriched uranium into HEU, Iran would not have sufficient HEU for a nuclear weapon before the

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[1] This paper is the product of the author's personal research and the analysis and views contained in it are solely his responsibility. Though the author is also a part-time adjunct staff member at the RAND Corporation, this paper is not related to any RAND project and therefore RAND should not be mentioned in relation to this paper. I can be reached at GregJones@proliferationmatters.com

[2] Gregory S. Jones, "Iran's Uranium Enrichment Program Making Strides but Still At Least Six Months From Being Able to Produce Enough HEU for a Nuclear Weapon." April 2, 2020. https://nebula.wsimg.com/0110bd8db6cebe189303e8aa10b23ece?AccessKeyId=40C80D0B51471CD86975&disposition=0&alloworigin=1

[3] The tails for these three steps are 2.0%, 11.8% and 46.9% respectively.

[4] Gregory S. Jones, "Iran's Uranium Enrichment Program Making Strides but Still At Least Six Months From Being Able to Produce Enough HEU for a Nuclear Weapon." April 2, 2020.

[5] "Verification and monitoring in the Islamic Republic of Iran in light of United Nations Security Council resolution 2231 (2015)," GOV/2020/51, International Atomic Energy Agency, November 11, 2020. https://www.iaea.org/sites/default/files/20/11/gov2020-51.pdf

latter part of March 2021. Even then, Iran will probably not actually produce this HEU. It is more likely that Iran will accumulate additional 4.5% enriched uranium, so that if Iran should eventually produce HEU it could have a sufficient quantity for more than one nuclear weapon. Iran is unlikely to produce this quantity of HEU before the end of 2021 at the earliest. As a result, it will probably be at least 2022 before Iran actually constructs and deploy nuclear weapons.

If Iran had an enrichment facility optimally designed to produce HEU, its current stockpile of 4.5% enriched uranium would be more than enough to produce the quantity of HEU required for a nuclear weapon. Indeed, such an optimal facility could produce 20 kilograms of 93.1% enriched uranium using only 442 kilograms of 4.5% enriched uranium feed (0.3% tails), meaning its current 4.5% enriched uranium stockpile would be sufficient for three nuclear weapons.

However, Iran does not have an optimal enrichment facility for the production of HEU and it would take many months for Iran to reconfigure all of its centrifuges to create one. The 1,845 kilograms of 4.5% enriched uranium feed required to produce enough HEU for a nuclear weapon using batch recycling in Iran's current enrichment facilities is far greater than 442 kilograms. By using batch recycling, a large amount of U-235 is temporarily "lost" in the tails, which have an enrichment far higher that 0.3%. This is why so much additional 4.5% feed is required for batch recycling. The advantage of using batch recycling is that the centrifuge plant can be used as is, significantly reducing the amount of warning available once Iran begins its dash to produce HEU.

What is to be done to stop Iran's steady progress towards a nuclear weapon? There appears to be no satisfactory solution. Covert action is being taken against Iran's nuclear weapon program. In July 2020, an explosion and fire destroyed the Iran Centrifuge Assembly Center near Natanz. On November 27, 2020 a key Iranian scientist, Mohsen Fakhizadeh, was assassinated. These actions, while slowing Iran's progress, are insufficient to stop its nuclear weapon program.

I feel that the current policy of maximum pressure is the best one available as it has imposed serious economic costs on Iran which, if nothing else, may deter other countries from wanting to follow in Iran's footsteps. However, it appears that Iran is so determined to acquire nuclear weapons that it is willing bear these costs to achieve its goal.

It has been reported that president-elect Biden may wish to return the U.S. to compliance with the Joint Comprehensive Plan of Action (JCPOA). One of the main problems with this suggestion is that in January 2021 five years of this agreement will have already elapsed. Three years after that, in January 2024, some of the restrictions on Iran's centrifuge manufacturing and testing expire. In five years, January 2026, there will no longer be any restrictions on the number or types of centrifuges that Iran is allowed to deploy. Once Iran is operating a large number of advanced centrifuges, the time required for Iran to produce HEU for nuclear weapons would become quite short, as President Obama admitted in 2015.[6] Returning to the JCPOA would also

[6] He said "…at that point the breakout times would have shrunk almost down to zero." See: "Transcript: President Obama's Full NPR Interview On Iran Nuclear Deal," April 7, 2015. https://www.npr.org/2015/04/07/397933577/transcript-president-obamas-full-npr-interview-on-iran-nuclear-deal

remove the severe economic costs imposed by the maximum pressure sanctions, restoring Iran's economy and easing its path to a nuclear weapon.

Further, Iran appears to have been eroding the JCPOA's restrictions even when the agreement was in force. The Joint Commission, in its capacity of defining the terms of the JCPOA, stated that the IR-1, Iran's main centrifuge, should have a capacity of no more than 1.0 SWU per year.[7] This determination already allowed Iran to increase its enrichment capacity, since most IR-1s at that time were producing only about 0.74 SWU per year. However, Iran's current rate of production of 4.5% enriched uranium suggests that Iran's IR-1s now have a capacity of about 1.2 SWU per year. Should the JCPOA come back into force, the U.S. will probably need to accept that the IR-1 upgrade is permanent. For this and other reasons, a restored JCPOA will allow Iran a breakout time less than the one year that was its original goal. Indeed, David Albright has calculated that even under the original JCPOA, the breakout time was never more than seven to eight months.[8]

Given this poor outlook for stopping Iran's acquisition of nuclear weapons, it has been reported that President Trump has considered conducting a military strike on Iran's centrifuge enrichment facilities. However, I am opposed to such action since a single military strike will do little to slow Iran's progress towards nuclear weapons and sustained military action would probably lead to a major war with Iran.

Israel effectively carried out one time strikes on nuclear reactors in Iraq in 1981 and in Syria in 2007[9]. But attacks on centrifuge enrichment facilities, even if carried out by the U.S., are quite different from attacking single nuclear reactors and it would be difficult for such attacks to be effective in the long-term. At its main enrichment facility at Natanz, Iran has 31 cascades and near Qom in an underground site, 6 more cascades, all of which are operating in parallel. An air strike on these facilities that scored multiple bomb hits would be able to shut the facilities down. However, the majority of the cascades would be undamaged and not able to operate only due to damage to piping and the loss of utilities. It would only take a few months of repairs before these undamaged cascades were back in operation. Even for the cascades that suffered bomb hits, the majority of the centrifuges would still be undamaged. Iran could pull out the undamaged centrifuges and use them to build new cascade as well as use additional centrifuges from storage. It would only take four to six months before Iran would return to close to full production.

A further problem is Iran's current stockpile of over 1,500 kilograms of 4.5% enriched uranium. This stockpile represents over a year of centrifuge plant operation but would be very difficult to

[7] "Communication dated 21 December 2016 to the Agency sent on behalf of High Representative Mogherini in her capacity as Coordinator of the Joint Commission established under the Joint Comprehensive Plan of Action," INFCIRC/907, 23 December 2016, "Procedure to determine the SWU attribution to the IR-1, IR-2m, and IR-4 centrifuge types," p. 1. https://www.iaea.org/sites/default/files/publications/documents/infcircs/2016/infcirc907.pdf

[8] David Albright and Sarah Burkhard, "Iranian Breakout Estimates and Enriched Uranium Stocks," Institute for Science and International Security, April 21, 2020, p. 5. https://isis-online.org/uploads/isis-reports/documents/Breakout_and_LEU_stocks__April_21%2C_2020__final.pdf

[9] Isabel Kershner, "Ending Secrecy, Israel Says It Bombed Syrian Reactor in 2007," *The New York Times*, March 21, 2018. https://www.nytimes.com/2018/03/21/world/middleeast/israel-syria-nuclear-reactor.html

destroy by an air attack. The total volume of this stockpile is small and it would be easy to hide or protect.

It is small wonder that in the past U.S. officials talked of bombing campaigns rather than single strikes.[10] By bombing Iran's facilities every few months, it would be possible to keep Iran's enrichment facilities shut down. Such a campaign would also have the advantage that the question of whether U.S. large bunker-buster bombs can actually penetrate and hit Iran's underground enrichment facility near Qom would largely be moot. No matter how deep and well protected a bunker is, it is always possible to collapse the entrance tunnels and cut off the utilities from the outside.

There are two problems with such an air bombing campaign. First, Iran could respond by dispersing its centrifuges. Indeed, centrifuge enrichment with its many parallel cascades would be ideal for such dispersal. The U.S. would be able to find and bomb some of these dispersed enrichment sites but many would continue in operation undetected. Second, such a prolonged bombing campaign would run a serious risk of turning into a large-scale war with Iran. Though no doubt the U.S. would eventually win the war, I think that such a war would be ill-advised and I am opposed to a major war with Iran.

In sum, Iran's appears to be determined to use its supposedly peaceful nuclear facilities to acquire nuclear weapons, despite the heavy economic costs imposed by U.S. sanctions. The only realistic option for stopping Iranian nuclear weapons appears to be for the U.S. to have a large-scale war with Iran, which in my view would be unwise. Instead, the U.S. may need to start planning for how it will deal with a nuclear-armed Iran.

[10] Joby Warrick, "Iran's underground nuclear sites not immune to U.S. bunker-busters, experts say," *The Washington Post*, February 29, 2012.