INSTITUTE FOR SCIENCE AND INTERNATIONAL SECURITY

REPORT

New Estimates of Iran's Breakout Capabilities at Declared Sites Using a New, Simple-to-Use Breakout Calculator

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A new Institute breakout calculator is presented and applied to several theoretical cases where Iran increases its stocks of low enriched uranium (LEU) above the limits allowed in the Iran nuclear deal, or Joint Comprehensive Plan of Action (JCPOA). In addition, breakout times for Iran's August 2019 inventory of LEU are developed.

If Iran decided to build nuclear weapons, it could use its existing, declared production-scale gas centrifuge plants, the Natanz Fuel Enrichment Plant and the Fordow Fuel Enrichment Plant, and low enriched uranium already produced there to make weapon-grade uranium (WGU), defined as uranium enriched to at least 90 percent U-235. This report introduces a new, easy-to-use calculator developed by the Institute to evaluate scenarios, commonly called "breakout times," by which Iran could produce enough WGU for one or more nuclear weapons. In line with previous conventions used by the Institute, 25 kilograms of WGU represents the amount sufficient for a single nuclear weapon.[1]

In this report, the new breakout calculator estimates realistic, minimum breakout times given Iran's current enrichment capabilities under the Joint Comprehensive Plan of Action and a set of additional, potential capabilities as it reduces its commitment to the JCPOA's centrifuge-related limits. Here, with one exception, the focus is on Iran's potential growth in its stocks of LEU hexafluoride rather than a systematic increase in the enrichment capacity at Natanz and Fordow, in further violation of JCPOA limits. Other scenarios will be addressed in future reports, as events and interests develop.

[1] This amount should not be confused with what is defined as a "significant quantity" of weapon-grade uranium by the International Atomic Energy Agency (IAEA), or 25 kilograms of uranium-235 in more than 90 percent enriched uranium. At 90 percent enriched, a significant quantity would correspond to 27.8 kilograms of weapon-grade uranium. Moreover, a first nuclear weapon may require more or less than this amount, depending on its design and the rate of losses in preparing weapons components from the weapon-grade uranium hexafluoride, which is the output of a centrifuge plant.

How does the Breakout Calculator work?

The new estimates are based on *modified ideal cascade calculations*, where the modifications are adjustments that compensate for the systematic, significant underestimating of breakout times by *ideal cascade calculations* applied to Iran's gas centrifuge program or other relatively small, less advanced centrifuge programs. The adjustments in the breakout calculator are based on complex computer simulations, which the Institute did in the past in conjunction with Houston Wood, Patrick Migliorini, and other associates at the University of Virginia, to model breakout times in Iran's enrichment infrastructure.[2] These previous, sophisticated simulations, which did not use ideal cascade calculations, accounted for performance limitations specific to Iran's first generation IR-1 centrifuges and their arrangement into a set of cascades organized into four steps that step-wise enrich from natural uranium to weapon-grade uranium; a similar approach was used for the second-generation IR-2m centrifuges. The adjustments to the new calculator reflect the effect on estimated breakout in this four-step enrichment process and further inefficiencies in Iranian cascade operations, in particular that the cascades are far from ideal, as defined under ideal cascade calculations. Without these modifications to the ideal cascade calculations, these simple calculations would result in breakout times that are too short and unrealistic for Iran's centrifuge program. The net effect of these modifications to the calculator is, in general, an increase in predicted breakout times by about one third to one half.

The breakout predictions are intended to represent a realistic minimum time Iran would need to produce its first 25 kilograms of WGU. They account for system limitations, centrifuge breakage, and other inefficiencies, but not for all the various problems or delays of the type that have been encountered by Iran's program, which could lengthen the needed enriching time further.

The calculator's estimates compared accurately to the earlier, more rigorous Institute and University of Virginia breakout calculations, with one exception. The new breakout calculator does not include set-up times, which, in earlier Institute calculations, were often two weeks. Thus, for cases where breakout times are a month or less, the breakout calculator produced noticeably shorter breakout times.

The calculator's methodology addresses the feedstocks of enriched uranium sequentially--first utilized are any stocks of near 20 percent enriched uranium, second any 3.5 (or 4.5) percent enriched uranium, followed by the use of natural uranium, until 25 kilograms of WGU were achieved. In the current model of the calculator, if a stock is used up in a particular month, the shift to the use of the next stock occurs in the following month. This, at times, generates anomalies in the breakout estimates.

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[2] See for example, "Iran's Evolving Breakout Potential," William C. Witt, Christina Walrond, David Albright, and Houston Wood, *Institute for Science and International Security,* October 8, 2012, http://isis-online.org/uploads/isis-reports/documents/Irans_Evolving_Breakout_Potential.pdf or "Iranian Breakout Estimates, Updated September 2013," Patrick Migliorini, David Albright, Houston Wood, and Christina Walrond, *Institute for Science and International Security,* October 24, 2013, http://isis-online.org/uploads/isis-reports/documents/Breakout_Study_24October2013.pdf

Overall, the breakout calculator allows for a rapid estimate of breakout times that is useful in better understanding the threat of various potential Iranian actions. It also serves to help set policy choices by allowing a quantitative estimate of Iran's most threatening actions to unwind the JCPOA. That being said, the calculator does not eliminate the need for sophisticated breakout calculations using detailed information about Iran's gas centrifuge effort.

It should also be pointed out that the estimates are given for the time needed to enrich 25 kilograms of WGU; the estimates do not include the additional time necessary for the nuclear weaponization process. However, based on the new information contained in the Iranian Nuclear Archive, a portion of which was seized by Israel in early 2018 and analyzed in detail by the Institute, if Iran were to attempt to make a missile-deliverable nuclear weapon, it would face engineering challenges, but would likely be able to fashion a weapon within several months, unlike the one year or more estimated pre-archive.[3]

Breakout Assumptions

Almost all of the estimates considered here assume that *until* Iran breaks out, it would maintain its current enrichment capability, as mandated by the JCPOA, which involves 5060 IR-1 centrifuges enriching at Natanz and up to 1044 IR-1 centrifuges dormant at Fordow.[4] However, it would increase its stocks of LEU hexafluoride, in violation of JCPOA limits, where the limit is 300 kilograms of less than 3.67 percent LEU and a small stock of near 20 percent LEU principally associated with the Tehran Research Reactor.[5] As of July 1, Iran had violated the 300 kilogram limit by going slightly over the cap. Throughout the summer, it continued to produce LEU in excess of the cap (see below). Moreover, while the JCPOA allows continued 3.5 percent enriched uranium production, it prohibits production of any uranium enriched above 3.67 percent. Nonetheless, Iran has also violated this limit by going up to 4.5 percent, and therefore breakout calculations using feedstocks of 4.5 percent enriched uranium are also considered. Another assumption under these scenarios is that *at* the time of breakout, Iran would activate the dormant centrifuges at Fordow and start to redeploy additional IR-1 centrifuges at both Natanz and Fordow, which are currently in monitored storage, at a deployment rate achieved prior to the JCPOA, namely about two cascades per month. It has thousands of IR-1 centrifuges in storage, enough to continue their reinstallation during the breakout times encountered in the estimates performed here.

Here, an additional consideration is whether Iran would also redeploy its 1000 IR-2m centrifuges at Natanz that were also put in storage under the JCPOA. Both breakout cases, with or without IR-2ms, are evaluated, but IR-2m redeployment early in a breakout is viewed as

[3] A series of over ten studies on the Nuclear Archive are available on the Institute's web site, www.isis-online.org.

[4] Of these 1044 centrifuges, almost a dozen are involved in stable isotope separation in cooperation with Russia. As of August 2019, 11 IR-1 centrifuges were involved in this work. See: http://isis-online.org/isis-reports/detail/iaea-iran-safeguards-report-analysis-nuclear-deal-violations-persist-cooper

[5] Ignored here are stocks of enriched uranium exempted by the Joint Commission from JCPOA limits. Because these stocks and their exact chemical forms are not known publicly, they cannot be included in this analysis.

more likely, given that this centrifuge is one of Iran's most advanced ones and is also available to use in large numbers in a breakout. Moreover, the IR-2m centrifuges appear to break less and operate better than the IR-1 centrifuges, which is reflected in the calculator. The calculator assumes that in this case, the 1000 IR-2m centrifuges would be reinstalled in six cascades in three months and operate somewhat better than the IR-1 centrifuges. Moreover, the IR-2m deployment would occur in parallel to the redeployment of IR-1 centrifuges that would also be installed at a rate of two cascades per month. The exclusion of the initial redeployment of IR-2m centrifuges in U.S. breakout estimates (along with those of some of its allies) appears to have been decided internally, while not flagged publicly, in order to preserve a public 12-month breakout time, a major advertisement of the JCPOA. If initial redeployment of the IR-2m centrifuges is included, the breakout time drops to about 7-8 months. Although this period of time is still substantial, the selling of the JCPOA emphasized achieving a twelve-month breakout time and a more nuanced discussion was not welcome or acknowledged publicly.

Another scenario considered is the expansion of Iran's total centrifuge enrichment capacity at Natanz or Fordow *before* it makes a breakout decision. Although Iran could increase its centrifuge capacity by deploying stored IR-1 centrifuges, here we consider only the deployment of the 1000 IR-2m centrifuges currently stored. Because the IR-2m centrifuges have an enrichment capacity several-fold that of the IR-1 centrifuges, the redeployment of 1000 IR-2m would roughly double Iran's nominal enrichment capacity, which currently involves 5060 IR-1 centrifuges at Natanz. Although the calculator factors in redeployment of these IR-2m centrifuges during breakout, this scenario tests the advantage of redeploying them prior to start of breakout, allowing for a slower, more careful installation of one of its most advanced centrifuges. Then, during breakout, this case considers the redeployment of only IR-1 centrifuges.

The calculator can evaluate many other scenarios not considered in this report, such as the deployment of more IR-1 or IR-2m centrifuges before or after breakout, as well as the case of other advanced centrifuges. Clandestine gas centrifuge plants can also be considered.

Key Results of Calculator Estimates

At JCPOA-allowed levels of centrifuges and enriched uranium stocks, the calculator estimates breakout times as 12.4 months, with only redeployment of IR-1 centrifuges during the actual breakout period, and 7.7 months if the 1000 IR-2m centrifuges are also redeployed during the breakout with the IR-1 centrifuges.

Growing Initial Stocks of 3.5 and 4.5 Percent Enriched Uranium. As pre-breakout stocks of 3.5 percent LEU accumulate, Figure 1 shows the reduction of breakout times, starting from the status quo. With a stock of 3.5 percent enriched uranium above approximately 1200 kilograms, the breakout time plateaus, reflecting a form of saturation in the production of the first 25 kilograms of WGU. (The additional LEU can be used to relatively more rapidly produce the second tranche of WGU). For no IR-2m redeployment, the breakout time plateaus at 5.5 months. With IR-2m redeployment, the breakout time plateaus at 3.7 months. Hence, by itself, the accumulation of 3.5 percent LEU would lower breakout times to about 3.7 to 5.5 months. The gap between the two redeployment strategies narrows from 4.7 to 1.9 months (see Figure 1), suggesting that as LEU stocks accumulate, the practical effect of redeployment strategies on breakout time diminishes.

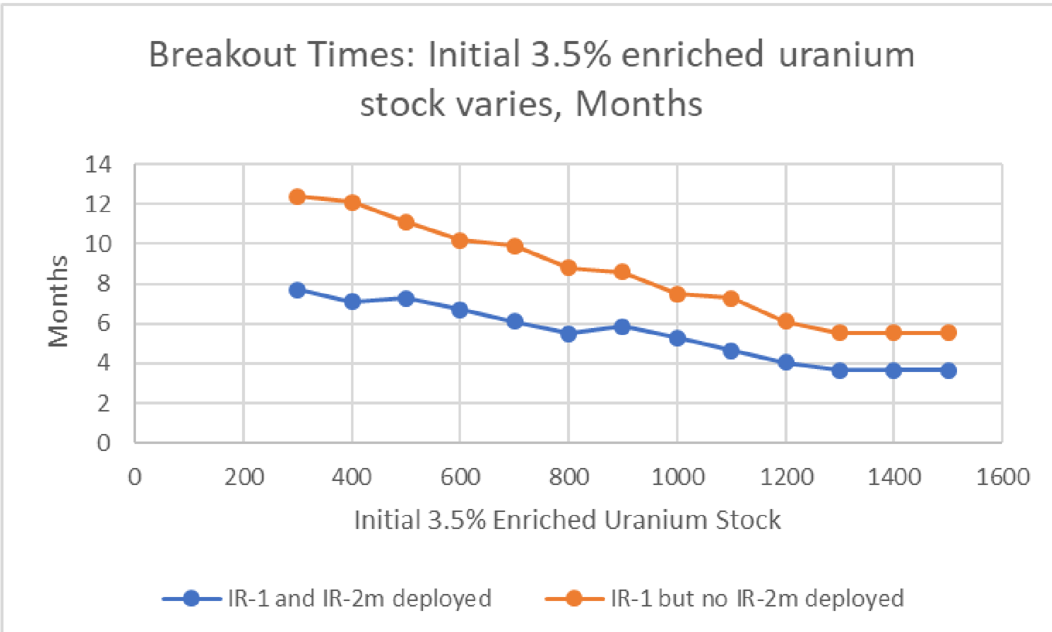

Figure 1. Decreasing breakout times based on increasing pre-breakout stocks of 3.5 percent LEU (hexafluoride mass), with no near 20 percent LEU. At the start of breakout, the initial enrichment capacity would be in line with the JCPOA, but would increase as additional centrifuges are deployed. Both cases of redeployment are considered.

If Iran continues to enrich at the level of 4.5 percent rather than at 3.5 percent, the effect is to lower breakout times relative to 3.5 percent feedstocks. At 300 kilograms of 4.5 percent enriched uranium, the breakout times in terms of IR-2m and no IR-2m redeployment, are 7.1 and 11.4 months, respectively (down from 7.7 and 12.4 months, respectively, for 3.5 percent). This reflects a reduction in breakout time of about 8 percent in each case. The effect is not larger because most of the weapon-grade uranium is produced from natural uranium feed after feeding in the relatively small stock of 4.5 percent enriched uranium. The percentage reduction increases as stocks of 4.5 percent enriched uranium grow, reaching as high as 20 percent or more for stocks of 700 kilograms of 4.5 percent enriched uranium versus 700 kilograms of 3.5 percent enriched uranium. The plateau in breakout time for the 4.5 percent stock occurs at a smaller initial enriched uranium stock than the case of 3.5 percent, namely at about 900 kilograms of 4.5 percent enriched uranium versus over 1200 kilograms for 3.5 percent. Comparing differences in plateau values, the reduction in breakout time using 4.5 percent enriched uranium, rather than 3.5 percent stocks, is about 5 percent with IR-2m redeployment and 13 percent without.

Growing Initial Stocks of near 20 Percent Enriched Uranium. The production of near 20 percent enriched uranium has a dramatic effect on lowering breakout times. This is not unexpected, given that its production represents finishing the second of four steps to making weapon-grade uranium. The enrichment effort is not linear, and finishing the first two steps accounts for about 90 percent of the total enrichment effort needed to reach WGU. In this case, the amount of 3.5 percent LEU is held constant at 300 kilograms, and both redeployment cases are considered. The results are in Figure 2, which shows that as near 20 percent enriched uranium stocks increase, breakout times steadily decrease—in the case of redeployment of both IR-1 and IR-2m centrifuges the breakout time reaches two months at a stock of 150 kilograms and drops to 1.15 months when the stock reaches 200 kilograms. In the case of IR-1-only redeployment, the values are similar with larger near 20 percent stocks, reaching 2.4 months at a stock of 150 kilograms, and 1.2 months when the stock reaches 200 kilograms. As observed with 3.5 percent LEU stocks, as stocks of near 20 percent LEU increase, the practical effect of the two different centrifuge redeployment strategies diminishes.

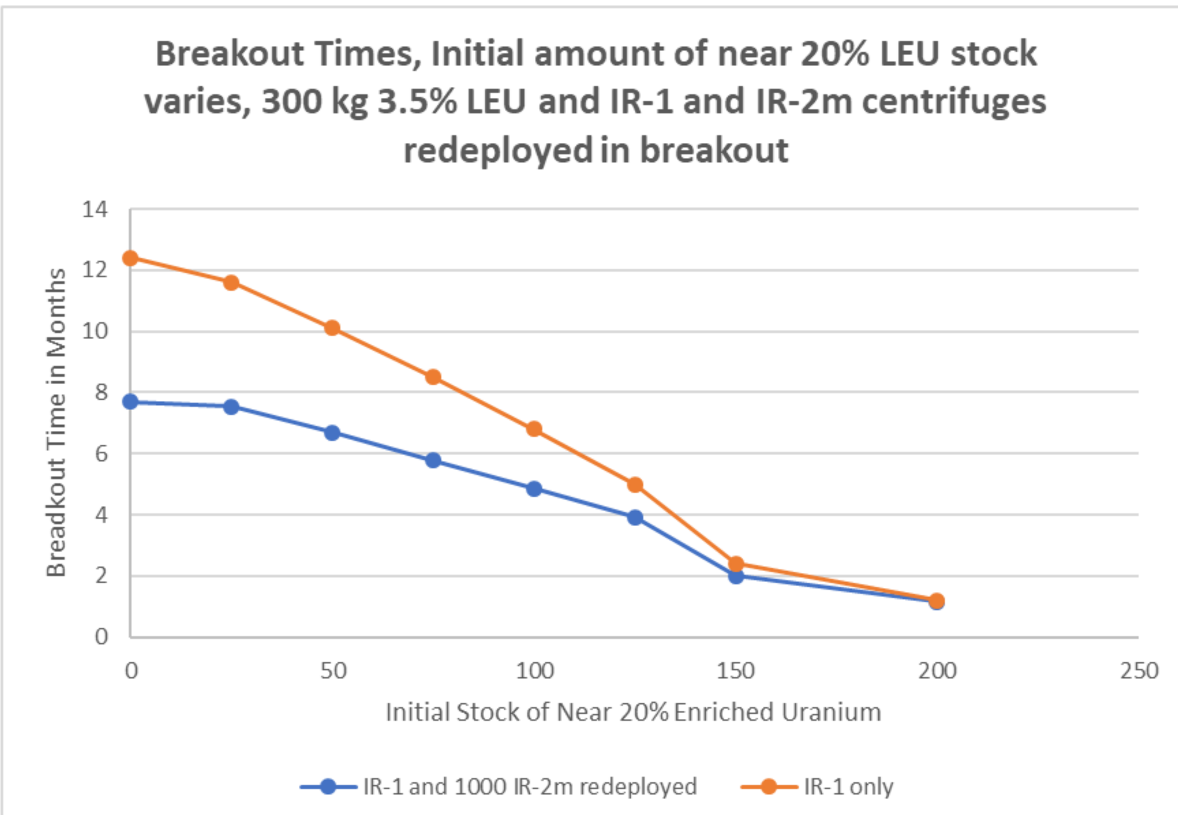

Figure 2. Decreasing breakout times based on increasing stocks of initial near 20 percent LEU (hexafluoride mass), with a fixed amount of 300 kilograms of 3.5 percent LEU (hexafluoride mass). At the start of breakout, the initial enrichment capacity would be in line with the JCPOA limit but would increase as additional centrifuges are deployed. The graph has an anomaly at 175 kilograms of near 20 percent enriched uranium and that data point is omitted. Both cases of redeployment are considered.

Growing Initial Stocks of both 3.5 and near 20 Percent Enriched Uranium. Increasing stocks of both 3.5 and near 20 percent enriched uranium will further lower breakout times. However, as stocks increase and breakout times reduce, the more determinant stock will be the near 20 percent LEU. Figure 3 shows several combinations of pre-breakout 3.5 and near 20 percent LEU stocks, assuming redeployment of both IR-1 and IR-2m centrifuges at breakout. As the amount of near 20 percent enriched uranium increases, the breakout times converge despite differing amounts of 3.5 percent enriched uranium. This convergence in Figure 3 happens first when there is a stock of 150 kilograms of near 20 percent LEU, where the breakout time is two months. At 200 kilograms of near 20 percent, the converged breakout time is about 1.15 months, because at that point, enough 20 percent enriched uranium is available to go forward, and no further LEU or natural uranium would be needed.

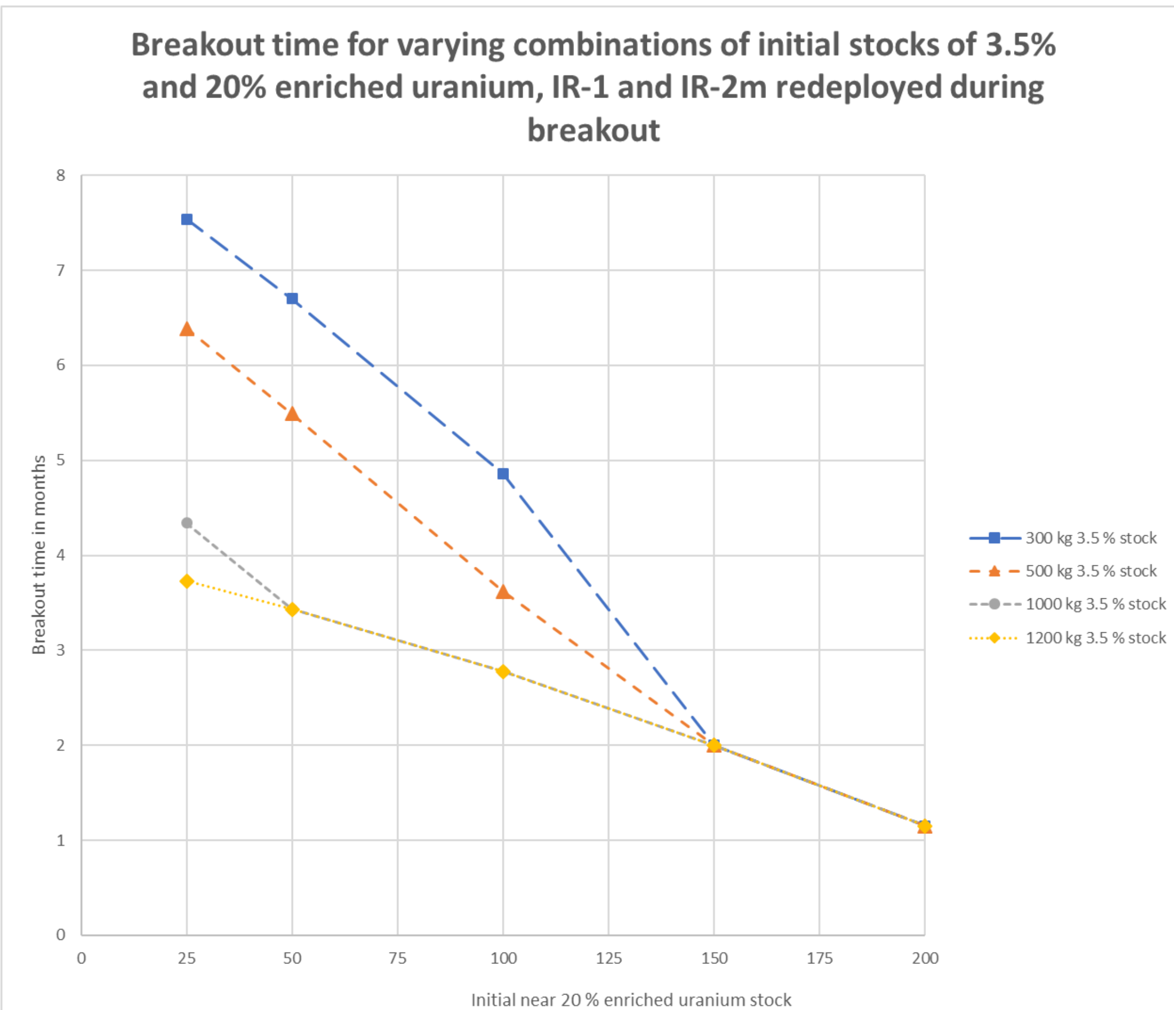

Figure 3. Breakout times, with increasing increments of stocks of 3.5 percent and near 20 percent enriched uranium (hexafluoride masses), and redeployment during breakout of both IR-1 and IR-2m centrifuges (the case of only IR-1 redeployment is not considered here). At the start of breakout, the initial enrichment capacity would be in line with the JCPOA but would increase as additional centrifuges are deployed.

Redeployment of 1000 IR-2m Centrifuges Prior to Any Breakout. Another scenario is based on Iran redeploying its stored 1000 IR-2m centrifuges prior to breakout. During breakout itself in this scenario, Iran would deploy only IR-1 centrifuges. Figure 4 shows the results, using a combination of 3.5 and near 20 percent enriched uranium stocks. One result is that this scenario, as expected, would achieve a somewhat lower breakout time than other ones above, reaching less than one month (0.85 months) if Iran accumulated a stock of 200 kilograms of near 20 percent LEU. One significant result is that with a stock of 1200 kilograms of 3.5 percent enriched uranium, the breakout time is two months. As in Figure 3, convergence of the breakout times, despite differing initial stocks of 3.5 percent enriched uranium, first occurs at 150 kilograms of near 20 percent enriched uranium.

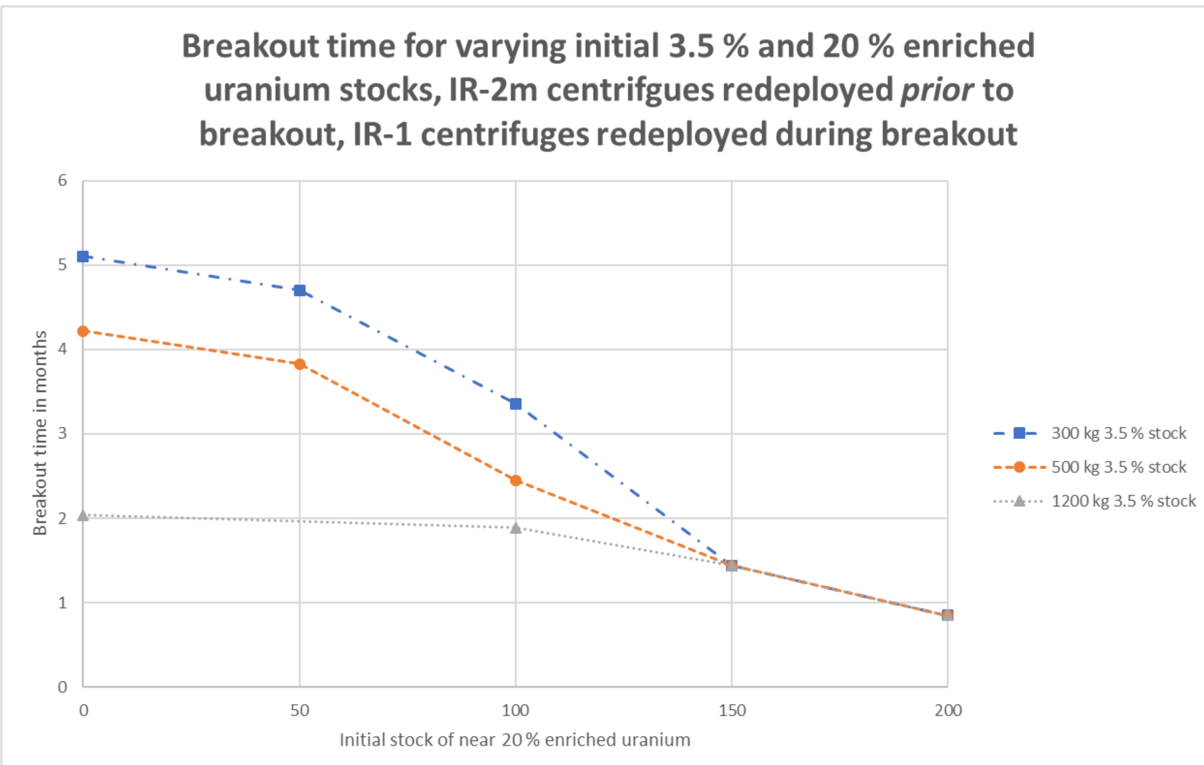

Figure 4. Breakout times, with increasing stocks of 3.5 percent and near 20 percent enriched uranium (hexafluoride masses), and redeployment *prior* to breakout of 1000 IR-2m centrifuges. During breakout, additional IR-1 centrifuges would be redeployed.

Time to Produce Stocks of LEU and Breakout Timelines

In the IAEA Iran reports, the JCPOA cap on less than 3.67 percent enriched uranium is measured in two equivalent ways, namely as 300 kilograms of less than 3.67 percent enriched uranium hexafluoride (UF_6), or 202.8 kilograms of uranium in less than 3.67 percent enriched uranium. The difference in mass reflects the mass of the fluorine atoms in uranium hexafluoride.

Recent and Current Inventories of LEU. Iran's enrichment rate increased six-fold in the weeks prior to exceeding the JCPOA cap on 3.67 percent LEU on July 1, 2019. As of May 20, 2019, Iran had a total stockpile of 174.1 kilograms of less than 3.67 percent LEU, of which 153.2 kg was in the form of uranium hexafluoride (uranium masses). On July 1, 2019, Iran had a total of 205 kg of less than 3.5 percent LEU, of which 184.1 kilograms was in the form of uranium hexafluoride.[6] From May 20 to July 1, Iran produced 30.9 kg of less than 3.67 percent LEU, which converts to 45.7 kilograms of less than 3.67 LEU in hexafluoride mass. During this period the average daily production was about 1.11 kg, or a monthly average of about 33.3 kilograms of less than 3.67 percent LEU (hexafluoride mass). For comparison, over the previous three months from February to May 2019, the average rate was about 5 kilograms per month of less than 3.67 percent LEU (hexafluoride mass).

Starting on July 8, 2019, the IAEA stated Iran was enriching up to a level 4.5 percent, in violation of the 3.67 percent enrichment limit. Over the summer, it continued to enrich up to the level of 4.5 percent.

As of August 19, the IAEA reported in its quarterly Iran report that Iran possessed about 357.4 kg of low enriched uranium (hexafluoride mass), all enriched below 5 percent, or the equivalent of 241.6 kg (uranium mass). The IAEA reports that of that latter figure, Iran has produced 25.1 kg of up to 4.5 percent LEU (uranium mass), or 37.1 kilograms (hexafluoride mass) in the form of uranium hexafluoride. It is worth noting that Iran is not producing additional LEU at full capacity.

Between July 1 and August 19, it produced on average 32.5 kilograms per month of less than 5 percent enriched uranium (hexafluoride mass). This is well below the maximum average amount Iran could produce in the 5060 IR-1 centrifuges at Natanz, which can produce up to 100 kg per month.

In the Table below, the February vs. May vs. August 2019 comparisons of these quantities show how Iran has increased its production of LEU, as measured in uranium mass only. The net increase in the total stock of LEU in Iran from May 20 to August 19 was 67.5 kilograms LEU (uranium mass), at an overall average rate of 22.3 kilograms (uranium mass) per month. Alternatively, these values convert to 99.9 kg LEU (hexafluoride mass), or an average of 32.9 kg LEU (hexafluoride mass) per month. Over the summer, Iran thus decreased slightly its average monthly production of enriched uranium, compared to the May/June period (see above).

[6] The IAEA reported: "On 1 July 2019, the Agency verified that the quantity of Iran's uranium enriched up to 3.67% U-235 was 205.0 kg." See: IAEA Director General, *Verification and Monitoring in the Islamic Republic of Iran in light of United Nations Security Council Resolution 2231 (2015),* GOV/INF/2019/8, July 1, 2019, http://isis-online.org/uploads/iaea-reports/documents/IAEA_Iran_report_1Jul2019.pdf

Table. Enriched Uranium Quantities, less than 5 percent and all quantities in uranium mass

	February 2019	May 2019	August 2019
Chemical Form			
UF_6	139.8 kg	153.2 kg	218.9 kg
Uranium oxides and their intermediate products	10.4 kg	10.4 kg	11.1 kg
Uranium in fuel assemblies and rods	4.3 kg	4.3 kg	4.6 kg
Uranium in liquid and solid scrap	9.3 kg	6.2 kg	7.0 kg
Enrichment Level Subtotals			
Uranium enriched to 3.67 percent	163.8 kg	174.1 kg	216.5 kg
Uranium enriched to 4.5 percent	0	0	25.1 kg
Totals of Enriched Uranium, <5%	**163.8 kg**	**174.1 kg**	**241.6 kg**

Decrease in Breakout Timeline. With Iran exceeding its caps on enriched uranium stocks and levels, the breakout timeline, or the amount of time Iran would need to produce enough weapon-grade uranium for a nuclear weapon, has shifted downward. The total shift downward in the breakout time is approximately one half of a month, meaning that the total breakout time has decreased by one half of a month from its value when Iran had a stock of 300 kg of less than 3.67 percent enriched uranium. In terms of the values predicted by the calculator, Iran's breakout time is as of mid-August 2019 7.3 to 11.74 months, compared to 7.7 to 12.4 months just prior to July 2019.

Predicting Iran's rate of production of LEU is difficult. As discussed, the rate is unlikely to exceed 100 kilograms per month (hexafluoride mass). For comparison, two scenarios are presented.

The first is that Iran continues producing LEU at a rate of 30 kilograms per month, but at an enrichment level of 4.5 percent and neither further increases its enrichment level nor enriches in additional centrifuges at Natanz or Fordow. In this case, Iran's stock of LEU will grow relatively slowly, reaching in twelve months from mid-August 2019, about 717 kilograms of LEU, where about 320 kilograms is 3.5 percent enriched and 397 kilograms is 4.5 percent LEU (hexafluoride masses). With this stock, the breakout times would decrease to about 5 to 8.5 months. If only 3.5 percent LEU were produced, the breakout times would be 6 to 9.7 months.

Several Worst-Case Projections of LEU Stocks. Using the existing IR-1 enrichment capacity at Natanz, Iran could produce more enriched uranium than above. However, it is currently not expected to produce more than approximately 100 kilograms of 3.5 percent LEU hexafluoride per month in the existing 5060 IR-1 Natanz centrifuges. If Iran re-activated near 20 percent LEU production at Natanz or Fordow, which it has threatened to do but so far has not done, it could produce up to about 10-15 kilograms of near 20 percent enriched uranium per month in up to 1000 IR-1 centrifuges.

Over a period of six months, using the above LEU production rates and the breakout calculator, Iran could accumulate a total of 900 kilograms of 3.5 percent enriched uranium and achieve a breakout time of 5.9 to 8.6 months, depending on the redeployment strategy. If Iran produced 4.5 percent enriched uranium instead, the breakout time would be shorter by up to 20 percent, which is a little more than one month.[7]

Over a period of 10 months, using the above LEU production rates and the breakout calculator, Iran could accumulate a total of 1300 kilograms of 3.5 percent enriched uranium and achieve a breakout time of 3.7 to 5.5 months, depending on the redeployment strategy. Stocks greater than 1300 kilograms would not change these results (see Figure 1), although they would speed up the production of the second batch of WGU.

The production of near 20 percent enriched uranium would significantly shorten these breakout times, and Iran has several times threatened to restart enrichment to this level. In this more speculative scenario, breakout assumes the redeployment of both IR-1 and IR-2m centrifuges. At the above rates of enriched uranium production, in twelve months, Iran could accumulate 1500 kilograms of 3.5 percent enriched uranium and 120-180 kilograms of near 20 percent LEU, resulting in a breakout time with those initial stocks of 1.2 to 2 months (see Figure 3). This range is rounded to one to two months, reflecting in the case of the lower bound of the use of at least some 4.5 percent LEU. In six months, using the above rates, Iran could accumulate 900 kilograms of 3.5 percent (or 4.5 percent) enriched uranium and about 60-90 kilograms of near 20 percent enriched uranium, with a breakout time of approximately 2.3 to 2.6 months, which is rounded to two to three months.

Conclusion

During the next many months, breakout times at Natanz and Fordow appear long enough to make an Iranian decision to break out risky. If Iran would quickly increase its breakout capability, it would be more likely to attract UN sanctions snapback or even military strikes. Therefore, the Institute assesses that Iran is unlikely to break out at Natanz or at Fordow in the near term, barring unforeseen developments. It may, however, slowly increase its violations of the JCPOA limits and continue to lower its breakout timelines toward levels that are more threatening.

In terms of shortening breakout times in the next year, the actions that are most provocative are the production of higher enriched uranium (near 20 percent enriched LEU) and possibly the deployment of the stored IR-2m or other advanced centrifuges.

[7] Iran would also likely have a stock of 3.5 percent LEU, which it would also likely use, making this a case with both 3.5 and 4.5 percent enriched uranium.

However, even in the case in which Iran takes no action other than to increase its stocks of up to 3.67 and 4. 5 percent enriched uranium, breakout times could shrink precipitously during the next two years. The potential for relatively rapid decreases in breakout times argues for relatively quick action against Iran's noncompliance with the JCPOA limits.