INSTITUTE FOR SCIENCE AND INTERNATIONAL SECURITY

REPORT

Iran's Long-Term Centrifuge Enrichment Plan: Providing Needed Transparency

Institute for Science and International Security

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The Associated Press recently obtained Iran's enrichment and enrichment R&D plan that was negotiated as part of the Joint Comprehensive Plan of Action (JCPOA). The plan is an integral part of the limits contained in JCPOA but it has not been made public. We believe the Associated Press has done a valuable public service and the plan should not be secret. The plan includes the expected growth of Iran's centrifuge program during years 9-13 of the JCPOA. We have seen the plan and report on it in detail in this report. Combined with information about the capacities of Iran's key advanced centrifuges, we have assessed Iran's breakout time at year 13 to be four months. This value based on this information is less than our August 2015 estimate of six months at year 13.[1]

Iran's long-term enrichment and enrichment research and development plan contains the major limitations on the numbers and types of centrifuges it can make and deploy during the first 13 years of the Joint Comprehensive Plan of Action. For reasons that remain unclear, the plan has not been made public, even though the contents of Iran's plan were negotiated intensively between Iran and the United States, and these limitations are fundamental to the JCPOA. Although members of the P5+1 discussed releasing this plan publicly, a decision was made not to do so, likely at the insistence of Iran. However, the reasons for non-public disclosure of all of its major provisions seem flawed, particularly given the public releases of other parts of the JCPOA's limitations, many of which are included in this plan.

In brief, during the first ten years of the JCPOA, starting from Implementation Day which occurred on January 16, 2016, Iran has committed to sharply limit its centrifuge program. After eight years, Iran's plan allows for the expansion of its centrifuge manufacturing capability and of its work on its two most advanced centrifuges, the IR-6 and IR-8. During years 11-13, it would build up the numbers of its advanced IR-4 and IR-2m centrifuge cascades and add one production level cascade each of IR-6 and IR-8 centrifuges. Following year 13, Iran apparently faces no restrictions on building and deploying advanced IR-4 and IR-2m centrifuges, although

[1] David Albright, Houston Wood, and Andrea Stricker, *Breakout Timelines Under the Joint Comprehensive Plan of Action*, Institute for Science and International Security Report, August 18, 2015. http://www.isis-online.org/uploads/isis-reports/documents/Iranian_Breakout_Timelines_and_Issues_18Aug2015_final.pdf

restrictions will remain for two more years on the number of IR-6 and IR-8 centrifuges it can manufacture, the amount of low enriched uranium (LEU) it can produce, and the LEU's enrichment level. Iran has stated that it intends to rapidly grow its centrifuge program as the limits are removed, which means that breakout timelines will also decrease significantly.

The limits on Iran's centrifuge program were a controversial aspect during the JCPOA negotiations. Iran's enrichment and enrichment R&D plan was developed during the deal's negotiation and its contents were approved by the P5+1. Nonetheless, Iran calls it expressly a "voluntary commitment." According to the JCPOA, "Iran will abide by its voluntary commitments, as expressed in its own long-term enrichment and enrichment R&D plan to be submitted as part of the initial declaration for the Additional Protocol to Iran's Safeguards Agreement." Iran's implementation of this plan will be monitored by the International Atomic Energy Agency (IAEA).

Although Iran's plan was not made public either after the JCPOA was finalized in July 2015 or after Implementation Day in January 2016, members of the P5+1 received copies of this plan, which is not surprising given the central importance of the document in the JCPOA. In the case of the United States, this plan (perhaps in slightly different versions) was submitted to Congress as a secret or confidential section. The Obama administration provided to Congress the plan that Iran submitted to the IAEA as part of its Implementation Day submissions.

The JCPOA envisioned that Iran's enrichment plan submitted to the IAEA would be distributed beyond the IAEA, which normally treats state declarations as confidential and not available to member states. According to Annex 1 of the JCPOA, "Iran will permit the IAEA to share the content of the enrichment and enrichment R&D plan, as submitted as part of the initial declaration, with the Joint Commission participants." Thus, Iran's plan has been circulated widely and is not typical safeguards confidential information collected by the IAEA from member states. Moreover, the language in the plan does not appear any more sensitive than any other language in the JCPOA.

Iran's plan is of overriding public interest, given the future risk of the JCPOA failing as Iran rebuilds and expands its centrifuge program and the increased potential for military conflict in the Middle East that could involve the United States and its allies, as Iran's nuclear weapons capabilities once again grow and breakout timelines drop. Not surprisingly, as was the case of the secret agreement between the IAEA and Iran on the Parchin site, Iran's enrichment and enrichment R&D plan was also obtained by the media.

Recently, the Associated Press gained access to Iran's plan submitted to the IAEA and revealed details about the contents in its reporting.[2] We have also seen a copy of the plan submitted to the IAEA and decided it is in the interest of the public to reveal its contents. We are not able to

[2] George Jahn, "Iran nuclear constraints to ease in about a decade, secret document reveals," The Associated Press. July 18, 2016.

provide the plan itself but we have copied its sections and present them below. Their accuracy was confirmed by a knowledgeable official who has seen the same document.

In our report, we have combined the data in the plan with additional information about Iran's key advanced centrifuges to preliminarily estimate the decrease in breakout times associated with the steps in this plan, in particular when the main limits outlined in the plan end, namely 13 years after Implementation Day. In this report, we provide a straightforward breakout timeline based on scaling from Iran's current enrichment breakout capability. We plan to release more detailed breakout assessments.

Iran's Enrichment and Enrichment R&D Plan

The document we have seen has four sections covering centrifuge limits during the first 13 years of the JCPOA, measured in years since Implementation Day. According to this convention, we are currently in the first year of the JCPOA. Year 10 would start in early 2026, year 11 in 2027, and year 13 in 2029. The first section for example deals with centrifuge constraints in years 1-8 and the fourth section covers actions in years 11-13.

Section 1 of the Plan

The first section of Iran's enrichment and enrichment R&D plan covers the centrifuge limits on the number of IR-1 centrifuges and advanced centrifuge research and development during the first eight years of the JCPOA. This section placed severe limits on Iran's centrifuge uranium enrichment program and was made public in Annex 1 of the JCPOA. Although this section and several other sections in the plan are already known publicly, we include all of the sections to facilitate understanding of the sections that were not revealed publicly and provide their context.

In this report, to identify when we are quoting language in the plan, we put it inside quotation marks without further citation. The reader should assume that any quotation without further attribution is from this plan. In the case of quotations from other documents, such as the public portion of the JCPOA, we clearly mark this quote as taken from other documents.

Opening line of s**ection 1 of Plan:** "Between years 1 to 8 after implementation of the JCPOA," Iran:

Section 1.1 "Will keep its enrichment capacity at no more than 5060 IR-1 centrifuge machines in no more than 30 cascades in their current configuration in currently operating units at the Natanz Fuel Enrichment Plant (FEP)."

> Section 1.1.1 "Whenever the level of stock of IR-1 machines falls to 500 or below, may maintain this level of stock by resuming production of IR-1 machines at a rate up to average monthly crash rate without exceeding the stock of 500."

Section 1.2 "Will continue to conduct enrichment R&D in a manner that does not accumulate enriched uranium, in addition:" (Authors' note: The centrifuges do enrich uranium, which Iran measures before it remixes the product and tails together into natural uranium).

> Section 1.2.1 "Mechanical testing on up to two single centrifuges for each type will be carried out on the IR-2m, IR-4, IR-5, IR-6, IR-6s, IR-7, and IR-8." (Authors' note: Mechanical testing typically does not include the use of uranium).
>
> Section 1.2.2 "Will continue the testing of a single IR-4 centrifuge machine and IR-4 centrifuge cascade of up to 10 centrifuge machines." (Authors' note: The IR-4 can use uranium[3]).
>
> Section 1.2.3 "Will test a single IR-5 centrifuge machine."(Authors' note: The IR-5 can use uranium[4]).

The first section, as stated above, places well-known and severe constraints on Iran's enrichment program, consistent with a goal of achieving a breakout timeline of at least 12 months. The 12 month figure is based on 5060 IR-1 centrifuges, a stock of 300 kilograms of 3.5 percent low enriched uranium hexafluoride, and on near 20 percent LEU hexafluoride, while assuming no redeployment of stored IR-2m centrifuges. (If redeployment of IR-2m centrifuges would occur in a breakout, a likely development, the breakout timeline would drop to seven months[5]).

The centrifuge R&D limits in the plan are intended to slow Iran's progress in developing advanced centrifuges. However, they also allow Iran to make progress in key areas.

Section 2 of the Plan

The second section, which covers years 1 to 8 and a half, discusses in more detail the allowed testing of the IR-6 and IR-8 centrifuges using uranium. The second section in essence allows Iran space to develop the IR-6 and IR-8 centrifuges, which Iran has stated represent its best hope for deploying an advanced centrifuge after year 10. Much of this section is also in the JCPOA with the exception that the timing of steps is more precisely defined in the non-public plan than in the public JCPOA.

Opening sentence of section 2 "Between years 1 to 8 and a half, in addition to continue the abovementioned activities."

[3] According to Annex 1 of the JCPOA, "for 10 years and consistent with its enrichment R&D plan, Iran's enrichment R&D with uranium will only include IR-4, IR-5, IR-6 and IR-8 centrifuges."
[4] Ibid.
[5] *Breakout Timelines Under the Joint Comprehensive Plan of Action*, August 18, 2015.

Section 2.1 “Will continue the testing of the IR-6 on single centrifuges and intermediate cascades (testing with uranium of roughly 10 centrifuges and then roughly 20 centrifuges, with each of these groups being tested with uranium for approximately equal time periods.”

Section 2.2 “Will start, upon implementation of the JCPOA, testing of the IR-8 centrifuge on single centrifuges and its intermediate cascades (completion of mechanical testing of single centrifuges in 1 year, testing with uranium of a single centrifuge, 3 centrifuges, roughly 10 centrifuges, and roughly 20 centrifuges sequentially with each of these groups being tested for approximately equal time periods).”

Section 3 of Plan: Centrifuge Build Up

Iran’s significant centrifuge scale-up starts after year 8. During the first two years, namely in years 9 and 10, Iran has stated it plans to focus on increasing its advanced centrifuge manufacturing capabilities and increasing the number of IR-6 and IR-8 centrifuges in test cascades containing up to 30 machines. Much of this section is contained in the JCPOA.

Opening sentence of section 3 “Between years 8 to 10, in addition to continue the abovementioned activities:” which include:

Section 3.1: “Will prepare at the end of year 8, for its gradual evolution to the next stage of its enrichment activities. In this regard, Iran will begin to build necessary appropriate manufacturing capacity.”

Section 3.2: “At the end of year 8, to be prepared for its gradual evolution to the next stage of its enrichment activities, will commence manufacturing of IR-6 and IR-8 centrifuges without rotors at a rate of up to 200 centrifuges per year for each type.”

Section 3.3: “Will commence the testing of up to 30 IR-6 centrifuges from one and a half years before the end of year 10.”

Section 3.4: “Will commence the testing of up to 30 IR-8 centrifuges from one and a half years before the end of year 10.”

Section 3.1 implies that Iran would be procuring equipment, materials, and other items needed to increase its domestic centrifuge manufacturing capability. By implication, such activities are forbidden in years 1-8. During years 9 and 10, many of these procurements would likely need to go through the JCPOA’s Procurement Channel. However, after year 10, the Procurement Channel is slated to end with the end of the provisions in United Nations Security Council (UNSC) Resolution 2231. Effective controls on exports to Iran after year 10 will need to be further developed. One possible step is to extend for another ten years UNSC Resolution 2231, including extending the life of the Procurement Channel.

In years 9 and 10, Iran will be able to make IR-6 and IR-8 centrifuges without rotors, meaning that it cannot make whole centrifuges during this period. But it will be able to make the non-rotating components at a rate sufficient for 200 of each of these centrifuges per year. This allowance would allow Iran to open and test its centrifuge manufacturing sites in anticipation of a much greater level of centrifuge production.

Section 4 of Plan: Deploying Advanced Centrifuges

The actual deployment of advanced centrifuges in years 11, 12, and 13 is described in section 4. It contains seven subsections with two footnotes and outlines Iran's voluntary centrifuge commitment between the years 11 and 13. The section summarizes Iran's plan to deploy about 2,500-3,500 IR-2m and IR-4 centrifuges by the end of year 13 and one production-scale cascade of each of the IR-6 and IR-8 centrifuges.

The opening sentence of section 4 starts with "Between years 11 to 13." (Authors' note: This opening sentence does not contain the introductory language of sections 2 and 3 "in addition to continue the abovementioned activities.")

Below, the section 4 subsections are reordered somewhat and organized by centrifuge types. Much of the information in section 4 was made public for the first time by the Associated Press.

IR-4 and IR-2m centrifuges

Subsections 4.2 and 4.3 focus on the deployment of the IR-4 and IR-2m centrifuges.

Section 4.2 "Beginning in year 11, will retrieve IR-2m and/or IR-4 centrifuges from storage and begin to deploy them for the production of enriched uranium, with the objective of expanding enrichment capacity and replacing IR-1 machines and would plan to phase out installed IR-1 centrifuges as more capable IR-2m and IR-4 centrifuge machines were installed."

Section 4.3 "During years 11, 12, and 13, will expand installed enrichment capacity (including the capacity of full-scale lead cascades), starting at the beginning of year 11 with the capacity of 5060 IR-1 centrifuges (with roughly 1 Kg U SWU[6] per machine), at a roughly linear rate throughout this period, by the production and installation of between 2500 to 3500 centrifuges (IR-2m or IR-4 or a combination of these two models) by the end of year 13. The number of such centrifuges will depend on the amount of SWU [footnote 1] attributed to each advanced centrifuge type based on performance data acquired by the IAEA [footnote 2] according to paragraph 55 of Annex 1 of the JCPOA."

Section 4.3 has two technical but important footnotes.

[6] SWU is separative work unit

Footnote 1 is a definition: "SWU is equivalent to kg U SWU per year and per machine for the purpose of the JCPOA."

Footnote 2 establishes a method of equivalence among centrifuge machines, similar to what has often been discussed. It states:

> "For example, if the IR-4 is deployed and the SWU attributed to the IR-4 is 3.6 SWU [sic] or less, the number of IR-4 machines would be 3500. If the SWU attributed to the IR-4 is 5 or greater, the number of machines would be 2500. If the SWU [sic] attributed to the IR-4 is between 3.6 and 5, the number of machines would be inversely proportional. A similar result would apply if the IR-2m is deployed. If both IR-2m and IR-4 centrifuges are installed, the number of IR-2m's and the number of IR-4's would be determined proportionally. In the event that IR-1's continue to be operated during years 11-13, the number of IR-2m and/or IR-4 machines would be reduced on an equivalent basis."

This definition of equivalence implies in general the amount of enrichment output to expect at the end of year 13. Considering first the limiting cases for the IR-4: 3.6 multiplied by 3500 equals 12,600 SWU/year, and 5 times 2500 equals 12,500 SWU/year. Similar limits apply to the IR-2m centrifuge. The difference between the values is negligible, and in further discussions we will use 12,500 SWU/year as the baseline enrichment capacity at the end of year 13 for IR-4 and IR-2m centrifuges.

However, one condition in this equivalence definition could lead to a larger annual enrichment output. The condition is that for the case of "5 or greater," the number of centrifuges would be 2500. So, for example, if the output was 6, the total enrichment output would be 15,000 SWU/year. Under this equivalence, Iran is incentivized to boost the enrichment output of the IR-4 and IR-2m centrifuges by increasing their rotor speeds, a difficult but achievable goal for Iran. It does not appear from the text of Iran's enrichment and enrichment R&D plan or the public portions of the JCPOA that such development to increase rotor speed is banned during the first ten years. In addition, such development is not banned after year 10. For example, during the first ten years, Iran could focus its development on the IR-4 centrifuge, which can use uranium, on achieving significantly higher rotor speeds. Such a process would likely require Iran to import more advanced materials and equipment, some of which should require approval by the Procurement Working Group associated with the Procurement Channel. In any case, this development would also benefit the IR-2m centrifuge, even though Iran can perform only mechanical testing of the IR-2m without the use of uranium during the first ten years.

IR-6 and IR-8 Centrifuges

Sections 4.1, 4.5, and 4.6 address the deployment of the more advanced centrifuges IR-6 and IR-8. According to Iran's public statements, the IR-8 is its most advanced centrifuge, and the IR-6 is a backup in case it cannot successfully deploy the IR-8 by this time frame.

Section 4.1 states: “Beginning in year 11, will start to install necessary infrastructure for the IR-8 at Natanz in Hall B of FEP.”

Section 4.5: “During year 11 and the first half of year 12, will plan to continue testing with uranium a cascade of up to 30 IR-6 centrifuges and will commence testing with uranium of a lead full scale cascade of up to 150 IR-6 centrifuges during the second half of year 12 and year 13.”

Section 4.6: “During year 11 and the first half of year 12, will plan to continue testing with uranium a cascade of up to 30 IR-8 centrifuges and will commence testing with uranium of a lead full scale cascade of up to 84 IR-8 centrifuges during the second half of year 12 and year 13.”

Additional Limits in Section 4

Two subsections of section 4 seek to limit the number of centrifuges Iran can build up to the end of year 13 and allow for adjustments to caps because of changes in the enrichment output of each type of advanced centrifuge.

Section 4.4 states: “Production of centrifuges will be consistent with the numbers and inventory necessary to implement the program described in this document.”

Section 4.7: “In the event that the measured performance data (according to the paragraph 55 of Annex 1 of the JCPOA) should change, the number of centrifuges will be increased or decreased accordingly every eight months on a SWU equivalent basis.”

A particularly challenging term to interpret and arrive at a common understanding with Iran is the word “consistent” when referring to requirements or the plan. Consistent is not defined in the JCPOA or in Iran’s long-term plan. Differing interpretations could be challenging to reconcile. Already, there are differences with Iran in interpreting the term “consistent” with its enrichment and enrichment R&D plan with regard to the on-going manufacture of centrifuge components to replace broken centrifuges (see section 1.1.1 above and section 61 of Annex 1).[7] Iran appears to be seeking to make, or making, more components than are justified for its replacement centrifuges.

After year 10, Iran could seek to build a considerable number of IR-4 and/or IR-2m centrifuge or their components above the base level of 2500-3500 centrifuges in its re-energized and expanded manufacturing pipeline. To Iran, “consistent” could easily involve hundreds, if not thousands, of extra IR-4 and IR-2m centrifuges, based on Iran’s intention to rapidly build an enrichment capacity of 100,000 SWU per year after year 13. However, this excess stock, if

[7] Article 61 of Annex 1, JCPOA: “Consistent with its enrichment and enrichment R&D plan, Iran will only engage in production of centrifuges, including centrifuge rotors suitable for isotope separation or any other centrifuge components, to meet the enrichment and enrichment R&D requirements of this Annex.”

rapidly deployed, would represent a surge capacity that would shorten the breakout timeline and allow for the more rapid production of additional weapon-grade uranium beyond the first significant quantity. As such, ensuring that Iran's stock of excess centrifuges and components is tightly controlled is a priority today and in the future.

Post Year 13

The plan does not continue after year 13. This is also what the Associated Press reported.

By implication, there do not appear to be any limits on Iran's ability to deploy IR-4 and IR-2m centrifuges after year 13. Similarly, numerical limits appear lacking on the IR-5, IR-6s, and IR-7 centrifuges. Although the IR-5 and IR-7 centrifuges appear to be more experimental in nature, the IR-6s is a smaller version of the IR-6.

However, manufacturing limits continue on the IR-6 and IR-8 centrifuges in years 14 and 15, even though Iran did not mention these limits in its enrichment plan. Missing in Iran's plan is the language found in the Annex 1 of the JCPOA: "After year 10, Iran will produce complete centrifuges with the same rate [namely 200 of IR-6's and 200 of IR-8's per year] to meet its enrichment and enrichment R&D needs. Iran will store them at Natanz in an above ground location, under IAEA continuous monitoring, until they are needed for final assembly according to the enrichment and enrichment R&D plan." The language appears to be binding through year 15 of the JCPOA. Why this important language is missing from Iran's plan is unknown.

There will also remain through year 15 limits on the size of Iran's enriched uranium stock and a ban on producing greater than 3.67 percent LEU. However, with regard to the former, exemptions to the 300 kg cap may become substantial, unless carefully guarded against.

Breakout Timelines at the End of Year 13

Iran's enrichment and enrichment R&D plan provides a baseline on the number and type of centrifuges that Iran expects to operate at the end of year 13. Its total enrichment capacity is planned to comprise IR-2m and/or IR-4 centrifuge production-scale cascades and IR-6 and IR-8 production level cascades.

The equivalence definition implies that from year 10 to the end of year 13, Iran's enrichment capacity will grow from 5060 IR-1 centrifuges with an output of about 4500-5060 SWU per year to 2500-3500 IR-2m and/or IR-4 centrifuges with a combined output of about 12,500 SWU per year. The value for total output of the IR-1 centrifuges assumes that each machine achieves about 0.9-1.0 SWU per year.

The IR-4 centrifuge has not worked well, which helps explain why Iran wants to keep working with at least small numbers of IR-4 centrifuges during the first eight years of the deal, including enriching uranium in them (prior to remixing the enriched uranium product with the depleted uranium tails). The IR-4 has the novel feature of a carbon fiber bellows. Carbon fiber is not

flexible like maraging steel, the more customary bellows material used in the IR-1 and IR-2m centrifuges, and is more susceptible to cracking.

In case Iran is unsuccessful in achieving a workable production model of the IR-4, it can still deploy the IR-2m, which uses a maraging steel bellows. Prior to the interim Joint Plan of Action, Iran was deploying the IR-2m in large numbers in the Fuel Enrichment Plant.

The IR-2m and IR-4 centrifuges have been operated for several years in the Natanz Pilot Fuel Enrichment Plant, including operating in production level cascades. Based on that operating experience, according to officials knowledgeable about these centrifuges and Iranian statements, these two machines have similar enrichment outputs. When operating in cascades, the IR-2m and IR-4 centrifuges achieved about 3.7 and 3.8 SWU per year, respectively. The enrichment values were greater when the centrifuges operated as single machines or in small cascades. In addition, as expected, the theoretical values were even higher. However, for our purposes, the key separative work outputs are the values when the centrifuges operate in production level cascades, which are about 80 percent of the theoretical values.

It is unclear if Iran could develop more capable IR-2m or IR-4 centrifuge models, such as by increasing rotor speeds to gain outputs over five SWU per year, and thereby exploiting the seeming ambiguity in the equivalence condition (footnote 2 in section 4.3). If it achieves these higher outputs, the plan leaves open the possibility of achieving an enrichment capacity greater than 12,500 SWU per year, while operating only 2500 centrifuges, a numerical limit of centrifuges mandated by the JCPOA.

By year 13, Iran also plans on deploying one production-level cascade of IR-6 centrifuges and a production-level cascade of IR-8 centrifuges. These cascades will increase Iran's total enrichment capacity. The IR-6 has operated and enriched uranium in single machines and in small cascades. Its theoretical and achieved outputs are 8.1 and 6.8 SWU per year, respectively, according to knowledgeable officials. Based on these values, the output in a production level cascade is estimated at about 6.5 SWU per year, where this value is taken as 80 percent of its theoretical value of 8.1 SWU per year. For a production level cascade of 150 centrifuges, the total output would be 975 SWU per year. The IR-8 has not enriched uranium and will not do so until year 2 of the deal (see section 2). Thus, only a theoretical separative work value is known at this time, which is 16.2 SWU per year, according to a knowledgeable official. As with the IR-6, the value in a production level cascade is estimated as 80 percent of this value or about 13 SWU per year. For a production level cascade of 84 IR-8 centrifuges, the total output would be 1092 SWU per year. It should be noted that Iran may encounter difficulties deploying the IR-6 and IR-8 centrifuges, although it has many years to succeed.

The total enrichment output by the end of year 13 would be 14,567 SWU per year. Today, as discussed above, Iran has an enrichment output of about 4500-5,060 SWU per year. With a stock of 300 kg of LEU (ignoring any contribution from near 20 percent LEU or the re-installation of stored centrifuges), the US government has stated that the breakout time is

greater than 12 months. Thus, at year 13, the enrichment output would have grown by a factor of 2.9 to 3.2, which is rounded to a factor of three. Linearly scaling the breakout timeline of 12 months leads to a breakout timeline of 4 months at the end of year 13.

This estimate of four months is two months shorter than what we estimated in August 2015, based on discussions with US and EU officials.[8] The shorter estimate is based on data presented here that is more detailed than the information we had in August 2015. Although simple scaling may underestimate breakout timelines, given the additional data in this current assessment, at least on a preliminary basis, we view the four month breakout timeline at the end of year 13 as more realistic.

Discussion and Conclusion

Iran's enrichment and enrichment R&D plan should never have been secret. We could find no sections in the plan that are more or less sensitive than anything else in the JCPOA. Iran's efforts to impose secrecy are uncalled for and against the spirit of the JCPOA and the P5+1 should have refused to keep it confidential. A particularly spurious claim is that because Iran submitted the plan to the IAEA as part of its Additional Protocol safeguards declaration, the plan should be kept secret. The plan is a vital part of the JCPOA; its inclusion in the initial declaration is no more sensitive than listing the entire JCPOA in this declaration. And doing so would not suddenly make the JCPOA confidential. Iran has a history of hiding information and facts; its current effort to intimidate the IAEA on this issue should be rigorously rejected. More transparency is needed, not less. Moreover, given the serious regional and international security implications posed by Iran's resumed enrichment and enrichment R&D after key JCPOA's limits expire, a robust public debate is needed over how to anticipate and mitigate effects.

One concern is that Iran may seek to accelerate the deployment of centrifuges beyond the timeline stated in its enrichment R&D plan, thereby shortening its breakout timelines sooner. Iran calls the plan a voluntary commitment, and it may seek to unilaterally modify its plan. Of course, members of the P5+1 would be expected to object, but it is unclear what in fact they could do under the JCPOA if Iran unilaterally changes its voluntary offer and accelerates its deployment of advanced centrifuges after year 10.

On the other hand, Iran's advanced centrifuges may not work or may work poorly, like the IR-1 centrifuges. Or Iran may come to accept that its centrifuge plan, even if successful, has almost no hope of ever being economically viable and delay or drop it in favor of buying enriched uranium from abroad.

If Iran persists and builds centrifuges under its long-term plan, it will be unlikely to create an economically viable centrifuge program but it can likely create one large enough to reduce breakout times significantly and support a clandestine, difficult-to-detect centrifuge effort able

[8] *Breakout Timelines Under the Joint Comprehensive Plan of Action*, August 18, 2015.

to make weapon-grade uranium. Thus, the implementation of this plan is expected to dramatically increase tensions in the region and increase the chance of military conflict, possibly as soon as year 9 of the JCPOA but certainly by year 13. Because of this risk, the P5+1 and the rest of the world should encourage Iran to make the more responsible decision and largely abandon its enrichment program.

Iran's enrichment and enrichment R&D plan shows further the complexity of the JCPOA and the need for robust oversight and enforcement of the deal. The US and its European partners must be vigilant at all times if the JCPOA is to accomplish its goals. On the other hand, there are many ways that Iran can undermine or weaken the limitations in the JCPOA and its long term enrichment plan. In the coming years, Iran needs to succeed in weakening or undermining the limitations only periodically. In essence, Iran can often fail in its efforts to weaken the JCPOA as long as it succeeds sometimes. This mismatch will pose one of the more difficult challenges for this US administration and succeeding ones.

The JCPOA is too important to not fully include robust Congressional oversight. Although Congress has established important oversight responsibilities, such as the Iran Nuclear Review Act of 2015, more is needed.