How to Make Sure Iran's One-Year Nuclear Breakout Time Does Not Shrink

by Olli Heinonen, Simon Henderson

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Brief Analysis

The final deal needs to specify the total enrichment capacity of Iran's installed centrifuges, mandate a robust verification regime, and include other restrictions to the nuclear program's size and content.

Under the U.S. parameters for Iran's uranium enrichment program announced in Lausanne on April 2, Tehran will decrease its stock of about 19,000 installed centrifuges to just 6,104, with only 5,060 of these designated for enriching uranium. This arrangement will last for ten years, and all of the centrifuges will be first-generation IR-1s. The parameters also state that "Iran will not use its IR-2, IR-4, IR-5, IR-6, or IR-8 models to produce enriched uranium" during this period, and that it will "engage in limited research and development with its advanced centrifuges, according to a schedule and parameters which have been agreed to by the P5+1." In addition, the amount of low-enriched stock that Iran can retain is capped at 300 kilograms of 3.67 percent-enriched uranium for the next fifteen years (i.e., uranium that contains 3.67 percent of the fissile isotope U-235).

The technical details underlying these parameters raise several concerns that go to the heart of the proposed deal's efficacy. For one thing, the 1,044 centrifuges designated only for non-nuclear enrichment will remain installed, so they could potentially be reconverted to enriching uranium in a short time regardless of technical or monitoring arrangements. More important, no details have been revealed about the agreed "schedule and parameters" for R&D on more advanced centrifuges. Iran's current timeframe for acquiring enough high-enriched uranium to make a nuclear bomb -- known as breakout time -- is around two or three months, and the United States wants a deal that extends that period to at least one year (see "Iran's Nuclear Breakout Time: A Fact Sheet," PolicyWatch 2394). In Washington's view, a full year would provide enough time to detect noncompliance and take diplomatic or military action if Tehran seems poised to make an illegal dash for a nuclear weapon. Yet the use of more efficient centrifuges would shorten that time, so Iran's determination to develop more advanced machines is as much a concern as, for example, its continuing retention of large low-enriched uranium stockpiles despite a commitment in the parameters that they be converted into less contentious forms (see David Albright and Serena Kelleher-Vergantini's June 5 article "State Department Explanation of Iran's Newly Produced 3.5 Percent Enriched Uranium Falls Short"). Using partially enriched feedstock could also reduce breakout time substantially.

Central to calculations about centrifuges is their efficiency, usually measured in terms of separative work units (SWUs), which relate to both the amount of material processed and the degree of enrichment reached. An SWU describes the annual enrichment output of a centrifuge, either as "SWUs uranium/year" or "SWUs UF6/year," where UF6 is uranium hexafluoride, the gaseous feedstock for a centrifuge. A typical 1,300-megawatt light-water power reactor requires 25 tons of 3.75 percent-enriched fuel annually. To produce this fuel from 210 tons of natural uranium, an enrichment effort of 120,000 SWUs is needed. But a nuclear explosive device requires high-enriched uranium (i.e., 90 percent or more U-235) containing twenty-five kilograms of U-235, and producing such material would necessitate an enrichment plant with an annual capacity of 5,000 SWUs.

Iran's IR-1 centrifuges are based on an original Dutch design that Tehran acquired from Pakistan. They are arranged in cascades at two known sites, Natanz and Fordow. According to analysts at the Institute for Science and International Security, Washington estimated the efficiency of an IR-1 at between 0.9 and 1.0 SWUs/year when assessing Iran's breakout capacity, whereas Tehran used a figure of 0.66 SWU/year. Therefore, from the U.S. perspective, Iran's allowed 5,060 IR-1s imply a breakout time of around a year.

The reality is more disturbing. The true performance of the IR-1s remains unknown -- their current capacity may be reduced by some parts of the enrichment cascades being isolated or individual machines being broken and not replaced, so their potential output may have been understated. Data derived from the International Atomic Energy Agency (IAEA) shows that IR-1s occasionally operate at 1 SWU/year or slightly better at Natanz and Fordow (see Figure 10 and Table 1 in "ISIS Analysis of IAEA Iran Safeguards Report," May 29, 2015). But in August 2014, the head of the Atomic Energy Organization of Iran, Ali Akbar Salehi, stated that IR-1s had "a nominal output of over 3 SWUs, but in practice they yield less than 2 SWUs." He presumably meant SWUs UF6/year, so his figures translate to 1.3 SWUs uranium/year. This suggests that Iran's actual breakout time under the Lausanne parameters could be seven or eight months rather than a full year.

Salehi also noted that one of the new centrifuges Iran was working on, the IR-8, had an efficiency of 24 SWUs, a very high figure. At the very least this means that Iran's enrichment capacity could soar after the ten-year nuclear deal expires. And if IR-8s became operationally capable sooner than that, breakout time would shrink drastically. Similar arguments can be made for the other centrifuge types Iran is developing. The latest IAEA report (issued May 29) notes that in the R&D area of the Natanz Pilot Fuel Enrichment Plant (PFEP), "Iran has been intermittently feeding natural UF6 into IR-1, IR-2m, IR-4, IR-6 and IR-6s centrifuges, sometimes into single machines and sometimes into cascades of various sizes." That facility also contains an IR-5 centrifuge (into which uranium feedstock was placed for a while against the understandings of last year's Joint Plan of Action) and a prototype IR-8 (but without the piping needed for feedstock to be used). Little is known about many of these centrifuges; IAEA inspectors have seen them but are not permitted to scrutinize their inner workings.

Iran is presumably attempting to develop the most practical and efficient machine -- a goal that requires the optimal balance of centrifuge length, composition, and spin speed. It has already installed six cascades of the IR-2m, which has an estimated output of 3-5 SWUs uranium/year (or up to five times the efficiency of the IR-1). Another twelve IR-2m cascades are planned, and while none of them has been fed with UF6, the latest IAEA report indicates that two IR-1 cascades at the PFEP are currently enriching uranium. In addition, one IR-2m and one IR-4 cascade are fed with natural uranium, but the resultant enriched uranium and depleted "tails" are promptly remixed back to natural uranium. In total, the potential enrichment capacity of the operating IR-1, IR-2m, and IR-4 cascades at this R&D facility is 1,300-1,700 SWUs/year, so if they are maintained in the final agreement as they are currently, Iran's breakout time will drop to eight months (or perhaps even less if Salehi's previously mentioned efficiency estimates for IR-1s hold true).

Moreover, the IAEA report is heavily caveated with expressions like "declared facilities" (allowing for the possibility of undeclared facilities), and it repeatedly warns that "the full implementation of Iran's obligations is needed to ensure international confidence in the exclusively peaceful nature of its nuclear program." Indeed, major uncertainty persists regarding the potential existence of another secret installation like Fordow, the enrichment facility that Iran built inside a mountain and did not disclose until it was discovered by U.S. and other intelligence services. Estimating detection time for clandestine facilities is difficult at best (e.g., see "The Iran Time Bomb," March 22, 2015).

Even without hidden facilities, establishing most any Iranian violation of the agreement would likely take several months. First, the IAEA and respective agencies in Washington would have to come to that technical judgment; toward that end, inspectors would need timely access anywhere at any time to confirm such findings. The next step would be to get the political leadership to accept that judgment, then sell the conclusion to the international community.

In short, close attention to several technical factors is essential to the success of a nuclear deal, including the number and type of installed, operable centrifuges; Iran's inventories of enriched uranium; the dismantling of excess centrifuges; unfettered inspection access; and enhanced intelligence on and enforcement of compliance. To maintain a credible verification and monitoring scheme, Iran's installed centrifuge capacity should not exceed 5,000 SWUs per year. That calculation depends on the efficiency of the centrifuges, not just their number.

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