Arms Control Association

Iran Nuclear Policy Brief

Analysis on Effective Policy Responses to Weapons-Related Security Threats

Breaking Down Iran's Breakout Capacity

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As efforts intensify to bring the Iran nuclear negotiations to a successful conclusion by November 24, the issue of breakout continues to occupy center stage. Setting limits on Iran's nuclear program to dissuade the leaders in Tehran from breaking out of the nuclear Nonproliferation Treaty and possibly building nuclear weapons is a central objective of the P5+1 powers (China, France, Germany, Russia, the United Kingdom, and the United States). Consideration of the effect of agreed limits on the time it would take Iran to build nuclear weapons is therefore a necessary step in formulating the P5+1 negotiating position, but is not sufficient for navigating the appropriate course toward a comprehensive agreement. Relying on the narrow definition of the term "breakout"—obtaining enough weapons-grade uranium gas for one bomb—does not fully capture the path that would have to be traveled. It is also necessary to consider "effective breakout"—the time needed to build a credible nuclear arsenal—in order to ensure that the proper balance between verification and limitations can be achieved.

HIGHLIGHTS

- One of the critical objectives of negotiating a comprehensive nuclear deal with Iran is to lengthen the amount of time Iran would need to build a bomb if it chose to break out of its nuclear Nonproliferation Treaty (NPT) obligations.

- The common definition of the term "breakout" is the time between the moment that the international community recognizes that a dash for a bomb is underway and the point at which enough fissile material for one weapon has been accumulated. The length of this timeline is a function of several factors.

    - The time elapsed between the start of a breakout attempt and the discovery of that attempt.

    - If the uranium path is the shortest route, the amount and enrichment level of the breakout country's uranium stockpile.

    - The state (gas or solid) and form (powder or metal) of that stockpile, and

    - If gas centrifuges are used to enrich uranium, their number and efficiency.

- Although this definition of breakout has some utility, it does not provide a reliable guide to effective-breakout timelines because it excludes important steps that would be required to build and deploy even one weapon and ignores Iran's particular real-world requirements for building a credible nuclear arsenal with multiple weapons.

- In addition to limits on the capacity to enrich weapons-grade material in a given time, P5+1 negotiators must seek other elements in a final deal, including strengthened international monitoring, that taken together, can dissuade Iran from seeking to break out of the NPT.

- A satisfactory compromise agreement will enable Iran to claim success in protecting its right to develop a peaceful and independent nuclear energy sector and convince Iran that pursuing the NPT breakout option is far too risky for the regime to seriously contemplate.

Background

The term "breakout" refers to a situation in which a non-nuclear-weapon state-party to the nuclear Nonproliferation Treaty (NPT) decides to build a nuclear weapon, abandoning its obligations under the treaty to use nuclear energy only for peaceful purposes. Because the most challenging task for any nuclear weapons aspirant is producing or otherwise acquiring the weapons-grade material[1] for the core of the bomb, the chief nuclear nonproliferation focus is on preventing this from happening.

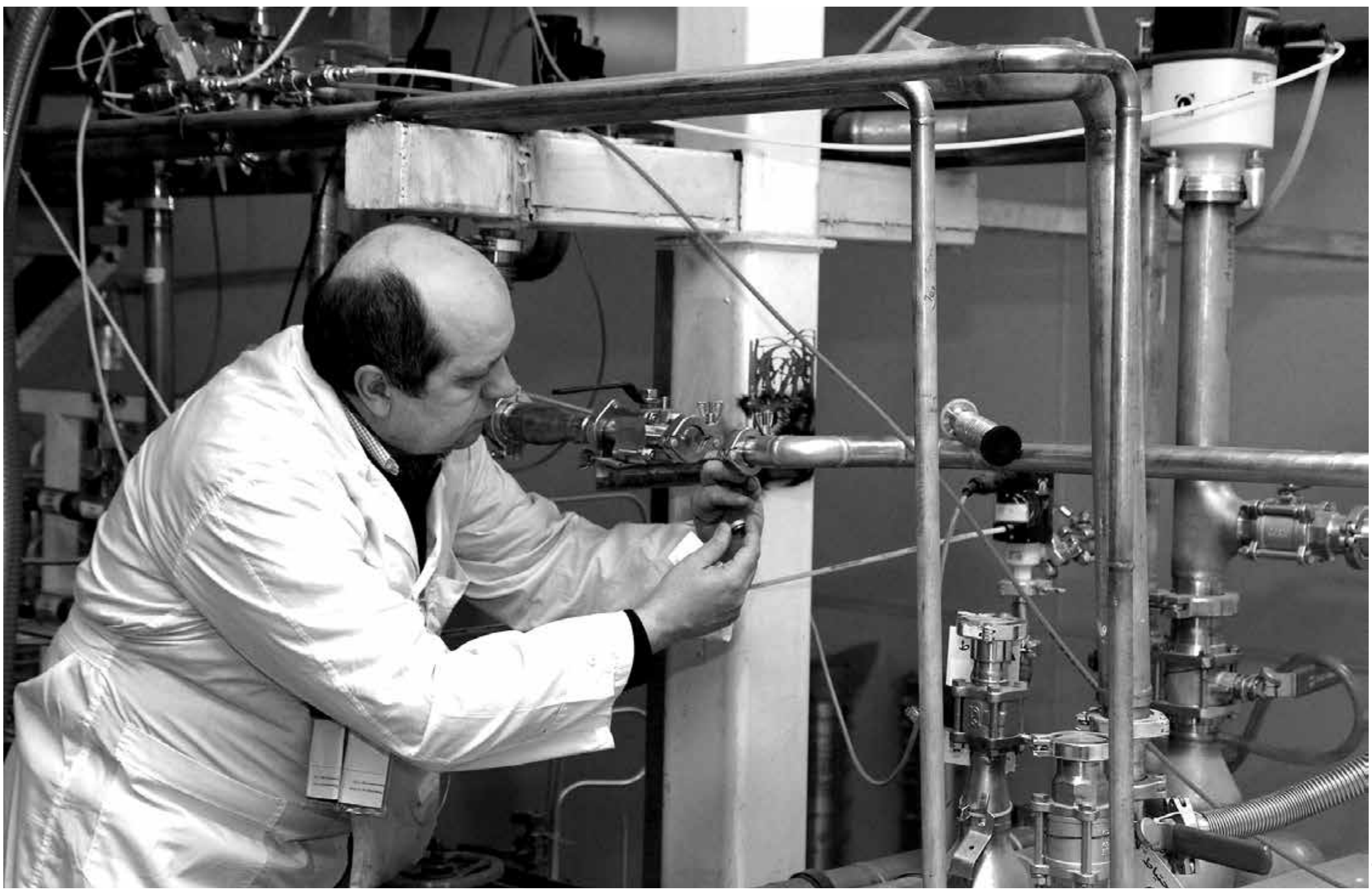
In the case of Iran, the industrial infrastructure and technological knowledge for producing weapons-grade material are, unfortunately, already in place. The U.S. intelligence community assessed in a 2007 National Intelligence Estimate and has repeatedly emphasized subsequently that Iran "has the scientific, technical, and industrial capacity to produce nuclear weapons, if it chooses to do so."[2] The critical question is whether it so chooses.

If Iran's leadership decided to build nuclear weapons openly, it would have to withdraw from the NPT under the treaty's supreme national interest clause, giving three months' notice. In such a circumstance, it would presumably eject the International Atomic Energy Agency (IAEA) inspectors, which currently provide timely and invaluable information on what is happening at Iran's declared nuclear facilities.

"Sneakout"

Yet, the intelligence community judges it more likely that Tehran would chose a clandestine effort, sometimes called "sneakout," not using facilities that it had declared to the IAEA. This would theoretically allow Iran to minimize the international community's warning time and ability to take effective blocking action. But adopting such a strategy would take longer to achieve results as the goal of avoiding notice by IAEA inspectors and Western intelligence agencies would take precedence over maximizing speed and efficiency.

A clandestine effort would include producing weapons-grade uranium at secret facilities, designing



KAZEM GHANE/AFP/Getty Images

An unidentified inspector from the International Atomic Energy Agency examines equipment at Iran's Natanz uranium-enrichment facility in January 2014. Such close international scrutiny of Iran's declared nuclear facilities makes clandestine activities elsewhere a more plausible scenario if Iran chose to build nuclear weapons.

and fabricating a warhead in secret, and secretly integrating the physics package into a delivery vehicle. Some of these steps could be completed before the fissile material was available, some of the relevant work would have to be done afterward.

Under these circumstances, an unacknowledged program, even if suspected and partially exposed, would allow Tehran to plan a surprise, presenting the international community with a *fait accompli* at a time of Iran's choosing by conducting a nuclear test, making a sudden announcement of "We have the bomb," or even signaling rather than advertising its capabilities through an Israeli-type opacity approach.

Whether Iran chose an open breakout, a clandestine sneakout, or some combination of the two, maximizing the time between detection of the effort and weapons deployment would be critical for thwarting the international community's ability to affect the outcome. The effect of alternative arrangements in extending or constricting this timeline in a final agreement has therefore become an important focus of analytical attention.

Breakout, Narrowly Defined

Discussions of breakout options commonly include calculations of the amount of time a state would need to produce enough highly enriched uranium (HEU) or plutonium for the core of a bomb. Although there are plausible paths for Iran to obtain either of these fissile materials, the uranium route is a much more proximate danger. Twenty-five kilograms of uranium with a concentration of the uranium-235 isotope greater than 90 percent is the approximate quantity needed for one bomb.

The speed with which this amount could be produced would depend on the circumstances existing when the decision was made to proceed with enrichment of uranium to weapons grade: the enrichment capacity of the installed centrifuges and the characteristics of the uranium stockpile—its

Figure 1: Steps to Building An Iranian Nuclear Weapon

The following major scientific, technical, and industrial steps are required for Iran to build a nuclear weapon using uranium:

Mining or Importation of Uranium Ore
Iran is believed to have large reserves of uranium and two working mines.

Milling of Uranium
Concentrating uranium from ore, i.e., increasing uranium oxide content to 65-85 percent to produce "yellow cake."

Processing (Conversion)
Converting yellowcake, a solid, into uranium hexafluoride, a gas.

Enriching Uranium Gas
Increasing the relative abundance of the uranium-235 isotope in the uranium hexafluoride

- to light-water power-reactor grade (3.5 percent),
- to research-reactor grade (20 percent), and then
- to weapons grade (90+ percent).

The IAEA estimates that 25 kg of weapons grade uranium hexaflouride is sufficient to produce the fissile core of one nuclear device.

Fabrication
Converting weapons-grade uranium hexafluoride to uranium dioxide powder and then into metallic forms for use in the fissile core of a nuclear device.

Weapons Design and Assembly
Designing and assembling the other non-nuclear components in and around the fissile material core to make a device capable of forming the "physics package" of a warhead, suitable for use as part of a combat-ready weapons system.

Nuclear Explosive Testing
Detonating the nuclear device as proof of concept. Typically, multiple nuclear test explosions are necessary to perfect warhead designs, particularly smaller, lighter, more efficient designs.

Weapons Integration With a Delivery System
Adapting the warhead for placement into a bomb or the nose cone of a delivery vehicle.

Missile Testing With Inert Warhead
Performing flight tests with an inert warhead to confirm the performance of the non-nuclear functions of the warhead, such as safing, arming, and fusing, which are necessary in order to achieve adequate levels of confidence and reliability.

CTBTO

Primary Seismic Station PS26 in Torodi, Niger, one of 278 certified facilities worldwide in the International Monitoring System (IMS), is shown in August 2005. The IMS would be very likely to detect any nuclear weapons explosive test by Iran.

size, enrichment level, state (gas or solid), and form (powder or metal).

If the values of the above variables are determined, a relatively accurate and reliable timeline can be estimated as a matter of scientific calculation. Experts generally agree about the timelines under this definition of breakout. For example, if Iran employed all of its installed IR-1 centrifuges—roughly 10,200—and used its stockpile of nearly 7,800 kilograms of low-enriched uranium hexafluoride as feedstock, it would be able to produce 25 kilograms of weapons-grade uranium hexafluoride in two to three months, assuming maximum efficiency and no technical delays. If Iran eliminated its stockpile of low-enriched uranium gas by converting it to powder and had only natural uranium, it would need at least six months to produce enough weapons-grade uranium hexafluoride for a bomb.[3]

The milestone being measured in this definition of breakout is the accumulation of enough uranium hexafluoride for one bomb, not the bomb's actual construction or initial operating capability. There is some utility in focusing on this narrow, common definition, particularly if the United States or Israel is contemplating the use of military force to disrupt an Iranian rush to build a bomb, because it would be easier to attack facilities during the more visible and vulnerable uranium-enrichment phase of the process than after the weapons-grade uranium was dispersed to undeclared facilities for weaponization. Yet, calculating breakout as conventionally defined is highly misleading because it does not encompass the full process of building a weapon.

Effective Breakout

There is a second, more relevant timeline that begins beyond the point at which sufficient weapons-grade uranium hexafluoride for one weapon has been accumulated. This timeline includes the completion of the five additional steps necessary before Iran could pose a credible threat of launching a nuclear attack (figure 1).

Once Iran had enriched sufficient uranium hexafluoride to weapons grade, it would need to convert this gas to powder form, then fabricate the metallic core of a weapon from the powder. Iran would have to overcome several additional and separate technical hurdles, not all of which could be done concurrently as uranium is further enriched. After being designed, the explosive device must be constructed and integrated into a delivery system, most likely a ballistic missile, according to the U.S. intelligence community.[4]

Iran would likely want to conduct an explosive test of the weapons package, given the sophistication of the engineering science and the low tolerance for design and manufacturing error. States developing nuclear weapons typically conduct multiple, large-scale nuclear test explosions to certify their warhead designs, particularly the smaller, lighter, and more efficient designs needed for missile warheads. Requiring sufficient weapons-grade material for at least one test device would double the amount of fissile material required before breakout to the first weapon could be achieved, further extending Iran's timeline.

Planning One Is Not Enough

It is highly improbable that Iran would plan to break out of the NPT by building only one nuclear weapon. Calculating timelines based on a one-device scenario compounds the misimpression left by using a breakout definition that falls short of actually building a weapon.

Even if Iran were willing to tolerate the large uncertainties deriving from an untested nuclear weapons design, a single weapon would add additional uncertainties about missile performance and the ability of the warhead to penetrate the sophisticated missile defenses deployed in the region. It would invite preemption and leave no means of deterrence once the single weapon had been launched. Tehran would therefore be staking everything on the deterrent value of one untested system and the assumption that there would be no second act.

If Iran chose to increase the effectiveness of a nuclear deterrent by planning to build multiple weapons, as is highly likely in a nuclear gambit, that decision would increase Iran's need for fissile material, thus further lengthening the breakout timelines and increasing the chances that the international community would detect and successfully block Iran's attempt.

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Looking at Timelines From Tehran

Before any final assessment is made about the adequacy of uranium-enrichment limits, it is necessary to realistically examine effective breakout options from Tehran's perspective. Assuming that Iran would be willing and able to race toward assembly of a bomb in a few months' time is not realistic because it is based on worst-case reasoning concerning the flawless performance of technical actions never before attempted by Iran and a too-narrow definition of what must be achieved to acquire a credible nuclear arsenal.

The appeal of the narrow definition of "breakout" is partly due to the relative simplicity of tracking enrichment compared with tracking the latter stages of the weapons development process. Accordingly, the international community's military leverage against a country pursuing nuclear weapons development is perceived to decline after that country has produced enough fissile material for one weapon.

It is not yet possible to accurately gauge the full impact of the enhanced transparency measures that will be part of any comprehensive agreement. But assuming in the worst case that Iranian clandestine enrichment efforts could escape detection until only a few weeks before sufficient weapons-grade uranium hexafluoride were produced, Iran still would be several months from fielding even a minimal nuclear force.

A robust inspection regime in the final comprehensive agreement would include increased reporting requirements for Iran on its nuclear activities and grant the right of short-notice, on-site inspections at undeclared sites to the IAEA. Although designed to detect clandestine enrichment activities, such a verification regime would significantly enhance the collection of information relevant to the identification of activities other than enrichment that could be targeted to disrupt a weapons development program.

Risking Exposure While Breakout Is Underway

Even if Iran were allowed to retain many thousands of centrifuges, it could not be confident of achieving effective breakout before its efforts had been exposed and disrupted. Iran's track record of keeping clandestine undertakings secret is not good. The public exposure by Western intelligence agencies of Iran's underground facility at Fordow in 2009 not only damaged Iran's prestige and credibility, but probably prevented Iran from using the facility as it was intended.

With existing U.S. national technical means of intelligence and the International Monitoring System established to verify compliance with the Comprehensive Test Ban Treaty, any explosive nuclear test by Iran would be very difficult to conceal. If Iran were to try to build nuclear weapons without testing, Tehran would have to accept a lower confidence level concerning the reliability of its warhead design or increase the amount of fissile material in the design to accommodate a wider margin of error, further lengthening the effective breakout timeline.

Premature discovery of an unambiguous dash to nuclear weapons development could have grievous and possibly existential consequences for the Iranian regime. The leaders in Tehran would recognize that trying to get everything in place to build a bomb quickly would be a very risky endeavor—all the more so if the final agreement included a rigorous inspection regime.

The technical criteria discussed thus far form an important but incomplete lens through which to view breakout. In the real world, the leaders in Tehran must take into account a broad range of legal and political factors internationally and domestically that extend far beyond breakout timeline calculations. The success or failure of attempting breakout would depend critically on the quality and scope of the international inspection regime, the ability of the international community to respond effectively to disrupt the breakout, and the number of weapons Iran would judge it needed to pose a credible deterrent.

Because Iran already has the capability to build nuclear weapons it follows that the realistic goal for the P5+1 in pursuit of a final deal is not to make breakout impossible but to make it a less viable option. Implementation of the Joint Plan of Action has already made breakout a more difficult and unattractive policy option for Tehran than it was a year ago. It appears that Iran is willing to accept even more expansive transparency measures in a future agreement.

If the P5+1 and Iran build on the progress from the negotiations earlier this year and seek creative, practical tradeoffs on the most difficult issue—defining Iran's uranium-enrichment capacity—there is at least an outside chance of reaching a compromise agreement that meets the needs of all parties.[5] In the context of such an agreement, the effective breakout timeline would remain sufficiently daunting for Tehran to be delivered from any temptation to break out of the NPT.

ENDNOTES

1. The material is considered weapons grade if it has a sufficient concentration of fissile isotopes, either uranium-235 or plutonium-239.

2. "Key Judgments From a National Intelligence Estimate on Iran's Nuclear Activity," *The New York Times*, December 4, 2007.

3. Iran has installed 1,008 IR-2 centrifuges, which are not yet operating. They are expected to be three to five times more efficient than the IR-1 centrifuges.

4. James R. Clapper, "Statement for the Record: U.S. Intelligence Community Worldwide Threat Assessment," January 29, 2014, p. 6 (given before the Senate Select Committee on Intelligence).

5. For an illustrative example of such an agreement, see Kelsey Davenport and Daryl G. Kimball, "A Win-Win Formula for Defining Iran's Uranium-Enrichment Capacity," *ACA Iran Nuclear Policy Brief*, August 28, 2014, http://armscontrol.org/files/Iran_Brief_Win_Win_Formula_Uranium_Enrichment.pdf.