Countdown to the Iranian Bomb

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The date Iran is liable to achieve nuclear weapons is of particular significance when considering how to handle the Iranian nuclear issue. Estimating the time needed by Iran to attain a nuclear capability will greatly affect the planning of political efforts aimed at stopping Iran before this happens. Even more so, it will affect the decision of whether and when to make a military move against Iran, because military action can have a significant impact only if taken before Iran has nuclear weapons. Assessing this timetable is also important for preparing for a scenario in which Iran does succeed in developing nuclear weapons despite all efforts to stop it.

Assessing the timetable for Iran's drive to attain nuclear weapons is a problematic, complex, and controversial task, and most attempts to draw a precise conclusion have not proven themselves. In 1992, for example, intelligence communities both in Israel and the United States estimated that Iran could reach a nuclear capability within five to eight years, i.e., no later than 2000. Clearly, this assessment was fundamentally flawed. The main difficulty facing estimations lies in the multiple unknown variables with regard to Iran's technological progress and political behavior; these have made it impossible to predict the rate of progress of Iran's nuclear program. And yet although this difficulty remains, the relatively large amount of information revealed in recent years about the Iranian nuclear program facilitates greater accuracy in forecasting the rate of Iran's progress on its road towards nuclear weapons.

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Israeli and American Intelligence Assessments

Over the last decade several differences emerged between Israeli and United States intelligence assessments about the anticipated timetable for Iran's nuclear program. The differences were not critical, and there were certainly no differences of opinion over Iran's desire for nuclear weapons. In general, however, the Israeli intelligence community has tended to be more pessimistic and present a shorter timetable for Iran going nuclear than the American intelligence community, which has tended not to go with the worst case scenario. These differences apparently stemmed from a different assessment of Iran's ability to overcome technological hurdles on its way to nuclear weapons and from different interpretations of intelligence information.

The current Israeli military intelligence assessment regarding Iran's nuclear timetable may be summarized as follows:[1] In 2008, Iran achieved full mastery of its uranium enrichment technology. Over 2009, it enriched uranium to low levels in quantities sufficient – once enriched to a high level – for a first nuclear bomb. In addition, Iran is improving its capabilities in the development of a nuclear explosive device and has completed the development of ballistic missiles capable of carrying a nuclear warhead. At the same time, Iran is not moving full speed ahead towards its first nuclear bomb. Instead, it is setting up an extensive and varied infrastructure of nuclear capabilities, in many forms and at a variety of sites. This infrastructure will enable it to decide when to break out and produce nuclear weapons, i.e., that conditions are ripe and the international cost it will have to pay for this move will be minimal, or that the need becomes vital. As part of this strategy, Iran is seeking to enrich a large amount of low enriched uranium (LEU). The moment Iran decides that it needs high enriched uranium (HEU), it will be able to amass the fissile material needed for one bomb within a few months to a year.

From a technical point of view, Iran, given optimal conditions, will be able to produce one nuclear explosive device core by the second half of 2010. Assuming somewhat less than optimal conditions, it can reach this stage by the second half of 2012.

Israel's military intelligence, therefore, does not specify a date by which Iran will attain nuclear weapons because that will depend on its explicit decision to move to the final stage of constructing

the bomb, a decision that does not seem to have been made yet. By contrast, the head of the Mossad, Meir Dagan, in the only statement of its kind as reported by the media, stated before the Knesset Foreign Affairs and Defense Committee that Iran would have the capability of launching its first nuclear bomb by the end of 2014, provided it does not encounter technical problems.[2]

The American intelligence community assessment of early 2009 may be summarized as follows:[3]

1. Iran is keeping the option open to develop nuclear weapons by developing various nuclear capabilities that bring it closer to producing such weapons, should it decide to do so. It is not known if Iran will eventually decide to build nuclear weapons. Iran has the scientific, technical, and industrial capacity to eventually produce nuclear weapons, making the central issue its political decision.
2. Iran has enough LEU − should this be enriched further to an HEU level − to produce nuclear weapons.
3. In the fall of 2003, Iran stopped its undeclared uranium enrichment activities and its program to develop a nuclear explosive device. This freeze was in place at least until the middle of 2007.
4. From a technical perspective, Iran will be able to produce enough HEU for nuclear weapons between 2010 and 2015. By contrast, the Bureau of Intelligence and Research (INR) of the American State Department has estimated that Iran will not attain this capability before 2013, because of anticipated technical problems.

In February 2010, the American intelligence community published its updated assessment.[4] Unlike its former assessments of late 2007 and early 2009, the updated assessment does not refer to the freeze of the military program and the timetable for Iran attaining nuclear weapons, and therefore it does not clarify whether the assessment in this regard has changed. A sign that a change in the assessment is in the offing may lie in the report published by the *New York Times* in early January 2010, where administration officials reported that the American intelligence community no longer believes that Iran is maintaining the freeze of its military nuclear program and in fact is continuing with it, albeit in a more limited scope. Moreover, the *Washington Times* reported at the same time that the American intelligence community concluded that Iran has not frozen its military nuclear program at all.[5] At any rate, today the differences between the American and Israeli assessments are not

fundamental. Both indicate that in terms of technical capabilities Iran will be able to produce the fissile material for its first nuclear bomb as early as 2010.

The Stages toward Nuclear Weapons

An examination of the timetable of Iran's progress in the nuclear track requires the definition of the stages Iran must go through on its way to nuclear weapons. Development and production of nuclear weapons by Iran is a process that has already started yet will still take years for the construction of an operational nuclear system. Three stages of this process can be identified:

The first stage is amassing fissile material that will quantitatively and qualitatively be enough for construction of the first nuclear bomb. This is a groundbreaking stage because from this point onwards the door is open for Iran to produce nuclear weapons. Technically, the time frame between this stage and actual weapons production is expected to be relatively short, because the activity to produce fissile material and turning it into a nuclear weapon will occur in parallel rather than consecutively. At this stage, Iran will not be able to attack any state with nuclear weapons because it will not yet have them in hand, but it will be able to reap some of the advantages it hopes to gain merely by being a nuclear threshold state.

The second stage is constructing the first nuclear bomb. At this stage the effect of a nuclear Iran will be created, and from that point onwards Iran will be able in practice to attack other nations with nuclear weapons. At the same time, the effect of a nuclear Iran will still be limited. Presumably, as long as Iran has only one or two bombs at its disposal it will not attempt to attack with them, even in the event that it adopts an offensive nuclear policy: first, the attack might fail because of technical problems or the interception of the launch vehicle, in which case Iran will be left without an ability to repeat the attack; and second, Iran will not possess second strike capability, and will thus be unable to deter a nuclear attack against it.

The third stage is constructing a relatively large operational nuclear stockpile of at least eight to ten bombs with various launching means, including ballistic missiles, cruise missiles, and fighter planes. Should Iran decide to produce nuclear weapons, it will likely strive to construct

such a stockpile in order to strengthen its deterrence vis-à-vis its enemies, reduce the risks and effectiveness of attacks on its nuclear installations, and develop a second strike capability in case of a nuclear attack on it.

In addition to Iran's technical capability to advance towards the objective of nuclear weapons, the nuclear timetable will be determined by political conditions, including decisions reached by Iran's leadership on the nuclear issue.

The Technological Timetable

There are four principal technological stages for producing nuclear weapons:

1. Producing the fissile material, i.e., HEU
2. Processing the fissile material into the core of the nuclear explosive device
3. Loading the core in the explosive device mechanism
4. Loading the explosive devices in the warhead, in a missile or airborne bomb

Developing the technology for the last three processes can occur concomitantly with the enrichment process, and it is likely that this will be completed even before the production of the fissile material for the first core. This means that the development timetable will be determined by the rate of production of fissile material. Executing the other stages will take place after this production, one step after another.

Based on information published to date, primarily reports by the International Atomic Energy Agency (IAEA), by the end of 2009 Iran had produced sufficient quantities of LEU to prepare one core of a nuclear explosive device, once this amount is converted to HEU. Moreover, the Iranians have learned the technique of processing uranium into the core of the explosive device (there is no difference here when using natural uranium or enriched uranium). Iran likely received the complete nuclear explosive device plans from Pakistan based on the Pakistani model. In addition, there are reports that the Iranians have loaded an explosive device in a warhead.[6]

Producing Fissile Material

Today, the enrichment of uranium to a low grade of 3.5 percent takes place at the large enrichment facility near Natanz. The enrichment there

is done by gas centrifuges fed with the material produced at a conversion facility at the nuclear complex near Esfahan. In late 2009, some 4,000 centrifuges were in operation at the facility and another 5,000 had been installed though not yet fed with material for enrichment.[7] Once completed, the production site is supposed to contain 54,000 centrifuges. All the centrifuges installed are of the outdated Pakistani P-1 model, with low enrichment capability. The Iranians are busy developing advanced models of centrifuges, which if properly installed and operated will enrich uranium at a higher rate than at present.

Should Iran copy the Pakistani process, the enrichment process from LEU to HEU will take place in three additional stages: enrichment from 3.5 percent to 20 percent, enrichment to 60 percent, and final enrichment to 90 percent.[8] All enrichment stages use the same machinery − the gas centrifuges − and only the numbers at the advanced stages and the connections between them differ at each stage. The brunt of the work takes place at the low enrichment stage. From this point onwards, only a small number of centrifuges are required for the more advanced stages. If the process is begun with LEU rather than natural uranium it is possible to produce HEU fairly rapidly.

Iran has two options for producing fissile material: one is to amass low enriched uranium, stop playing by the rules (the "breakout" scenario), and rapidly enrich the LEU it has to HEU; the other is to build a secret facility for HEU production. It is possible that the secret facility discovered near Qom was precisely such a facility. One way to produce HEU is through enriching natural uranium. According to a rule of thumb, 3,000 centrifuges of the model the Iranians already have can produce enough HEU for one core in one year, assuming that these centrifuges serve all the stages of enrichment. According to Iran's declaration, that is the number of centrifuges supposed to be installed in the enrichment facility near Qom. The other involves enriching LEU. Based on one assessment, the same 3,000 centrifuges will be able to produce enough HEU for two to five cores in one year if fed with LEU supplied by the facility in Natanz.[9]

The Rate of LEU Production in Iran

Although the number of centrifuges in the actual uranium enrichment operation is not fixed and their number even dropped in late 2009, the rate

of enriched uranium production to LEU levels has increased somewhat, and in this period stood at 1.88 kg per day.[10] At this rate, Iran would need 16 months in order to amass enough LEU to be converted into 25 kg of HEU − an amount that according to IAEA definitions is enough for the core of one nuclear explosive device.[11]

If this rate continues and if we take into account the LEU reserves Iran already has, which is more than enough for the first core, by the second half of 2010 Iran will have enough LEU for enrichment to HEU for two cores, and by 2012 − for three. In a worse case scenario, should the rate increase − because of continuous production, installation and operation of new centrifuges, operation of centrifuges already installed but not yet operational, and/or the installation of more advanced models of centrifuges − the rate of LEU production will accelerate accordingly. Such scenarios are realistic, though at present it is not possible to predict the rate of enrichment.

The Rate of HEU Production in Iran

The timing of enriching uranium to HEU will depend on a political decision. It is reasonable to assume that the Iranian regime will decide to prepare all systems for such a possibility and then wait. One should regard the Iranian decision of February 2010 to enrich their 3.5 percent enriched uranium to 20 percent, a level still considered (implicitly, not by any sort of official definition) to be LEU in this context.[12] In such a case, Iran will have passed a critical stage, greatly reducing the timetable for producing significant quantities of HEU.[13] The other possibility is that Iran will not make all the preparations and will wait to decide whether to construct a separate system for high level enrichment or transform one of the existing systems for low level enrichment into a high level enrichment system. Such a conversion process would extend the timetable by several months. According to one estimate, in a situation of LEU production of sufficient quantities and the operation of 3,000 centrifuges with the appropriate connections, enough HEU will be produced for one core in a period of two and a half to five months.[14]

The Timetable for the Advanced Stages

The timetable calculations for the advanced stages of developing nuclear weapons are based on assessments alone. Nevertheless, because

technologies and techniques have likely been developed in advance, the margin of error cannot be too great, and essential changes in timetables, should they occur, would be the result of mishaps or accidents.

The stage of processing the enriched uranium gas produced by the gas centrifuges and turning it into metal is estimated to take three to six months, at least for the first core. It may be assumed that afterwards this stage will be fairly short and will last about one to three months. The stage of casting the hemispheres and machining them to their precise specifications would last some three months, assuming that the professionals in question have been trained and will be skilled enough when receiving the enriched material for processing.

The stage of inserting the core into the nuclear explosive device will constitute a part of the operational system, because it is not reasonable to assume that this stage would occur before instructions are issued by the political echelon in preparation for a drill, experiment, or actual operational use of the warhead. On the other hand, the machining of the fissile material itself is not necessary before all the preparations are complete, because it is possible to do this with "cold" matter − a core containing natural uranium only. This is also valid for incorporating the nuclear core into the explosive device in the warhead, because this stage will not be done before there is a real need, and even at this stage "cold" drills are possible, without an operational core.

Timetables for Nuclear Development

While it is possible to arrive at estimated timetables on the basis of the information presented above, it is clear that the decision to enrich uranium from LEU to HEU is not a simple one, as this involves breaking the rules. In the simplest scenario, in which the entire enrichment process, from natural uranium to HEU, takes place in secret at a hidden facility, the entire process, from processing the natural uranium to constructing a nuclear explosive device, would likely take place sequentially in order to obtain the largest number of warheads as soon as possible.

If all the rules are broken, Iran will likely seek to amass at least a minimal amount of LEU that would allow it to produce at least three cores from fissile material, as it would need one explosive device for testing (in all likelihood underground), a second device for additional experiments should the first one fail (as occurred in India, Pakistan, and North Korea),

and a third device for proclaiming (even if not explicitly) the existence of an operational nuclear capability.

From all of the above, one may be able to offer the following timetables for two main scenarios: one in the event that Iran continues processing uranium at the current rate, and the other in the event that Iran progresses faster.

First scenario: Iran proceeds with its uranium enrichment in Natanz at the current rate

1. Enriching enough LEU for three cores – mid-2012. The time estimates for LEU enrichment are not precise, because they depend on the number of centrifuges in operation at this stage of production. For some unknown reason, not all of the centrifuges installed in Natanz are operational at present. It may be that this is due to a technical problem, but it is also possible that these are designated for rapid HEU production, should a decision to go ahead be taken.
2. Enriching enough HEU for the first core, when the centrifuge system is ready, two and a half to five months. Usually, the rate of HEU is more rapid than that of LEU production.
3. Processing the first core after enrichment – four to nine months. Producing the core from HEU is not necessarily a long process, and requires less than a year from the time there is enough HEU for each core.
4. Accordingly, the completion of processing the first core will take six and a half to fourteen months from the time a decision is made, if the system for converting LEU into HEU is ready. On the other hand, if the system is not yet ready, three to six more months will be needed in order to prepare and run the system, assuming that the existing LEU system only needs to be converted. In other words, if the project gets off the ground in early 2010, for example, the first core could be ready at some point between late 2010 and late 2011. Installing a whole new enrichment system will add nine to twelve months. (In such a case, if work commences in early 2010, the completion of the production of the first core would take place in the second half of 2012.)

Completing the production of any additional core would take four to nine months. Thus, completing the processing of three cores would take

eight to eighteen months after the completion of the production of the first core.

Second scenario: Iran steps up the rate of uranium enrichment

If all the centrifuges currently installed in Natanz, including the ones that are not yet in operation, are operated and working to produce LEU at the rate of the existing system, the output of enriched uranium would roughly double. Thus, if the installed centrifuges are operated at the beginning of 2010, Iran will have enough LEU to allow − after its conversion to HEU − the production of a second core by the end of 2010, and three cores by the end of 2011. In this scenario, the timetable is shortened by about six months. The installation of advanced centrifuges and making them operational further increases the rate of enrichment.

Again, these calculations refer to optimal conditions in which the systems are ready on time and there is skilled manpower to continue the process. Severe mishaps can of course delay the process. In early January 2010, the *New York Times* reported[15] that the American administration, after a renewed examination of available intelligence about the state of the Iranian nuclear program, estimates that reasons exist for two possible delays: one, mishaps in the design and production of the centrifuges, causing the reduction of the numbers of operational centrifuges in Natanz from 5,000 in June 2009 to about 4,000 at the end of the year. The IAEA report states that there is evidence of failures in the enrichment system. However, it also seems that the systems are becoming more efficient. It may be that the assessment is based on information available to the American intelligence community. Even so, it is hard to rely on such mishaps occurring over time, as the Iranians have the knowledge, experience, and tools to help them overcome such faults.

The second reason is the uncovering of the enrichment facility in Qom, which according to sources in the Obama administration has postponed the possibility that Iran would use it as a secret facility for HEU production. Such a claim is well founded, if the Iranians were indeed planning to use the facility as part of a clandestine enrichment route and if they do not possess additional secret facilities as many suspect. However, the discovery of the facility need not cause any real delay in the project. The facility's construction schedule has not changed since its discovery, and one may assume that the Iranians will operate it on time

unless mishaps occur along the way. Therefore, if Iran intends to defy all rules, the facility in Qom will be able to fill the function designated for it.

The Political Considerations

From a technical point of view, Iran, given optimal conditions, will be able to produce one nuclear explosive device core by the second half of 2010. Assuming somewhat less than optimal conditions, it can reach this stage by the second half of 2012. However, while there is no doubt that Iran is preparing the technological infrastructure for nuclear weapons production, there is no firm evidence that it has already made the decision to produce such weapons. Iran may prefer to remain on the verge of production until it estimates conditions are ripe for going forward. Politically speaking, there are several considerations that could affect Iran's decision on the issue.

The first consideration concerns the pressures exerted on Iran to suspend its nuclear program. To date Iran has rejected all demands to agree to a deal whereby it would suspend its uranium enrichment. In October 2003 and November 2004 Iran did arrive at an agreement with European governments to suspend uranium enrichment for a limited period of time and may in 2003 have unilaterally frozen the military component of its nuclear program for an unknown period. However, since then it has adopted an uncompromising stance and announced that no pressure will make it relinquish its right to continue constructing its nuclear program. Currently, it seems that the American administration may succeed in enlisting international support for tightening the sanctions against Iran. The hope is that Iran's economic vulnerability and its internal unrest will motivate Tehran to reconsider its position on uranium enrichment. The chances of such a move succeeding depend on the convergence of two conditions: obtaining international agreement to institute painful sanctions against Iran, which is far from a certainty, and Iran's concern about a military move against it should it refuse to change its position, a concern that for now is still not acute.

> Iran may decide to postpone its decision to produce nuclear weapons until it estimates that the conditions are such that it is in a better position to withstand the anticipated pressures.

A second consideration concerns the cost of moving to a stage that will leave no room for doubt that Iran has decided to produce nuclear weapons. When Iran decides to embark on nuclear weapons production, it will have to withdraw from the Nuclear Non-Proliferation Treaty (NPT) or enrich uranium at a secret facility and hope it is not discovered. Both routes are problematic. Withdrawing from the NPT will constitute much more than just a hint that Iran has decided to produce nuclear weapons (though it is safe to assume that there will be those who will defend Iran and claim that even if it is a serious step, it does not constitute definitive proof of its decision to produce nuclear weapons). One may expect such a move to generate even more severe sanctions against Iran, while Russia and China will find it more difficult to refuse to participate, and it may serve as a pretext for Israel and/or the United States to make a military move against Iran. Enrichment of uranium to HEU levels and activity toward the production of an explosive device in secret, undisclosed facilities may perhaps buy Iran more time until their discovery. However, when discovered, the results will be similar to Iran's withdrawal from the NPT, and perhaps even direr. Therefore, Iran may decide to postpone its decision to produce nuclear weapons until it estimates that the conditions are such that it is in a better position to withstand the anticipated pressures.

The third consideration concerns Iran's basic approach: does it intend to produce nuclear weapons or does it intend to stop on the threshold of weapons production? At present, there is not enough of a basis to determine whether Iran will decide to continue sequentially until it attains nuclear weapons or whether it will decide to stop on the threshold, some production months away, and postpone the decision of whether to remain there or continue towards weapons to a later time. A decision to remain on the threshold could be an original intent or a direct result of a compromise it will have to make in order to cope with the pressures.

An Iranian consideration for stopping on the threshold depends primarily on the costs and penalties. Iran may estimate that by stopping on the threshold it will be able to continue to claim that it is not producing nuclear weapons and is not seeking to become a nuclear state, and that it will be difficult to prove it has indeed attained such weapons. Thus Iran will be able to attempt to minimize the cost it will have to pay internationally as a result of developing weapons. At the same time, Iran may estimate that its ability to complete nuclear weapons production

within a short time frame will give it the strategic deterrence it needs should the American or Israeli threat to carry out a military move against it grow more acute, especially in light of the fact that it continues to develop ballistic missiles openly and without incurring any international pressures. From Iran's perspective the drawback of this approach lies in the fact that it will not bring it the regional and internal prestige it can obtain by having nuclear weapons and it will also not provide it with reliable deterrence and a readily-available response should it come under the threat of immediate attack. This leads to the further conclusion that should Iran assess that it is under imminent threat of a military move it is liable not to stop on the threshold but rather decide to proceed rapidly towards nuclear weapons.

The last consideration is the internal dimension. One of the reasons Iran desires a nuclear capability is its expectation that this will bring greater prestige and strengthen its status at home. Given this assumption, the internal crisis Iran is undergoing is liable to strengthen its interest in obtaining nuclear weapons sooner rather than later. The internal confrontation taking place is also one of the possible reasons that the regime has decided to take a rigid stance and reject the uranium deal that was discussed internationally in November 2009. At the same time, the internal situation in Iran will apparently not delay the progress of the nuclear program. In the meantime, the regime is not about to collapse any time soon. Even if it undergoes change, it should be remembered that even the leaders of the reformist movement are committed to the nuclear program. Therefore, were they to gain political control, a long process of dialogue would have to take place to induce them to renounce the goal of obtaining nuclear weapons if, indeed, they would even be willing to consider such a step.

Notes

1 Maj. Gen. Amos Yadlin, head of IDF Military Intelligence, in an address at the annual conference of the Institute for National Security Studies, December 15, 2009; Maj. Gen. Yadlin's address to the Foreign Affairs and Defense Committee of the Knesset, cited by *Haaretz*, March 23, 2009.

2 *Haaretz*, June 22, 2009.

3 Dennis Blair, *Annual Threat Assessment of the Intelligence Community for the Senate Select Committee on Intelligence*, Washington, D.C., February 12, 2009, www.cnn.om/2009/WORLD/meast/03/01/us.iran.nuclear/index.html.

4 Dennis Blair, *Annual Threat Assessment of the US Intelligence Community for*

the House Permanent Select Committee on Intelligence, Washington, D.C., February 3, 2010.

5 David E. Sanger and William J. Broad, "U.S. Sees an Opportunity to Press Iran on Nuclear Fuel," *New York Times*, January 2, 2010, www.nytimes.com/2010/01/03/world/middleeast/03iran.html., and Eli Lake, Review: Iran Never Halted Nuke Work in '03, *Washington Times*, January 19, 2010, http://www.washingtontimes.com/news/2010/jan/19/review-says-iran-never-halted-nuke-work-in-2003/.

6 Institute for Science and International Security (ISIS), October 2, 2009, http://isis-online.org/uploads/isis-reports/documents/IAEA_info_3October2009.pdf.

7 IAEA Report, November 16, 2009, http://www.iaea.org/Publications/Documents/Board/2009/gov2009-74.pdf.

8 ISIS, http://isis-online.org/isis-reports/detail/misconceptios-about-irans-nuclear-program.

9 Ibid.

10 Analysis of the November 18, 2009 IAEA report can be found at ISIS, "Nuclear Iran," http://www.isisnucleariran.org/assets/pdf/ISIS.

11 The numbers cited here are estimates since the rate of uranium enrichment to HEU will largely depend on the structure of the enrichment system and its physical parameters. Moreover, over-production of HEU will be required because of losses and waste at the coming stages. At the same time, it is also possible that the detonator facility will need a smaller amount of HEU.

12 The excuse in such an event would be that the research reactor in Tehran requires uranium enriched to such a level. Such an excuse, however, is feeble, because that reactor needs only insignificant amounts of HEU. In any case, Iran cannot produce this fuel by itself.

13 The media reported that an Iranian source said that Iran is planning to enrich uranium to 60 percent, the last stage before enrichment to military grade. Enrichment to this level lies beyond what is generally considered acceptable.

14 See note 8.

15 See note 5.