Center for Energy and Security Studies
www.ceness-russia.org

Mailing address: 3rd Tverskaya-Yamskaya, 24, office 5, Moscow, 125047, Russia
Tel.: +7 (495) 227-0829, fax: +7 (499) 176-0829
E-mail: ceness@ceness-russia.org

ASSESSING THE TIMETABLE FOR AN IRANIAN NUCLEAR WEAPON*

Mark Fitzpatrick

Is it fair to accuse the Islamic Republic of Iran of seeking nuclear weapons? Tehran claims that its nuclear programme is entirely peaceful and that its uranium enrichment programme is only intended for fuel production. Yet if Iran truly had nothing to hide, why does it take positions that do nothing but hide its nuclear activities? Its systematic violations of NPT safeguards obligations and obstruction of IAEA investigations into allegations of nuclear-weapons-related work are well documented. Iran repeatedly bars experienced inspectors from the International Atomic Energy Agency (IAEA), refuses to provide satisfactory answers to IAEA questions and is the only proponent of an obsolete version of a safeguards provision on early notification of new facilities that seriously impedes the IAEA's ability to detect nuclear-weapons indicators.

Notwithstanding the civilian nuclear energy purpose of projects such as the Bushehr reactor, the totality of the evidence indicates beyond reasonable doubt that Iran also seeks a capability to produce nuclear weapons should its leaders choose to take this momentous step. This capability has been growing inexorably for 25 years, ever since work on uranium enrichment was initiated in the mid-1980s. The endeavour has not been a crash effort akin to America's Manhattan Project, which produced two kinds of nuclear weapons in three-and-a-half years, or Pakistan's nuclear bomb project, which reached the nuclear-weapons threshold about 11 years after launching an enrichment programme. If Iran wanted to produce the fissile material for a weapon as soon as possible, it could have moved more quickly. Overall, Iran's leaders have tried to keep their presumed weapons intentions ambiguous. Yet the 'purely peaceful' justification is not credible.

All states that have acquired nuclear weapons have done so using two kinds of fissile material: plutonium and highly enriched uranium. Iran is likewise pursuing both of these paths. In its case, the plutonium path is further away. The heavy-water research reactor under construction at Arak is ostensibly for civilian purposes but is similar in size and kind to reactors used by India, Israel and Pakistan to produce plutonium for weapons. To separate the plutonium from the reactor's spent fuel would require a reprocessing capability that Iran does not now have. In any case, the proliferation threat from Arak is at least several years away because Iran has not been able to produce or to procure the large metal components for the reactor. The 2013 scheduled completion date for Arak cannot be met.

The Bushehr nuclear power reactor is also a potential source of weapons-usable plutonium. Its annual discharge rate of about 25 tonnes of spent fuel will, in theory, contain enough plutonium for a few dozen nuclear weapons. However, the 'reactor-grade' plutonium produced as a by-product of electricity generation is not easily suitable for

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weapons. Although Iran could operate the Bushehr reactor in a way that would produce 'weapons-grade' plutonium, doing this would tip off inspectors. The credibility of this scenario also depends on Iran's ability to build and conceal a reprocessing plant for spent fuel for this kind of reactor, which is technically challenging.

The most pressing proliferation concern stems from Iran's development of uranium-enrichment technology. The enrichment programme based at Natanz has been delayed by technical troubles stemming from the faulty design of the first-generation centrifuge employed, Iran's rush to install as many centrifuges as it could and industrial sabotage, including targeting by the Stuxnet computer worm. Iran's ability to operate more than about 4,000 centrifuges at Natanz is limited by its access to key raw materials and equipment. Despite claims of self-sufficiency, the enrichment programme is still dependent on foreign supplies of certain materials such as maraging steel and carbon fibre. Iran may be able to overcome these constraints over time, but strict application of export controls and intelligence scrutiny of international black markets will hamper its ability to rapidly expand uranium production.

Break-out scenarios

Notwithstanding the technical troubles at Natanz and centrifuge-production limitations, Iran has already produced a sizable amount of low-enriched uranium (LEU). If further enriched, the current stockpile would be enough for one or two nuclear weapons. How much LEU is needed as feed material for weapons-grade highly enriched uranium (HEU) depends on the production method. There is a trade-off between speed and efficiency; the faster a country tries to manufacture a bomb, the more uranium feed material would be needed. Timelines must also distinguish between the production of the first bomb, which takes longer, and the production of additional bombs.

In one scenario, if Iran uses for weapons purposes the 4,000 or so centrifuges that appear to be working well at Natanz and if these centrifuges can continue to perform at their maximum output to date, then a little over a year and seven months would be required for the first bomb's worth of HEU. This scenario assumes that Iran would use a four-stage production method developed by Pakistan and sold by A.Q. Khan on the black market. This also assumes that one implosion-type bomb requires 25kg of HEU, the IAEA figure for a 'significant quantity'. The timeframe takes into account the time needed to reconfigure the Natanz cascades for HEU production and a large wastage factor that invariably accompanies the production of the first bomb, both in the production of HEU gas and in the machining of the HEU metal. Because of the wastage factor, the first bomb would require about 2,900kg of 3.5% LEU, which is about what Iran had on hand at the end of 2010. Subsequent bombs would take a minimum of 32 weeks, and each would require about 1,300kg of LEU. At its most current rate of production, Iran can produce this much LEU in ten months.

In theory, a quicker path, called a batch enrichment process, could be pursued that does not require cascade reconfiguration and entails less wastage in producing the initial bomb's worth of HEU. In this scenario, the first weapon's worth of HEU could be produced in six months and subsequent bomb quantities produced in four months. However, this method would require more LEU feed material and has never been done in practice. Rather than using the unproven batch process, it seems more likely that, if Iran wanted to go for a bomb, it would use tried-and-true methods of centrifuge configuration for which it probably obtained plans from the Khan network.

Whichever method were used, at least six more months would be required to convert the gasified HEU into metal and fashion it into a weapon. The minimum timeline, then, for the first weapon, is over two years under the Pakistan method and one year for the batch method. Developing a means to deliver a nuclear weapon adds to the timeline.

For a credible nuclear deterrent, one bomb would be insufficient. Given the need for a replacement in case of bomb failure, as well as the presumed requirement for a second-strike capability and possibly for a test, it would seem foolhardy for a nation to go for broke, with the international reaction this would entail, before it could manufacture at least a handful of weapons. Assembling such an arsenal would multiply both the amount of weapons-grade uranium that would be needed and the amount of time it would take Iran to reach the threshold capability.

Any of the possible break-out paths based on the use of the centrifuges at Natanz for HEU production would inevitably give several weeks' warning, at the very least, to international inspectors. If it did decide to build a nuclear bomb, there are other possible paths Iran might take that would minimise that warning or at the very least hide the plant more effectively from possible military attacks. These would involve the construction of a clandestine HEU production facility (or a set of facilities employing a multi-stage process). Such ‘sneak-out’ options would require either the diversion of safeguarded feed material, or, more likely, the production of UF_6 at a clandestine conversion plant using yellowcake produced and transported out of sight of surveillance satellites. Iran’s ability to mine and produce its own yellowcake at Gchine, as announced in December 2010, lends credence to this scenario, since IAEA regular safeguards do not cover uranium mining.

Clandestine HEU production is the most likely break-out option – and the most worrisome one. To succeed, Iran would have to keep both the enrichment plant and the upstream feed-material chain – uranium mining, milling and UF_6 conversion – secret. Iran’s willingness to construct secret enrichment facilities, under the guise of adherence to an obsolete reporting requirement if they are discovered, is thus extremely troubling. Iran’s 2006 suspension of its adherence to the Additional Protocol, which granted IAEA inspectors access to more sites, increased the uncertainty about clandestine production. Iran’s declaration in December 2009 that it intends to build a total of ten other enrichment plants, while surely an exaggeration given Iran’s inability even to fully outfit Natanz, added to the international unease caused by the 2009 revelation of a previously secret enrichment plant at Fordow, near the holy city of Qom.

International concerns were also heightened by Iran’s commencement in 2010 of enrichment to nearly 20%. The military implications of such enrichment are significant: in any future dash to weapons-grade uranium, starting with 20% enriched material instead of 3.5% LEU would reduce by a factor of five the amount of extra effort required. The justification for enriching to 19.75% is weak, given Iran’s current inability to produce reactor fuel of any kind from enriched uranium. To justify producing this level of enriched uranium, Iran says it is needed for the ageing Tehran Research Reactor, which almost eight years ago was characterised as nearing the safety limits for which it had been designed. Even if Iran is eventually able to fabricate fuel from the 19.75% enriched uranium, standard safety practices would require the fuel to be tested for an extended period of time in a reactor before it could be safely used. By the time any fuel is produced, the Tehran Research Reactor may not have sufficient power to allow this testing to take place. One way or another, Iran would probably have to turn to outside help to test the fuel or else use it in an unsafe way.

The IAEA has received evidence from several countries that points to an extensive and sophisticated nuclear-weapons design programme. The IAEA reports that the information relating to possible military dimensions comes from multiple sources and to a great extent is internally consistent. Its investigation into these matters has been blocked by Iran's unwillingness to provide substantive answers to its questions, or to allow key individuals cited in the documents to be interviewed.

Although most of the documents concerning possible military dimensions relate to alleged past activities, in February 2010 the IAEA for the first time referred to the possibility of current undisclosed activities related to the development of a nuclear payload for a missile. It is not clear whether the paper studies indicated in the documents have been translated into practical work on an actual nuclear-weapons design. A case can be made that the documents regarding weaponisation work do no more than indicate an Iranian desire to have a capability to produce nuclear weapons, and do not signal a commitment to build them. However, until Iran has sufficient enriched uranium to make break-out worth the risk, there is little practical difference between striving for a capability and striving for a bomb.

Iran's claim of peaceful intent, and the religious prohibition that underlies stated policy, could be a useful basis for a negotiated solution to the problem. Iranians attuned to the reality of global politics recognise that nuclear weapons would make Iran a target of international hostility, spur further proliferation in the region and help America plant its 'nuclear umbrella' in their neighbourhood. Although the temptation for Iran's leaders to eventually translate nuclear potential into reality could be difficult to resist once the option is available to them, many argue that Iran will be content to have a nuclear-weapons option without actually producing nuclear weapons.

Whether or not Iran's adversaries will allow it to become a virtual nuclear-capable nation is uncertain, especially as it establishes more 'facts-on-the-ground' by increasing its stockpile of LEU and developing more powerful centrifuges. If Iran is able to produce large numbers of more advanced centrifuges, the break-out options will become more alarming. At present, however, the likelihood that any dash by Iran for a bomb would be detected before it assembled a single weapon, much less the small arsenal that would be needed to make break-out worth the risk, allows time for a negotiated solution, should Iran's leaders decide to seek one.