Statement on Iran's ability to make a nuclear weapon and the significance of the 19 February 2009 IAEA report on Iran's uranium-enrichment program

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Summary

Various media reports[1] and a government official[2] have interpreted the recent IAEA report on Iran's nuclear program as suggesting that Iran has enough fissile material to make a nuclear weapon. We find these claims misleading with respect to Iran's existing stocks and capabilities.

According to the IAEA, Iran does not possess any uranium with an enrichment level suitable for use in nuclear weapons. Additionally, unless Iran makes significant modifications to its centrifuge cascades, the claims being made overestimate the amount of weapon-usable uranium that could be produced from Iran's low-enriched uranium stocks by a factor of three.

We estimate that it would take Iran roughly a year to make a "significant quantity" of weapon-grade uranium, and that a more realistic estimate is three years.

What material does Iran have?

According to the IAEA, Iran possessed as of the end of January an estimated 1010 kg of 3.5% enriched uranium-hexafluoride. This is equivalent to 683 kg of uranium metal. If processed in an ideal, loss-free cascade, this could be converted into approximately 25 kg of 90% enriched uranium metal, or almost one IAEA "significant quantity," the amount that the IAEA believes to be sufficient to make one first-generation nuclear weapon. This calculation appears to be the basis for the claim that Iran has achieved "breakout capability."

Iran does not, however, possess an ideal, loss-free cascade designed to produce highly enriched uranium. Iran has a number of small cascades designed to produce enrichment in the 3 to 5% range. Additionally, process losses in the range of 15-20% should be expected.

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[1] For example: Thom Shanker, "U.S. Says Iran Has Material for Bomb," *The New York Times*, March 1, 2009; David Albright and Jacqueline Shire, "IAEA Report on Iran: Nuclear Weapons breakout capability achieved..." Institute for Science and International Security

[2] In a March 1, 2009 interview with Adm. Mike Mullen, Chairman of the Joint Chiefs of Staff, on CNN's John King asked Mullen: Does Iran have enough fissile material to make a bomb? Mullen responded, "We think they do." Later, Mullen's spokesperson, Cpt. John Kirby, clarified that Mullen was referring only to the International Atomic Energy Agency's February findings that Iran has 1010 kilograms of low-enriched uranium. See: IAEA Director General Report to the Board of Governors, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions 1737 (2006), 1747 (2007), 1803 (2008) and 1835 (2008) in the Islamic Republic of Iran*, 19 February 2009 (GOV/2009/8).

How much weapon-grade uranium could Iran produce from the LEU it has?

If Iran decided to produce weapon-grade highly enriched uranium (HEU) in the Natanz enrichment plant, it would have two options:

1. Process the low-enriched uranium at least two additional times through the existing cascades (also called batch recycling);

2. Re-pipe the centrifuges to build new cascades designed specifically for producing weapon-grade uranium.

Option 1 produces HEU the fastest, is the least subject to delays, and requires no modifications to the cascades. However, it would require about three times more low-enriched uranium (LEU) feed than Iran has now. This is because the cascades have not been optimized for HEU production and will produce waste containing low- and medium-enriched uranium. Assuming no process losses, Iran could produce about 10 kg of weapon-grade uranium using the LEU stockpile it has at this time.

Option 2 is more efficient in its use of the uranium, but significant delays in preparing for this strategy are inevitable. In choosing this option, Iran would need to shutdown and re-pipe all of its cascades. The re-piping process would take several months and be highly visible. Also, the shutdown of a centrifuge places high levels of stress on the machine and can result in machine failure. Assuming no process losses and no machine failures, Iran could produce about 25 kg of 90% enriched material using the current stockpile of LEU with a reconfigured cascade.

How much HEU is required for a bomb?

The IAEA definition of a significant quantity is approximately equal to 25 kg of 90% enriched uranium.[3] A gun-type bomb, like that used over Hiroshima, can be easily made but requires about two IAEA significant quantities of HEU. The gun-type weapon exploded over Hiroshima used 64 kilograms of uranium with an average enrichment of 80%.

An implosion-type weapon, such as that used over Nagasaki, would need less uranium—about 18 kg of weapon-grade uranium.[4] Implosion-type weapons are more sophisticated and require some specialized components. Iran is reported to have investigated implosion designs in the past, but terminated its development effort in the fall of 2003.[5]

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[3] Technically, the definition is 25 kg of uranium-235 in enriched uranium, which corresponds to 27.8 kg of 90% enriched uranium.

[4] The Nagasaki bomb used about 6 kilograms of plutonium. The critical mass of highly enriched uranium is about three times larger than the critical mass of plutonium.

[5] IAEA, *Implementation of the NPT Safeguards Agreement and relevant provisions of Security Council resolutions 1737 (2006) and 1747 (2007) in the Islamic Republic of Iran,* 22 February 2008 (GOV/2008/4); The National Intelligence Council, "Iran: Nuclear Intentions and Capabilities," November 2007.

How long would it take Iran to produce a "significant quantity" of HEU?

In this section we assume no undeclared facilities or feedstock.[6]

If Iran were to batch recycle its LEU feedstock through its existing cascades, it needs first to produce an additional 2,200 kg of low-enriched UF_6. At current LEU production rates, this would take an additional 31 months.[7] If Iran were able to operate its existing 4,000 machines at the ideal level of performance, it would take just over 6 months.[8]

Once Iran obtained sufficient LEU, it would then take additional time to convert it into HEU. Under optimal conditions, a 4000-machine cascade would require seven weeks to process the LEU into HEU. At current performance levels, this step would require an additional 4 to 6 months. Thus, the time for producing a bomb's worth of HEU via this route is between eight months and three years.

Alternatively, Iran could re-pipe its cascade to optimally use its existing LEU inventory. This, avoids having to produce additional LEU feedstock, but would take a number of months to shutdown, re-pipe, and restart the cascades. After the new cascade is running and tested, the 4000 machines could theoretically produce a significant quantity in approximately the same amount of time as it would take to batch convert the LEU to HEU. In this case, an additional eight weeks of enrichment is required if the machines operated at ideal performance, or 6 to 9 months if operated at current performance levels. This option, while faster over all, requires that Iran be overtly producing weapon-grade uranium for a longer period of time (perhaps over a year), and might thus be more likely to be stopped by outside actions before it could finish.

Iran is currently installing under vacuum approximately one cascade of 164 P1-machines per month.[9] If this rate of expansion continued and new cascades were seamlessly integrated into the process, the batch-recycle option could be shortened to about 24 months at current performance levels, or 7 months with ideal centrifuge performance. Similarly, the re-piping option would take 5 to 8 months after re-piping was complete at current performance levels, or 7 weeks after re-piping was complete with ideal performance.[10]

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[6] The calculations in this section are based on computations reported in Alexander Glaser, "Characteristics of the Gas Centrifuge for Uranium Enrichment and Its Relevance for Nuclear Weapon Proliferation," *Science & Global Security*, Vol. 16, pp. 1-25 (2008).

[7] Based on the reported production of 171 kg of product during a 74-day period between 18 November 2008 and 31 January 2009, as reported by the IAEA in GOV/2009/8.

[8] Assuming 2.5 kg-SUW/machine/year and tails at 0.40%. In both cases, an additional 10% more time should be added to compensate for process losses.

[9] Based on the rate at which Iran is able to bring cascades into the "operating but under vacuum" state. Iran was able to install 15 cascades (at 164 machines each) in the 14 months between December 2007 and February 2009.

[10] We assume that the effort of re-piping the existing cascades would temporarily halt the installation of new cascades.

Conclusions

We have argued that, while Iran might in theory have enough LEU feedstock to produce HEU for a bomb, a lengthy effort is still required. To use only its existing LEU stockpile would require breaking out of safeguards in a detectable manner, several months to shutdown and re-pipe the cascades, and then an additional 6 to 9 months of uninterrupted operation (at current centrifuge performance rates). In this case, the international community would have roughly a year to respond.

The faster option of batch recycling is not yet available to Iran. Iran still needs to produce LEU for an additional 31 months (at current performance rates), and then spend at least four months converting LEU to HEU, bringing the total effort to about 3 years. In this case the international community would have around four months to respond.

If Iran agreed to convert its stockpile of low-enriched uranium-hexafluoride into uranium-oxide, the form needed for nuclear-reactor fuel, it would alleviate this concern because the oxide form cannot be used in a centrifuge cascade.