Comments on *Wall Street Journal* Editorial and Our Breakout Estimates[1]

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October 30, 2012

The Wall Street Journal published an editorial on October 19, 2012 titled "Tick-Tock Tehran," which referenced our recent ISIS report, *Iran's Evolving Breakout Potential*. We would like to point out a central conclusion of our report, namely that the chance Iran will "break out" and build a nuclear weapon in the next year remains low. A straightforward method to help keep this probability low is to increase the frequency of International Atomic Energy Agency (IAEA) inspections of Iran's main uranium enrichment plants. In addition, while we did not explicitly discuss this subject in our report, Iran is unlikely to build a gun-type nuclear weapon like the type that destroyed Hiroshima. If Iran decided to build a nuclear weapon, it would not be able to build a gun-type significantly faster than the other type of crude fission weapon, an implosion type that was used to destroy Nagasaki and has already been pursued by Iran, according to evidence assembled by the IAEA.

Breakout Estimates and Detection Time

Our estimates provide the length of time that Iran would need to produce enough weapon-grade uranium for a nuclear weapon, if Iran decided to do so. At this time, it is widely accepted that Iran has not made a decision to actually build a nuclear weapon, although it appears to be furthering its capability to make them.

Our estimate that Iran can currently break out in as little as 2-4 months provides adequate time for the United States to both detect and respond to the breakout before Iran accumulates enough weapon-grade uranium for one nuclear weapon. Because Iran fears a military response, it is unlikely to breakout. We assessed in our study that breakout times could reduce to about one month during the next year. But in all the scenarios we considered, the breakout would remain detectable to provide time for U.S. action. As a result, during at least the next year, our estimates support that the likelihood of an Iranian breakout will also be low.

We share the WSJ's concern for Iran's growing nuclear weapons capability. Because of significant uncertainties in charting Iran's nuclear progress, we do not know what additional nuclear capabilities Iran may have in place one year from now. As a result, we did not estimate breakout times in late 2013 or afterwards, and statements suggesting that breakout times are bound to shrink significantly by then are just speculation at this point. Depending on what technical obstacles Iran encounters, how much of its enriched uranium it converts to fuel plates for the Tehran Research Reactor, and other variables, breakout times may not shrink at all.

But we believe that even if breakout is detectable during the next year in a timely manner, every effort should be made to improve the speed at which it would be detected and reduce the time needed for a U.S. response. Moreover, Iran may decide to improve its breakout capability by increasing the number of its centrifuges. In either case, one simple way to improve the chance of detection is to increase the frequency of inspections by the International Atomic Energy Agency at the Natanz and Fordow centrifuge enrichment sites. The inspectors

[1] This is a longer ISIS response built on a shorter letter by printed by the WSJ on October 30, 2012, which can be viewed here: http://online.wsj.com/public/page/letters.html

are the most credible witnesses to Iran's activities at these sites. Currently, inspections occur on average about once every two weeks, and some of them are unannounced. The IAEA can increase the frequency of both regular and unannounced inspections, improving the likelihood of prompt breakout detection. If the inspection frequency became weekly—even if the Iran were to increase its number of centrifuges significantly compared to current quantities--the chance of detecting a breakout would be at least as good as, or even better than, it is today. If breakout times do in fact shorten in late 2013, more frequent IAEA inspections would help maintain early detection capabilities. There would be sufficient time for a response before Iran would accumulate enough weapon-grade uranium for a nuclear weapon, thereby ensuring that breakout at Natanz and Fordow would remain a risky proposition.

This approach cannot substitute for a solution to the Iranian nuclear crisis, and in the longer term Iran can pursue other paths to the bomb that can be difficult to detect in a timely manner. For example, we, like many governments, currently assess that Iran is unlikely to have a secret centrifuge plant able to produce significant amounts of enriched uranium. Iran has said that it wants to build new centrifuge plants and has stated that it feels no obligation to tell the IAEA until a plant is essentially finished. Thus, ISIS has estimated that in 2014 Iran could succeed in building a secret centrifuge plant without it being declared to the inspectors or detected by intelligence agencies. At this plant, it could secretly produce weapon-grade uranium in what is often called a "sneak-out" to nuclear weapons, This is a worst-case assessment, and Western intelligence agencies may in fact detect this plant, as they detected the secret Fordow enrichment plant in 2009, well before it became operational. Fordow's exposure crippled Iran's ability to use the now IAEA-inspected site in a sneak-out. But as Iran's capabilities expand, its ability to build and outfit secret centrifuge sites will also grow. Thus, finding a solution during the next year is a priority. But at the same time, increasing Iran's hesitation to break out remains a critical priority for preventing an Iranian nuclear weapon, while allowing the chance for other remedies to bear fruit.

Gun-Type Design Unlikely

Our report also notes that were Iran to accumulate enough weapon-grade uranium for a nuclear weapon, it would still need more time to build one. According to the report, "Iran would need many additional months to manufacture a nuclear device suitable for underground testing." It would need "even longer to make a reliable warhead for a ballistic missile." The WSJ editorial offers a crude gun-type bomb of the type that destroyed Hiroshima as a way for Iran to save time in building the nuclear weapon, compared to building the conceptually more difficult implosion-type design. However, we assess that gun-type nuclear weapons are an unlikely choice for Iran and in any case will not save it a significant amount of time in fielding a nuclear device for an underground test aimed at establishing a nuclear weapon status or a deliverable nuclear weapon able to fit on a ballistic missile.

The biggest weakness of choosing a gun-type design is that Iran would need double the amount of weapon-grade uranium compared to that needed for an implosion-type design, increasing the time to breakout and accumulating sufficient weapon-grade uranium for one weapon from at least 2-4 months to at least 4-8 months. This doubling reflects the design of first generation gun-type devices, which are highly inefficient. The South African gun-type design contained about 55 kilograms of weapon-grade uranium. The Hiroshima bomb, called Little Boy, required 64 kilograms of uranium enriched on average to about 80 percent. The first two South African gun-type devices also held 80 percent enriched uranium, reflecting the difficulty, like the early U.S. enrichment program, of achieving 90 percent enriched uranium. However, the lower enrichment does not affect breakout times significantly.

Although gun-type fission devices are conceptually easier to design and develop than the implosion-type, they too can pose challenging engineering problems if a reliable explosive device with a significant yield is sought. Weaponizing one for a ballistic missile is possible but poses several additional difficulties that Iran would need to overcome.

If Iran chose to pursue nuclear weapons, we believe it would build an implosion-type weapon. According to evidence assembled by the IAEA, Iran conducted a structured program to develop this type of weapon prior to 2004 and may have continued on an *ad hoc* basis afterwards. Internal IAEA assessments state that although Iran did not finish its work on creating a reliable warhead for a ballistic missile, it learned enough to make a crude fission implosion weapon. There is no evidence to support that Iran has worked on gun-type fission devices. Thus, Iran's implosion-type design appears to have a significant head-start.

One advantage of a gun-type design is that the need for a full-scale test can be replaced by a certain type of criticality test. This type of experiment is referred to as "tickling the dragon's tail," suggesting the danger inherent in the test. In essence, a simplified "dragon" machine, or pulsed fission reactor, involves a slug of highly enriched uranium sliding down a wire or track through a cylindrical annulus of highly enriched uranium, simulating in slow motion what occurs in firing a gun-type design. The United States conducted such experiments in early 1945 at Los Alamos during the Manhattan Project; South Africa used Building 5000 at the Pelindaba site in about 1979, soon before it built its first nuclear explosive device. If a slug had become stuck in the U.S. dragon machine, the highly enriched uranium would have become supercritical, causing a small nuclear explosion (on order of tens or hundreds of kilograms of TNT). Thus, any dragon-type reactor must be built with safety as a primary concern, and it must be operated carefully. South Africa apparently attempted to mitigate this danger in several ways. It built Building 5000 at the bottom of a depression surrounded by hills in an isolated portion of its main nuclear site. It placed the control room in Building 5100, which was almost three quarters of a kilometer away and shielded from its dragon test by a hill.

An implosion program can also be developed to eliminate the need for a full-scale nuclear test to prove that the design will work, although this process is not as simple as with a gun-type program. The available information about Iran's implosion work to date supports that Iran is unlikely to require a full-scale test to prove the efficacy of its design, off-setting this perceived advantage of a gun-type design. The implosion program would need to systematically and rigorously carry out a series of tests involving both the high explosive system and the neutron initiator and a dummy core. Using these testing methods, commonly called "cold" tests, the device can be certified, as was done by Pakistan for example in 1984, long before it conducted an underground nuclear explosion in 1998. If the Iranian regime orders the detonation of a nuclear explosion underground, it will likely have already satisfied itself that the device will work and will likely aim mainly to establish itself as a nuclear weapons power.

Thus, when considering the extra weapon-grade uranium, the head-start afforded an Iranian implosion design, and the need to develop, test, and manufacture a gun-type device, the total amount of time Iran would require to build a gun-type device for underground testing would not differ significantly from the time needed to construct an implosion design of the type that Iran is believed to have developed until at least the end of 2003.