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## The Twenty Percent Solution

### *Breaking the Iranian Stalemate*

Iran and the rest of the world are stalemated. Obama's deadline for Tehran to address concerns about its nuclear program passed at the end of 2009, so the White House is moving to harsher sanctions. But the US is having trouble rallying the needed international support because Iranian intentions remain ambiguous. The deadlock includes negotiations on fueling Iran's medical isotope reactor. With no progress on that front, Iran has begun its own production of 20-percent uranium for reactor fuel, a worrying development that could put Iran closer to a nuclear weapon. Yet, even while talk of sanctions escalates, Tehran says it is still interested in buying the 20 percent reactor fuel from foreign suppliers.

The Tehran Research Reactor (TRR) deal has backfired. The offer, to trade a large part of Iran's low enriched uranium (LEU) for finished TRR fuel elements, was meant to abate the potential Iranian nuclear threat by reducing Iran's stockpile of enriched nuclear material. By artificially coupling two distinct problems, re-fueling the TRR and Iran's enrichment program, the US, France and Russia have given Tehran a reason, even a humanitarian one, to enrich to higher concentrations. The move to 20 percent enrichment will reduce by more than half the time needed for Iran to get a bomb's worth of material.

There are clear indications, however, that Iran's decision is not irreversible. A technical assessment shows that Iran is not really serious about 20 percent enrichment at this stage. The Islamic Republic has agreed in principle to the IAEA-brokered deal of swapping domestic

LEU for foreign-made TRR fuel rods and is still looking to purchase fuel. Moreover, Tehran has said that it will stop enrichment to high concentrations once a deal is struck and the suppliers deliver on it.<sup>1</sup> Currently, the only point of contention is where and when the swap will take place – Iran wants to keep the LEU on own soil under agency safeguards until the fuel rods are delivered, but the US, France, and Russia propose that Iranian LEU be shipped out immediately and be held outside the country until the fuel elements are ready.

By arguing about the details, we are losing track of what our goals are. Our main concern should be to make it more difficult – not easier – for Iran to build a nuclear weapon. Iranian defiance has become a

<sup>1</sup> "Nuclear Swap Deal Still on the Table: Salehi." *Press TV*. 10 Feb. 2010. Web. 5 Apr. 2010. <<http://www.presstv.ir/detail.aspx?id=118302&sectionid=351020104>>.

basis for harsher sanctions but 20 percent enrichment is a costly price to pay. We currently face a greater Iranian breakout threat, one that sanctions will not reverse but may actually exacerbate. Indeed, sanctions may be the appropriate, but only when other measures have been exhausted. We believe there is still a viable option to see the fuel deal through and reduce the threat of a potential Iranian nuclear weapons program.

We propose the perfect litmus test for Iranian nuclear intentions. The international community should accept the terms of Tehran’s exchange proposal. The big achievement has already been made: getting Iran to agree to the fuel swap. This was a decision that met considerable domestic opposition within Iran. Leaving the LEU in Iran is not a dangerous concession and would not be a change from the current state of affairs since all of the nuclear material would remain under IAEA safeguards. If the material is shipped to a location outside Natanz, such as Kish Island, this could further alleviate concerns about the possibility of a quick breakout. Under our proposal, Iran would be required to suspend 20 percent enrichment as soon as a fuel deal is made and permanently stop enrichment to higher degrees when the fuel is actually delivered. If we act quickly and the deal is successful, we will set the nuclear clock back by both stopping 20 percent enrichment and perhaps even leave Iran with less than a weapon’s worth of LEU. We will build confidence – for the West, that Iran is willing to cooperate, and for Iran, that the West can provide credible fuel guarantees.

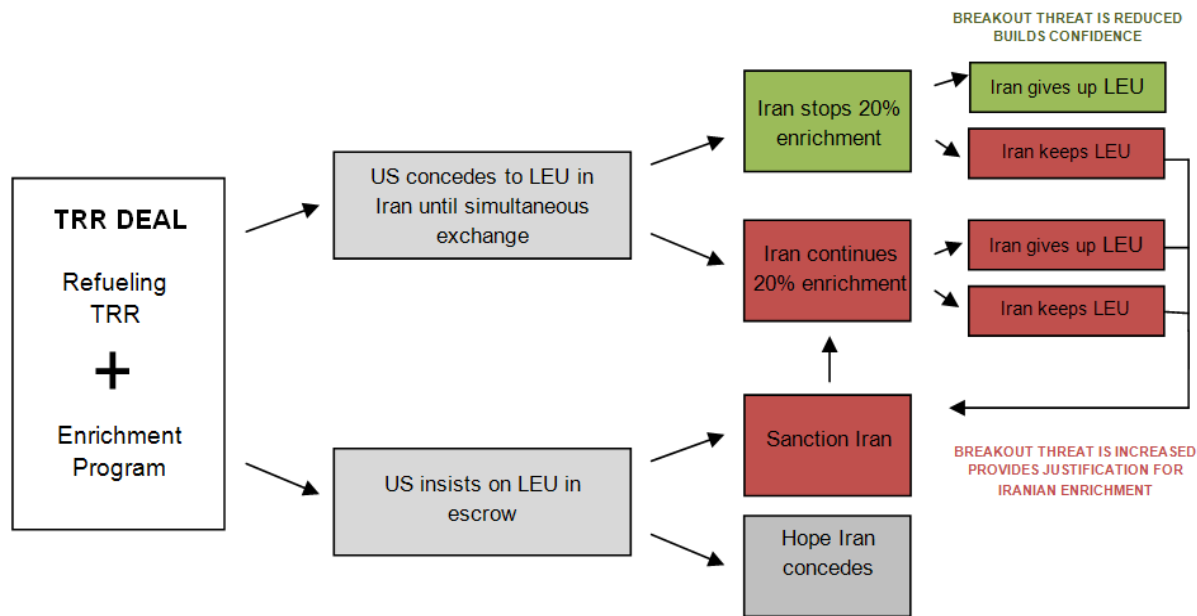


Figure 1: Possible outcomes in the Tehran Research Reactor deal

This test of intentions has low down-side risk and high potential payoff. Having taken away the *raison d’être* for enriching to higher degrees, if Iran does not stop production of 20 percent uranium and ship out their LEU after having received TRR fuel on *their* terms, it will be clear to the most skeptical observer that Iran’s program is motivated by a bomb. Yet, even in this worst case, we will be no worse off than we are already,<sup>2</sup> but will have stronger international support for coercive options. Indeed, whatever small and transient risk exists in accepting Iran’s conditions is a small price to pay for

<sup>2</sup> Even the worst possible case, that Iran would divert the imported 20 percent reactor fuel to a bomb program, is not plausible for reasons discussed later on in this report.

resolving the ambiguity in Iran's nuclear efforts. And, in the best case, this could be the first page of new relationship with Iran.

## 1 BACKGROUND

### 1.1. Coupling Cancer Treatment with the Iranian Enrichment Program

Tehran made a formal inquiry to the IAEA in June 2009 to purchase fuel for its medical isotope reactor calling on Article 3 of the Agency's Statute<sup>3</sup> to "make provision ... for materials, services, equipment and facilities to meet the needs of research on ... atomic energy for peaceful purposes." During his trip to the United Nations in September 2009, Ahmadinejad publicized<sup>4</sup> Iran's willingness to purchase fuel for the TRR from any country, including the U.S., and even to exchange 3.5 percent enriched uranium in partial payment. Iranian officials claim that the reactor is running low on fuel and securing a supply of uranium is dictated by the need for medical isotopes for Iran's 850,000 cancer patients.<sup>5</sup>

At the same time, Iran has steadfastly refused to discuss its nuclear program after prolonged and unsuccessful negotiations in 2005. Iran's official position is that it has answered all of the IAEA's *legitimate* questions regarding its enrichment activities and considers its nuclear file closed. According to the agency, however, there are outstanding issues regarding possible military dimensions of Iran's nuclear program.<sup>6</sup> In defiance of Security Council resolutions, Tehran insists that it will never suspend uranium enrichment, which it views as its legal right under the NPT.

With regard to refueling the TRR, Ahmadinejad announced that "the fundamental rights of the Iranian nation [in the nuclear issue] are not subject to negotiation; [Iran's] nuclear activity and cooperation will be carried out only in the framework of the IAEA."<sup>7</sup> Even so, Iran participated in the Geneva talks in October 2009, perhaps in part to diffuse tension after the September 25 announcement<sup>8</sup> by Presidents Obama and Sarkozy and Prime Minister Brown that Tehran had been constructing a clandestine enrichment facility in the mountains of Qom. It was at these talks that the US, France, and Russia artificially coupled the two distinct problems of the TRR fuel replacement and Iran's enrichment at Natanz.

The IAEA-brokered proposal called for Iran to export 1200 kg of uranium hexafluoride (UF<sub>6</sub>) from its LEU stockpile produced at Natanz, which would be further enriched to 20-percent by Russia and then incorporated into fuel rods by France. In theory, this was an ingenious win-win deal, purportedly<sup>9</sup> suggested by the White House. Iran would be able to purchase the rods at a lower price and receive outside technical support. This would prove to Tehran that international fuel supplies were reliable and undermine its ostensible justification for a domestic uranium enrichment program. At the same time,

<sup>3</sup> International Atomic Energy Agency. *Statute of the IAEA*. Web. 5 Apr. 2010. <[http://www.iaea.org/About/statute\\_text.html](http://www.iaea.org/About/statute_text.html)>.

<sup>4</sup> Weymouth, Lally. "Ahmadinejad's Nuclear Offer." *Newsweek*. 23 Sept. 2009. Web. 5 Apr. 2010. <<http://www.newsweek.com/id/216040/page/4>>.

<sup>5</sup> "Russia Says New Iran Sanctions No Solution." *Press TV*. 10 Feb. 2010. Web. 5 Apr. 2010. <<http://www.presstv.ir/detail.aspx?id=118346&sectionid=351020602>>.

<sup>6</sup> For more information see Barzashka, Ivanka, and Ivan Oelrich. "Judging the Mood at the IAEA." Web log post. *FAS Strategic Security Blog*. Federation of American Scientists, 22 Mar. 2010. Web. 9 Apr. 2010. <<http://www.fas.org/blog/ssp/2010/03/judging-the-mood-at-the-iaea.php>>. and Oelrich, Ivan, and Ivanka Barzashka. "There's Still Nothing New on Iran." Editorial. *Bulletin of the Atomic Scientists* 19 Mar. 2010. 19 Mar. 2010. Web. 9 Apr. 2010. <<http://www.thebulletin.org/web-edition/op-eds/theres-still-nothing-new-iran>>.

<sup>7</sup> Savyon, A., and Y. Mansharof. "Iran's Answer to the West: 'Iran Has Lost Its Patience'; 'We've Already Begun Production [of 20%-Enriched Uranium]'" *MEMRI - The Middle East Media Research Institute*. 17 Nov. 2009. Web. 05 Apr. 2010. <<http://www.memri.org/report/en/0/0/0/108/0/3803.htm>>.

<sup>8</sup> White House. Office of the Press Secretary. *Statements by President Obama, French President Sarkozy, and British Prime Minister Brown on Iranian Nuclear Facility*. 25 Sept. 2009. Web. 5 Apr. 2010. <[http://www.whitehouse.gov/the\\_press\\_office/Statements-By-President-Obama-French-President-Sarkozy-And-British-Prime-Minister-Brown-On-Iranian-Nuclear-Facility/](http://www.whitehouse.gov/the_press_office/Statements-By-President-Obama-French-President-Sarkozy-And-British-Prime-Minister-Brown-On-Iranian-Nuclear-Facility/)>.

<sup>9</sup> Sanger, David E. "Iran Threatens to Back Out of Fuel Deal." *New York Times*. 19 Oct. 2009. Web. 5 Apr. 2010. <<http://www.nytimes.com/2009/10/20/world/middleeast/20nuke.html>>.

the breakout threat would be reduced by leaving Iran with only 767 kg of LEU, as of February 2010, and thus extending the time Iran would need to produce a nuclear weapon.

## 1.2. Iranian Domestic Opposition to the Fuel Exchange Deal

Iran has officially agreed to the fuel exchange, but not without substantial internal dissent. Ahmadinejad had broadly accepted the idea of a fuel swap before the formal negotiations began in October, responding to proposals Iran had received in advance. On 21 October 2009, Ali Asghar Soltanieh, Iran's ambassador to the United Nations, stated that Iran agrees to the exchange deal "in principle"<sup>10</sup>, but on 7 November 2009, Ala Al-Din Boroujerdi, chairman of the Majlis National Security Committee, stated that "Iran is not to give any of its 1,200 kilograms fuel to the other party to receive 20 percent [enriched] fuel and whether gradually or at once, this will not be done and [the deal] is called off."<sup>11</sup> This opinion was echoed by conservative newspapers, such as *Jomhuri-e Eslami*, which stated that Iran would not agree to give up any uranium for further enrichment. At the same time, other Iranian officials such as Mohsen Rezai, Iranian Expediency Council secretary, suggested that Iran transfer only 280 to 350 kg of LEU, instead of the 1200 kg proposed by the U.S. and its allies.<sup>12</sup>

In addition, Iran had concerns about how the fuel swap would take place. In late October 2009, Iranian news agencies reported that Iran was willing to take part in a simultaneous exchange of its low-enriched fuel for 20 percent uranium<sup>13</sup> but, in November, reports stated that Iran had offered a two phase exchange, each involving 400 kg of low-enriched uranium.<sup>14</sup>

Domestic opposition in Iran to the exchange amount and how the exchange would occur has since tapered off. In December 2009, Iran's Minister of Foreign Affairs, Manouchehr Mottaki stated that Iran had agreed to the proposal to swap the 1200 kg of fuel but that Tehran is prepared to swap the first 400 kg of LEU on the island of Kish.<sup>15</sup> In February 2010, Iran stated that the fuel deal is still on the table and in an official statement to the IAEA said that it is "ready to exchange the TRR required fuel assemblies [...] with the LEU material [...] produced at Natanz, simultaneously in one package or several packages in the territory of the Islamic Republic of Iran."<sup>16</sup>

## 1.3. Current Points of Contention

Currently, the only point of disagreement between Iran and potential fuel suppliers is how and where the fuel swap will occur. Iran prefers that it keep its nuclear material under IAEA supervision on its soil. As a concession, Tehran has suggested that nuclear material can be moved to a location outside Natanz, such as Kish Island in the Persian Gulf, until it can receive the fuel rods. According to the current proposal by France, the U.S., and Russia, the material should be held in escrow in a third country, such as Turkey. The advantage of this proposal is that the breakout threat would be reduced

<sup>10</sup> "Iran Accepts Draft Nuke Deal 'in Principle'" *CNN*. 22 Oct. 2009. Web. 5 Apr. 2010. <<http://edition.cnn.com/2009/WORLD/meast/10/21/iran.nuclear/index.html>>.

<sup>11</sup> "Report: Iran Will Not Ship Uranium out of the Country." *CNN*. 7 Nov. 2009. Web. 5 Apr. 2010. <<http://edition.cnn.com/2009/WORLD/meast/11/07/iran.uranium.shipment/index.html>>.

<sup>12</sup> Savyon, A., and Y. Mansharof. "Iran's Answer to the West: 'Iran Has Lost Its Patience'; 'We've Already Begun Production [of 20%-Enriched Uranium]'" *MEMRI - The Middle East Media Research Institute*. 17 Nov. 2009. Web. 05 Apr. 2010. <<http://www.memri.org/report/en/0/0/0/108/0/3803.htm>>.

<sup>13</sup> Derakshi, Reza, Firouz Sedarat, and Fredrik Dahl. "Iran Ready for More Talks on Nuclear Fuel Plan: IRNA." *Reuters*. 30 Oct. 2009. Web. 5 Apr. 2010. <<http://www.reuters.com/article/idUSTRE59T3PL20091030>>.

<sup>14</sup> "Iran Proposes Two-staged Uranium Exchange: Report." *Press TV*. 8 Nov. 2009. Web. 5 Apr. 2010. <<http://www.presstv.ir/detail.aspx?id=110757&sectionid=351020104>>.

<sup>15</sup> Dunlop, W. G. "Iran Offers to Swap 400 Kilos of LEU on Kish for Atomic Fuel." *Agence France Press*. 12 Dec. 2009. Web. 5 Apr. 2010. <[http://www.google.com/hostednews/afp/article/ALeqM5iJYu5xNldpBU1\\_xctNC7fKEGJxw](http://www.google.com/hostednews/afp/article/ALeqM5iJYu5xNldpBU1_xctNC7fKEGJxw)>.

<sup>16</sup> *Communication Dated 19 February 2010 Received from the Permanent Mission of the Islamic Republic of Iran concerning the Supply of Fuel for the Tehran Research Reactor*. GOV/INF2010/5. IAEA Board of Governors, 22 Feb. 2010. Web. 5 Apr. 2010. <[http://www.armscontrolwonk.com/file\\_download/225/GOV\\_INF\\_2010\\_5.pdf](http://www.armscontrolwonk.com/file_download/225/GOV_INF_2010_5.pdf)>.

immediately since partially enriched material leaves the country. On the other hand, Iran sees a requirement to ship out the LEU first as suspicious because both the US and France have backed out of fuel supply contracts in the past. Ahmadinajad said that “[considering] the history of the Western powers, the Iranian government is coming to the negotiations with no trust.”<sup>17</sup> Moreover, Iran has talked up its enrichment program into such an important domestic political symbol that acceptance of such terms would be seen as caving to outside powers and would face strong domestic criticism. At the same time, Western countries said their current proposal is “fair and balanced”<sup>18</sup> and therefore non-negotiable.

Since the second half of 2009, Iran has been warning that it would start its own production of 20 percent uranium if a deal for foreign purchase did not come through. As a sign of defiance and in hopes of gaining leverage over the deal, on February 7 Iran stated<sup>19</sup> that it had delivered on its warning. Although Tehran’s announcement that higher enrichment levels had been achieved was initially met with skepticism<sup>20</sup> by the West, Iranian production of 20 percent uranium has since been verified by the IAEA.

Obama’s deadline for engagement expired at the end of 2009 and now the U.S. is using Iran’s continued defiance as a justification for harsher sanctions against Iran. But the White House is also having trouble convincing all UN Security Council members, Russia, China, and Brazil in particular, to support another round of stronger sanctions. The net result is that a deal that was supposed to ease worries on the Iranian nuclear threat has potentially significantly shortened the time needed for Iran to get a bomb’s worth of material.

## 2 ENRICHMENT BRINKSMANSHIP<sup>21</sup>

### 2.1. Increasing Breakout Potential by 20 Percent Enrichment

Iran’s decision to enrich uranium to 20 percent is a troubling development because a stockpile of the material increases the breakout threat in two ways. First, it reduces by more than half the amount of time needed to produce a *significant quantity*<sup>22</sup> (SQ) of highly enriched uranium (HEU) when compared to using existing stockpiles of 3.5 percent uranium as feed.

Second, because the higher concentration, a smaller quantity of material presents a breakout concern. IAEA safeguards must be adjusted to be able to detect smaller diversions of material, something that the agency has not done yet, as noted in the February 2010 report.<sup>23</sup> However, Iran has indicated that safeguards will be altered according to agency standards.<sup>24</sup>

<sup>17</sup> Savyon, A., and Y. Mansharof. "Iran's Answer to the West: 'Iran Has Lost Its Patience'; 'We've Already Begun Production [of 20%-Enriched Uranium]'" *MEMRI - The Middle East Media Research Institute*. 17 Nov. 2009. Web. 05 Apr. 2010. <<http://www.memri.org/report/en/0/0/0/108/0/3803.htm>>.

<sup>18</sup> "US Says 'nothing New' in Iran Nuclear Offer." *Agence France Press*. 12 Dec. 2009. Web. 5 Apr. 2010. <[http://www.google.com/hostednews/afp/article/ALeqM5gpfwxeD94fI\\_5SKcJDfxhhXyG4IQ](http://www.google.com/hostednews/afp/article/ALeqM5gpfwxeD94fI_5SKcJDfxhhXyG4IQ)>.

<sup>19</sup> "Defiant Iran Set to Begin Higher Enrichment of Uranium." *Agence France Press*. 7 Feb. 2010. Web. 5 Apr. 2010. <[http://ca.news.yahoo.com/s/afp/100207/world/iran\\_nuclear\\_politics\\_210](http://ca.news.yahoo.com/s/afp/100207/world/iran_nuclear_politics_210)>.

<sup>20</sup> The White House. Office of the Press Secretary. *Briefing by White House Press Secretary Robert Gibbs and CEA Chair Christina Romer, 2/11/10*. 11 Feb. 2010. Web. 5 Apr. 2010. <<http://www.whitehouse.gov/the-press-office/briefing-white-house-press-secretary-robert-gibbs-and-cea-chair-christina-romer-211>>.

<sup>21</sup> We have addressed this question in more detail in a forthcoming article in the *Bulletin of the Atomic Scientists*.

<sup>22</sup> This is the IAEA measure of the amount needed for a crude nuclear weapon.

<sup>23</sup> *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*. Rep. no. GOV/2010/10. IAEA Board of Governors, 18 Feb. 2010. Web. 5 Apr. 2010. <<http://www.iaea.org/Publications/Documents/Board/2010/gov2010-10.pdf>>.

<sup>24</sup> Currently, this is not an extremely urgent concern since the rate of production of 20 percent uranium of the single cascade at the pilot plant at Natanz is quite small.

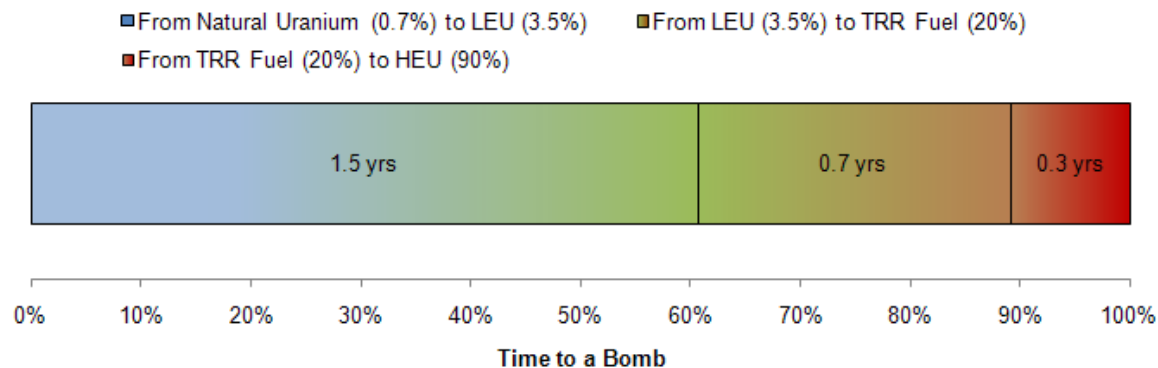


Figure 2: Time required for 3772 IR-1<sup>25</sup> centrifuges to enrich a SQ of HEU, starting from natural uranium and passing through concentrations of 3.5 and 20 percent

## 2.2. Could Iran Produce Fuel for the TRR Itself?

Iran's rationale for starting domestic 20 percent enrichment is the need to provide for fuel for the TRR, which is the country's sole source of medical isotopes. Fuel for the reactor was initially supplied by the US in 1967 and then in 1992 by Argentina. Although Iran has no experience manufacturing the fuel elements, it has the technical capability and infrastructure to do so in theory. After producing uranium at 20 percent concentrations at its facilities in Natanz, Iran would have to convert the enriched uranium hexafluoride to uranium oxide to make fuel pellets at its Uranium Conversion Facility.<sup>28</sup> Iran would then produce the cladding and manufacture the fuel rods at its new Fuel Fabrication Plant, inaugurated in 2009.

In practice, producing the fuel elements for a small research reactor will be expensive, since Iran would have to set up additional production lines and the costs will be protracted over very few fuel elements. Domestic production is also not without risk, a fact recognized by Iranian officials who said they will proceed "cautiously" with the fuel manufacture.<sup>29</sup> Although Iran has long been designing a facility for production of fuel rods for its Arak heavy water reactor, it has no experience in making elements for the TRR. Precise manufacture and quality control is vital since a failed fuel element can lead to a dangerous and expensive reactor accident. For these reasons, Iran was looking to purchase the fuel from abroad and, despite its own enrichment to higher concentrations, has said that it is still interested in a deal.

Because Tehran claims that the TRR is running out of fuel to emphasize the urgency of a deal, many analysts have speculated that Iran may not have the time to produce its own fuel elements. This implies that, pressed for time, Iran would be forced to acquiesce to the US, France, and Russia version of the proposal. But Iran is unlikely to be short of fuel soon.

Based on the limited information publicly available, it is not possible to definitively determine when the reactor will run out of fuel, but very likely not in the immediate future. According to IAEA historical data as of 1998, the reactor has been operating at significantly less than maximum power. If the reactor has continued operation at moderate capacity, it may have enough remaining fuel for almost

<sup>25</sup> For a detailed analysis of estimating IR-1 centrifuge performance, see Oelrich, Ivan, and Ivanka Barzashka. *Calculating the Capacity of Fordow*. Issue brief. Federation of American Scientists, 7 Dec. 2009. Web. 8 Apr. 2010. <[http://fas.org/policy/\\_docs/12-08-09-fordowissuebrief.pdf](http://fas.org/policy/_docs/12-08-09-fordowissuebrief.pdf)>.

<sup>28</sup> According to unconfirmed reports of contamination of Iran's enriched uranium, further purification steps may be required before fuel pellets are made.

<sup>29</sup> "Iran 'starts Enriching Nuclear Fuel to 20%' at Natanz." *BBC*. 9 Feb. 2010. Web. 5 Apr. 2010. <<http://news.bbc.co.uk/2/hi/8505426.stm>>.

9 years. If this is the case, the potential shortage of medical isotopes will not be enough to convince Tehran to accept the West's deal since Iran would have enough time to master domestic TRR fuel production. Moreover, allowing Iran to manufacture its own fuel for the TRR would dramatically enhance the credibility of its rationale for an enrichment program. This would also mean that Tehran would continue with 20 percent enrichment, thus increasing the breakout threat.

### **2.3. Twenty Percent Enrichment: A Show of Force**

Our technical assessment shows that Iran is not yet serious about 20 percent enrichment and producing TRR fuel itself. According to the most recent IAEA report, Iran is enriching 20 percent uranium in a single cascade at the pilot enrichment plant. Although in theory one cascade produces 20 percent uranium at about twice the rate that the reactor consumes it, this low rate of production is likely too small to be efficient for fuel fabrication purposes.

However, Tehran has shown no indication that it plans to expand capacity. To produce 20 percent uranium, Iran can use the very same centrifuge cascades now in place at Natanz. This means that all 23 operational cascades could be fed with existing LEU to produce in just 4 months the entire 116 kg of fuel sold in 1992 by Argentina, or enough to fuel the reactor for more than 20 years. Iran could then make the required fuel elements for the TRR in one batch. Ramping up production would also, of course, quickly create a 20 percent stockpile, which more than halves the time needed to produce enough HEU for a bomb.

If 20-percent enrichment were strategically important, Iran would have reason to carry out the operation at the better-protected underground Fuel Enrichment Plant at Natanz, rather than the above-ground pilot plant nearby.

In addition, according to the most recent IAEA report, Iran has not yet set up for conversion of enriched  $UF_6$  to uranium oxide at the Uranium Conversion Facility and there are no obvious preparations for manufacture of research reactor fuel assemblies at the Fuel Fabrication Plant. Thus, despite the rhetoric of urgency, Iran does not seem to be rushing domestic TRR fuel production.

We believe that Iran's decision to enrich to 20 percent is predominantly an exercise in brinksmanship at this stage. A good example is Iran's movement of the majority of its LEU stockpile to the pilot plant. The maneuver had no technical rationale since it would have taken the single cascade about 10 years to enrich the entire nearly 2 tons of low enriched  $UF_6$  to 20 percent. The move was far more likely a signal that Tehran wants its intentions to be taken seriously.

Consequently, 20 percent enrichment maybe not be an irreversible development if it is meant to serve an alternate purpose. Moreover, Tehran has signaled they are still interested in exchanging domestic LEU for reactor fuel and even that they will stop enrichment to higher concentrations if a deal is made.

## **3 THE FAS PROPOSAL**

The solution to the immediate crisis is an exchange of Iranian LEU for foreign TRR fuel elements. A successful deal would simultaneously reduce the potential breakout threat and build confidence in Tehran that credible fuel guarantees do exist, ultimately undermining the justification for a domestic nuclear fuel cycle. The issue at hand is how to make a successful deal possible.

### **3.1. Does Selling Iran TRR Fuel Increase the Breakout Threat?**

First, it must be made clear that denying Iran the purchase of fuel for the medical isotope reactor has never been a serious option. Indeed, the West argues that outside suppliers can easily and reliably provide Iran with all the uranium it needs cheaper than Iran can produce it itself and that is precisely why there is no justification for Iran's own uranium enrichment, which can have dual use. UN Security Council resolutions that target Iranian's nuclear program allow the supply of low-enriched uranium for light water reactors. Currently, Tehran has a 10-year contract for fuel-supply with Moscow for the Russian-built Bushehr reactor that proceeds in parallel with the disagreement about the Iranian enrichment program.

There is very little security concern in selling Iran reactor fuel and, aside from the disagreement about enrichment at Natanz, Iran's right to peaceful nuclear energy as a NPT signatory. Since the TRR is under IAEA safeguards, nuclear material will be monitored just as it would be anywhere else and any diversion would be detected.

In theory, Iran could ignore the safeguards, disassemble the fuel rods, and reconvert the solid uranium oxide pellets to uranium hexafluoride gas for further enrichment to bomb-grade material. While having the 20 percent feedstock reduces the time to a bomb's worth of highly enriched uranium (HEU), converting the uranium oxide to uranium hexafluoride form adds time. Moreover, domestic politics would make this breakout scenario highly improbable. If the Iranian government causes a shortage of medical radiation treatment because of ambitions to advance its weapons program by a few months, the legitimacy of the regime would be seriously undermined.

### 3.2. Why Insist on Shipping LEU First?

Despite substantial domestic opposition, Iran has agreed to the general idea of exchanging Natanz-produced LEU for the TRR fuel elements. Currently, the only point of contention between Iran and the US and its allies are the details of where and how a swap would take place.

The proposal set forth by the US, France and Russia requires Iran to ship 1200 kg of low enriched UF<sub>6</sub> out of the country, as soon as the deal is made, but the Islamic Republic would receive the TRR fuel about a year or so later. A reason for the time lag could be that Iranian LEU would have to be physically moved to Russia, where it would be further enriched. (There have been speculations<sup>31</sup> that the material would have to be purified in France before that.) The material would then be shipped to France where manufacture of the fuel elements would actually take place. It is difficult to say exactly how long it would take to make the fuel rods out of Iranian LEU, but manufacturing the elements from *exactly* the same material is not a necessary requirement. They could, for example, be produced from French uranium already at hand.

The reasons for the swap are likely more strategic than narrowly technical. The sooner Iran ships out its nuclear material, the sooner the breakout threat would be reduced. When the deal was proposed in October 2009, Iran had a stockpile of 1763 kg of low enriched UF<sub>6</sub>. If Iran had exported the 1200 kg of low enriched UF<sub>6</sub> then, it would have not had enough LEU remaining to make a SQ of bomb-grade material until it replenished that stock. If Tehran were to export its uranium tomorrow, we would have approximately 6 months before they would have produced enough LEU for a single bomb. But this is largely symbolic. Because Iran keeps enriching uranium, the LEU swap would prolong the time to a nuclear weapon, but not remove the threat altogether.

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<sup>31</sup> Pollack, Joshua. "France's Role in the LEU-TRR Deal." Web log post. *Armscontrolwonk.com*. 9 Oct. 2009. Web. 6 Apr. 2010. <<http://www.armscontrolwonk.com/2498/frances-role-in-the-leu-trr-deal>>

Iran has not yet made a decision to make a bomb<sup>32</sup> and will likely not be enriching to HEU levels in the immediate future, so not having enough LEU for a significant quantity of HEU in the short term is not as significant as it may seem. After the requirement for a minimum amount of material has been met, even if Iran has double or triple that quantity, it would take the exact same amount of time to make a single nuclear weapon using a fixed enrichment capacity. In other words, if taking away LEU does not reduce the amount of material to a point where Iran would not have enough for a weapon, the swap would have an effect on the number of warheads that Iran could produce, not on how fast it can produce them.

Moreover, the window of time gets smaller as negotiations are further protracted. Even if Iran ships out 1200 kg of LEU as required, it would have enough LEU for a SQ of HEU as early as October this year, assuming current enrichment capacity of 3772 IR-1 centrifuges. Because in the near future Iran is likely to install additional centrifuges, perhaps even more advanced models, the material could be produced even quicker. In addition, a SQ of HEU assumes the production of a crude nuclear device. More sophisticated designs would require considerably lower amounts of enriched uranium and this notional timeline would be substantially irrelevant.

Consequently, the requirement that Iran first export its LEU is likely predominantly dictated by political concerns -- not by a symbolic reduction of Iran's weapons potential, but by the need for guarantees that Tehran would not renege on the deal. The West is wary because Iran's entire nuclear program is a legacy of suspicious and ambiguous behavior grudgingly acknowledged. If Tehran takes the fuel rods but does not export the LEU as agreed, the U.S. and its allies would look duped and the enrichment clock would not be set back.

In sum, although insisting that Iran ship out LEU first has the advantage of immediately reducing the breakout threat, this is short-lived and Iran would quickly regain capability for a rapid breakout option. The large benefit comes from the actual reduction of Iran's LEU stockpile. Insisting on an *immediate* export of Iranian LEU provides a transitory advantage, which wanes every day that a deal is not made. The reason the immediate export option is particularly appealing is largely political, dictated by the lack of trust that Tehran will keep its part of the deal. But Iran, itself, has some legitimate claim to be wary of the West. Both the US and France have backed out of nuclear fuel agreements in the past.

### 3.3. A Closer Look at Iran's Terms

Tehran is willing to give up its LEU for TRR fuel but only in a simultaneous exchange in one or multiple packages. Iranian officials have also suggested that although LEU should remain in the country, it could be removed from Natanz and stored under Agency safeguards at a remote location, such as Kish Island. This option would, similar to the US, French and Russian proposal, immediately reduce the breakout threat, since material would have to be moved back to Natanz for further enrichment, thus delaying any potential weapons manufacture.

The major nonproliferation benefit from the TRR deal comes from the fact that Iran's LEU stockpile would be reduced, not *when* that would happen. From a technical perspective, the difference between the US proposal and Iran's version is not dramatic. Immediate export of nuclear material provides a short-lived benefit compared to the simultaneous exchange option, in which the swap would take place a year or so later. Both options reduce the threat by exactly the same amount at the time when the fuel rods are actually delivered (see *Figure 3*). For example, if a deal is made in the immediate future, Iran

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<sup>32</sup> *Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, Covering 1 January to 31 December 2009*. Rep. Office of the Director of National Intelligence, 25 Mar. 2010. Web. 8 Apr. 2010. <[http://www.dni.gov/reports/2009\\_721\\_Report.pdf](http://www.dni.gov/reports/2009_721_Report.pdf)>.

would have exactly the same amount of LEU a year from now when it receives the TRR fuel, whether it had exported the 1200 kg of low enriched UF<sub>6</sub> as soon as the agreement was signed or does so later, when it actually receives the fuel rods. If the LEU is shipped out immediately, ostensibly there is the benefit is a several month window during which Iran would not have enough LEU to serve as feedstock for a quick breakout attempt, but we have shown that even that advantage is small.

### 3.4. A Cost to Waiting

More importantly, however, until a deal is struck, Iran could continue to build up an inventory of 20 percent enriched material. And a stockpile of 20 percent uranium would significantly reduce the time to a nuclear bomb. By starting enrichment to higher concentrations, Iran has *de facto* put a clock on negotiations.

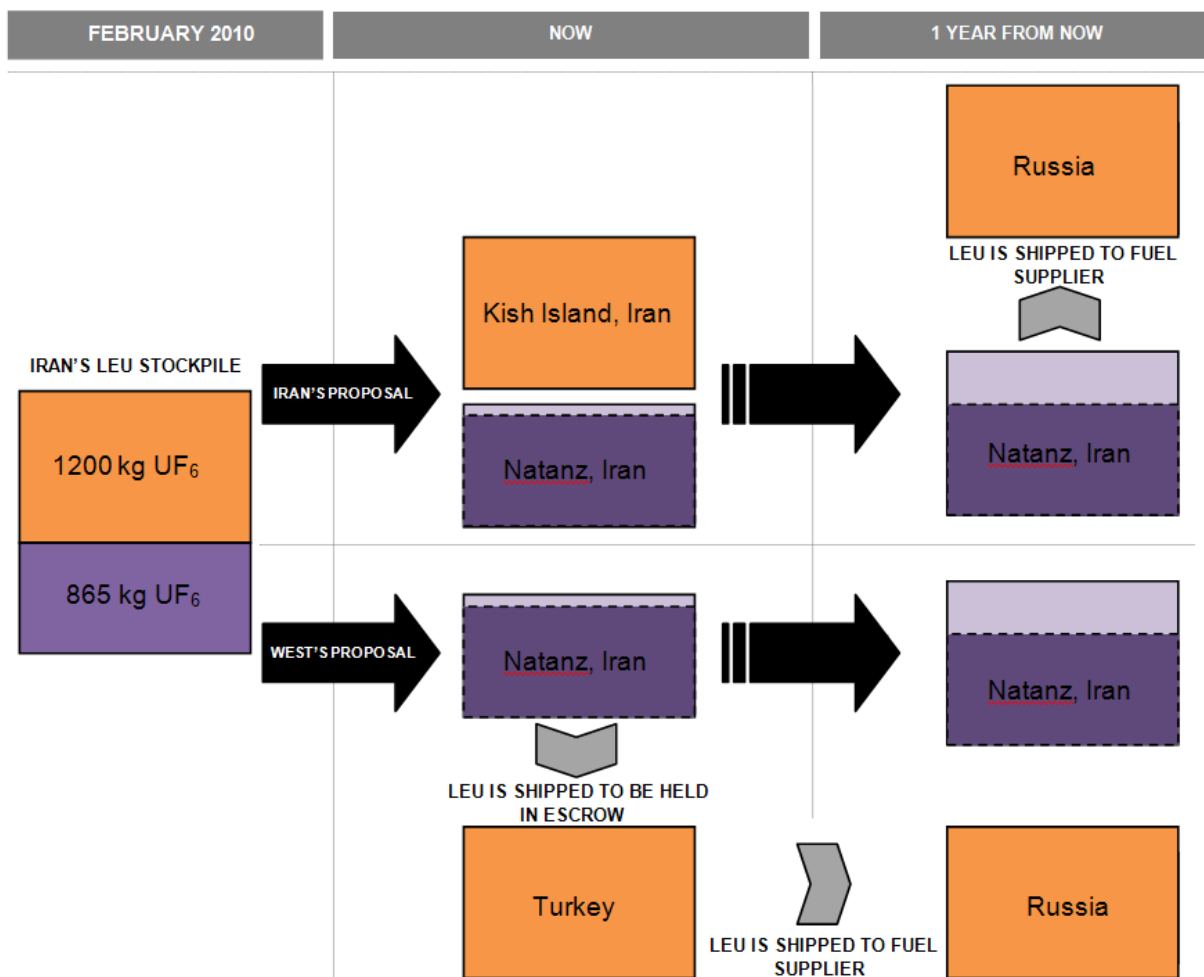


Figure 3: Movement of LEU in Iran's simultaneous exchange proposal and the US, France and Russia's immediate export option

Under these circumstances, it is better to agree to Iran's deal today than it is to hold out for the West's deal six months from now when any strategic advantage from having Iran ship out LEU first would have definitely expired. If an inventory of 20 percent material builds up, then the negotiations will inevitably have to involve some way to export that material as well, further complicating any exchange.

### 3.5. What Should Be Done?

The US, France and Russia should simply say “yes” to a simultaneous exchange of Iranian LEU for TRR fuel in one or more packages. Iran should be further required to move the 1200 kg of low enriched UF<sub>6</sub> to Kish Island under IAEA safeguards, as an additional safety measure. Agreeing to Iran’s terms would not be a big concession, as we have shown, and the maneuver could arguably provide a certain degree of tactical surprise.<sup>33</sup> Under the new deal, Iran would be required to suspend 20 percent enrichment as soon as an agreement is signed and permanently stop enriching to higher concentrations when the fuel elements are in their possession.

If we agree to sell fuel under Iran’s terms and Iran delivers on its promise to export the 1200 kg of low enriched UF<sub>6</sub> and stop enrichment to higher concentrations, we can set back the nuclear clock. We will reduce the breakout threat in two ways. First, Iran’s LEU stockpile will be reduced by about 60 percent, basically depriving them of a bomb’s worth of material. Second, Iran will cease 20 percent enrichment. A successful nuclear deal would indirectly have political benefits. It would build transparency and build confidence on both sides – for Iran, that it can trust international fuel guarantees and for the West.

But there is a potential risk. Iran could take the TRR fuel and refuse to give up its LEU according to the agreement, as the Western negotiators have feared. In addition, Iran could refuse to stop 20 percent enrichment. But even in this worst case, Tehran’s incompletion will be evident and would make Iranian malicious intentions clear. We believe the additional danger from handing over the TRR fuel is so small that even if Iran reneges, we will come out ahead. Iran has been skillful in managing the ambiguity about its intentions just enough to keep other countries, particularly China and Russia, from supporting sanctions. We believe that the benefit of the clarity that would come from having Iran not honor its end of the bargain would outweigh the slight increase in risk from shipping the fuel elements, making a stronger case for sanctions or even military options.

### 3.6. Overcoming Political Hurdles

We believe that securing Iran’s agreement to the terms of our proposal is very likely. Saying “yes” to Tehran’s own timing of shipping out the LEU would compel them to accept the deal or admit that intentions to purchase fuel from abroad were just rhetoric and ultimately an excuse to enrich to higher concentrations. Similarly, Tehran should have no problem agreeing to permanently stop 20 percent enrichment once the fuel rods are received. Our technical analysis shows that Iran is not yet serious about 20 percent enrichment. In addition, Iranian officials have stated that they are still interested in buying fuel from abroad and would cease enrichment once that objective is achieved. It may be slightly more difficult convincing Tehran to suspend enrichment immediately once the agreement is *signed*. However, in the context of the US and its allies’ agreement that Iran ship out LEU once fuel is received, this could be an acceptable compromise for Iranian officials.

It will be a bigger challenge to convince the US, France and Russia to renounce their original proposal that Iran should ship out LEU immediately after a deal is made. We have shown that strategically, shipping Iranian nuclear material later is not a big concession. Reducing the Iranian breakout threat depends on whether LEU leaves the country, not so much when that takes place. In this context, securing Iran’s agreement to the fuel swap, after significant domestic opposition, is a big step towards a successful deal.

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<sup>33</sup> If anyone believes that the TRR deal was simply Iran’s excuse to enrich to 20 percent, then acceding to Tehran’s terms would be an unexpected move and will impede its advancement to a nuclear weapon.

Whether Iran actually needs reassurances of reliable fuel supply or not, refueling the TRR is a low risk way to demonstrate to the people of Iran and the world that Iran can buy fuel on the international market. Having the TRR and the Bushehr reactor operating with foreign fuel, undermines Iran's fundamental public justification for its enrichment program. We believe this is a great, although perhaps somewhat intangible, benefit of accepting Iran's timing.

Insisting that Iran ship out LEU first is driven largely by political concerns: lack of trust that Iran would meet its part of the bargain because of suspicious past behavior. These worries are not without ground, but we believe that even this worst case is not more dangerous than the status quo, but only make Tehran's nuclear intentions apparent and strengthen international consensus for tougher action.

Accepting Iran's proposal may not be a politically appealing option because Obama's deadline for engagement has passed and he has promised<sup>34</sup> Iran severe consequences. The main item on the U.S. agenda now is passing harsher sanctions through the Security Council, but America is having trouble convincing members to adopt the new measures. Iran's ambivalent intentions impede an international consensus on punishments. Arguably, the US had a better chance of passing sanctions after the tumultuous disclosure of Fordow, Iran's allegedly clandestine enrichment facility. Getting Russia and China aboard will either require the US to make dangerous concessions on other policy issues or to adulterate language, turning once "crippling"<sup>35</sup> punishments into reprimands.

Even as the US and its allies are moving to punish Iran, the State Department said that "[t]here is a still a deal on the table."<sup>36</sup> The reason the TRR deal is still being considered is that, if successful, it would be a big step forward in engaging Tehran, while reducing Iran's breakout potential and undermining the justification for their enrichment program. The proposal was part of Obama's effort to engage Iran on the nuclear issue and mark a "new beginning"<sup>37</sup> in the US-Iranian relationship. The proposal put forth by the US, France and Russia artificially coupled refueling the medical isotope reactor with Iran's enrichment program in an effort to reduce tensions. Combining the two issues was not without risk. Accepting Iranian LEU as partial payment for the TRR fuel rods could be interpreted as legitimizing Iran's enrichment program – an apparent contradiction to calls that Iran suspend enrichment.<sup>38</sup> But the benefits were judged to outweigh the drawbacks.

Sanctions are not a goal in themselves. Ultimately, the objective should be to impede or delay Tehran in capability and incentive to produce a nuclear weapon, if it decides to do so. The current approach to sanctions would punish Iran, but not put time back on the nuclear clock. Moreover, punishment will not coerce Iran to accept the terms of the TRR proposal set forth by the US, France and Russia. Our calculations show that the research reactor is not likely to run out of fuel soon, so Tehran is unlikely to concede because of a medical isotope shortage either.

If sanctions are passed, the defiant Iran would reject the TRR deal and proceed with manufacturing fuel for its medical isotope reactor domestically. It is likely that Tehran would have the time, infrastructure and technical knowledge to produce the fuel elements eventually. Although there are indications that Iran is not serious about 20 percent enrichment now, sanction could make this decision permanent, ultimately putting Iran closer to a bomb. More importantly, Iran could quickly increase production of

<sup>34</sup> White House. Office of the Press Secretary. *Remarks by the President in State of the Union Address*. 27 Jan. 2010. Web. 8 Apr. 2010. <<http://www.whitehouse.gov/the-press-office/remarks-president-state-union-address>>.

<sup>35</sup> Reid, Tim. "Hillary Clinton: US Will Organise 'crippling' Iran Sanctions If Diplomacy Fails." *Times Online*. 22 Apr. 2009. Web. 8 Apr. 2010. <[http://www.timesonline.co.uk/tol/news/world/us\\_and\\_americas/article6149692.ece](http://www.timesonline.co.uk/tol/news/world/us_and_americas/article6149692.ece)>.

<sup>36</sup> Erdbrink, Thomas, and Glenn Kessler. "Ahmadinejad Backs Deal to Remove Bulk of Enriched Uranium from Iran." *Washington Post*. 2 Feb. 2010. Web. 8 Apr. 2010. <<http://www.washingtonpost.com/wp-dyn/content/article/2010/02/02/AR2010020200640.html>>.

<sup>37</sup> "A New Year, A New Beginning." Interview by Barack Obama. White House, 19 Mar. 2009. Web. 6 Apr. 2010. <<http://www.whitehouse.gov/nowruz/>>.

<sup>38</sup> In theory, if the White House decoupled the two issues, fuel for the TRR would be sold to Iran without preconditions such as an LEU exchange. At the same time, the US would still push for sanctions due to Iran's failure to comply with multiple IAEA inquiries about the military dimensions of its program.

20 percent uranium, reducing by half its time to a bomb in just 4 months. This could be done legally and under IAEA supervision. Allowing Iran to manufacture fuel for the TRR also provides an ostensible justification for its enrichment program.

If the U.S. accepts Iran's terms to the agreement, this could be portrayed as a victory by Iran and may lead Tehran to believe that extortion tactics (such as proceeding with 20 percent enrichment) work. However, the benefits of a successful TRR deal far outweigh concerns about Iranian domestic propaganda, which will always be present.

## 4 SUMMARY AND CONCLUSION

There is no question that Iran should be allowed to buy fuel for the Tehran Research Reactor. As an NPT signatory, Iran is entitled to peaceful nuclear energy and the fact that the reactor produces medical isotopes evokes humanitarian concerns. In addition, providing fuel for the reactor will prove to Tehran that credible fuel guarantees do exist, which would undermine the ostensible justification for Iran's enrichment program.

Although Iran is likely capable of manufacturing fuel for the TRR before existing stocks run out, this would not be a favorable development. Tehran has stated they are still interested in purchasing fuel from abroad. At this stage it does not seem to be serious about enrichment to higher concentrations and has stated that it would stop production if a deal is made. Giving Iran a reason to continue with 20 percent enrichment would significantly shorten the time in which it could build a nuclear weapon and also support the rationale for a domestic enrichment program.

The current fuel proposal calls for an exchange of Iranian LEU for fuel elements. If the swap takes place, this would reduce Iran's breakout potential. The US, France and Russia insist that enriched material leave Iran as soon as a deal is signed. Iran is steadfast that nuclear material should not leave the country until the fuel rods are received. The nonproliferation benefit from the TRR deal is in that Iran's LEU stockpile would be reduced, when that is done so is less significant. A technical analysis shows that the option proposed by the US and its allies has short-lived strategic benefits compared to Iran's proposal and is largely motivated by political concerns – lack of trust that Tehran will adhere to the terms of the agreement.

Accepting a simultaneous exchange of Iranian LEU for TRR fuel is not a dangerous concession, but is the perfect test of Tehran's nuclear intentions. If, even under its own terms, Iran does not ship out nuclear material and stop 20 percent enrichment, its malicious goals would be evident. This would make a case for stronger sanctions and even military options. If indeed the deal is successful, the Iranian nuclear threat would be reduced and confidence between would be increased.

The benefit of a successful deal is widely acknowledged, but the current stalemate has impelled the US and its allies to harsher sanctions. Sanctions are indeed an appropriate measure, but only when diplomatic options have been exhausted. At this stage it is uncertain whether the White House can secure international support for crippling measures, which in the long run may debilitate the regime. But punishing Iran will in effect increase the nuclear threat by compelling Iran to continue with 20 percent enrichment. We believe there is still a low-cost way to achieve a TRR deal and at the same time test Iran's nuclear intentions.

## About the Authors



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## About FAS

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