A MULTILATERAL ENRICHMENT FACILITY IN IRAN AS A SOLUTION TO THE NUCLEAR CRISIS

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Abstract

A little known report issued in early 2005 by a group of experts might contain the seeds for solving the current Iranian crisis. The group, convened by the International Atomic Energy Agency (IAEA), examined the technical aspects of a number of options for multinationalizing the nuclear fuel cycle as a way of assuring all countries in good standing with the Nonproliferation Treaty access to peaceful nuclear technology. One option examined in general by the IAEA experts group could be used to guarantee Iran's future nuclear fuel supply and prevent its abuse for military purposes. We examine this option in detail for the case of Iran. It could be used to solve the Iranian crisis by constructing an enrichment facility on Iranian soil jointly owned and operated by Iran and Western governments. As a condition for this plant being built, Iran would pledge—and undertake additional safeguard requirements to verify—that it is not engaging in enrichment activities anywhere else; a pledge other countries have made under similar circumstances when they joined URENCO, a European enrichment consortium. Furthermore, the very nature of the joint venture would guarantee that Iran could not covertly divert any of the LEU or the plant's enrichment capabilities for military purposes. Western technicians would be present at, and in fact jointly operate, the facility 24-hours per day, seven days per week; Western accountants would be monitoring all the business activities of the venture; and Western managers would be involved in all operating decisions.

Key Words: Iran, Enrichment, Multilateral, Nonproliferation, Nuclear Crisis

1. Introduction

During the last three years, the West has set the bar unrealistically high, asking for more Iranian sacrifices than are necessary to ensure that Tehran does not acquire nuclear weapons. As a result, the West has been obliged to retreat in the course of negotiations, and at present is acquiescing in Iran's experimentation with uranium enrichment.

All this plays into the hands of extremists in Tehran. Indeed, the Iranian inclination to compromise may now be less than it was just a few months ago.

A new element needs to be injected into the Western approach to Iran's nuclear program. That element, we believe, can be found in a proposal we drew up last year, the details of which have, at official request, only recently been made public.

Our proposal is a compromise designed to meet the bottom line of both sides — namely, enrichment on Iranian soil with the participation of Iranian scientists, but in a framework that prevents the Iranians from making nuclear weapons. This is to be achieved by a multilateral operation in Iran that includes all enrichment-related facilities and is run on a commercial basis and, of course, under International Atomic Energy Agency safeguards.

The proposal encompasses what we believe is the most important lesson to be learned from the recent search for weapons of mass destruction in Iraq: The best way of preventing proliferation is the most intrusive and comprehensive inspections possible, combined with the fulfillment of the Nonproliferation Treaty's promise of peaceful nuclear technology to countries who forsake nuclear weapons.

A treaty between Iran and the EU-3 — France, Germany and the United Kingdom — would establish a commercial partnership with the governments as shareholders; others could be invited to join. The capital would be provided by the shareholders.

The board of the partnership would determine policy and control the budget. It would appoint an international company to run the day-to-day operations. And, of course, Western scientists and engineers would be present 24 hours a day, seven days a week, and providing continuous scrutiny of Iran's activities.

Iran would lease all its enrichment-related equipment and facilities to the partnership, and would undertake not to enrich and reprocess except through the partnership. The countries that formed Urenco, the European enrichment consortium, have already made exactly the same pledge regarding enrichment.

The partnership would also lease Urenco centrifuges and install them in the new joint enrichment plant in batches, the first in a few months, the last seven or more years later — for a total of, say, 50,000 centrifuges. Until the first batch comes into operation, the partnership would use Iranian P1 centrifuges, a very inefficient machine whose design the Iranians bought from the Pakistani renegade scientist A.Q. Khan. All of the P1 centrifuges would be phased out as soon as the Urenco centrifuges begin to operate. We estimate that during the interim period, Iran's existing P1 centrifuges could not produce enough highly enriched uranium for a nuclear weapon.

To preserve secrecy, the sensitive parts of the P1 centrifuges would be "black boxed," or fully enclosed behind opaque barriers, and handled only by Iranians. Similarly, the sensitive parts of the Urenco centrifuges would be black boxed and handled only by Urenco nationals. Self-destruct mechanisms would be installed in the Urenco cascades to deter and spoil expropriation.

Were the Iranians to accept our plan, they would be unlikely to expropriate the internationally owned facilities. In addition to technical measures that would help prevent such a takeover, doing so would be a seizure of the property of powerful governments well placed to retaliate by various means. Such a move would signal Iran's intention to produce nuclear weapons while leaving the country vulnerable until the weapons had been built and tested.

The IAEA would be consulted on the design of the plant and would operate three forms of safeguards: full-scope, additional protocol and specially agreed transparency measures. Full scope safeguards and the additional protocol are the iaea standards for ensuring npt compliance and give inspectors considerable privileges in going where they will and inspecting what they want. They are, however, far from allowing inspections anywhere, anytime. The proposed treaty's additional transparency measures could increase those rights and build up confidence that Iran was not pursuing enrichment related research anywhere else in the country.

Each shift of workers would have a majority of non-Iranians, and non-Iranians would hold key positions in the management company. Together, these measures would protect both against both diversion of material and the establishment of a clandestine facility.

The low-enriched uranium produced would be sold commercially on the global market as fuel for nuclear power reactors, and profits would be distributed according to shareholding. The Iranians would be customers like all others. Whereas the P1 centrifuges could never produce enough low-enriched uranium for more than one reactor, the Urenco machines could easily satisfy the needs of the full Iranian program — 20 nuclear reactors by 2035 — and still have approximately half the output to contribute to a virtual fuel bank.

2. Economic Considerations

Assuming that the multilateral enrichment facility will eventually (perhaps seven or more years from the start) be operating with 50,000 URENCO TC-21 centrifuges, a lot of LEU will become available. We estimate that the facility's annual production of LEU at 4% enrichment will be about 840 tons. That would suffice to provide all the fuel needed to sustain forty-two 1000-MW reactors. Since Iran plans to have twenty such reactors in 2035, we assume that country would be a regular customer.

The supply of reactor fuel currently exceeds demand globally, so a large new enrichment plant would be dependent commercially either on a significant increase in the number of reactors requiring fuel or on superior cost-effectiveness or a mixture of the two. The appropriate calculations require a degree of clairvoyance and a detailed knowledge of the uranium market which we do not claim. But since the issue cannot be neglected and needs to be illuminated, we make some simple exploratory calculations.

Taking account of increasing demand for electricity worldwide and of the political and environmental arguments being made in favor of nuclear power, we find it plausible to assume an increase globally in the number of reactors. As an illustration, the IAEA has projected a 60% increase in worldwide nuclear power capacity by 2030 in what they refer to as a reasonable estimate. This will produce a corresponding increase in demand for LEU, which over the years will considerably exceed the current capacity.

Probably, the centrifuge machines used in the multilateral facility (after the P1s are phased out) will have some efficiency advantage over a good deal (but not all) of the competition. Of course, many other considerations will need to be taken into account to reach good estimates of relative cost efficiency. Nevertheless, on the face of it, there will be space in an expanding market for a multilateral enrichment plant.

Prudently, instead of building the entire 50,000-centrifuge facility in about seven years, it might be built over a longer period in perhaps seven tranches with approximately 7000 in each tranche. If we assume that after running in, a 15,000 centrifuge plant is in full operation, say, five to six years from the start, it could at that time be producing annually 230 tons of LEU at 4% enrichment. Thus, after say six years of operating, the plant could have produced 690 tons of LEU. This compares with an annual refuel requirement of 20 tons of LEU (to be provided by the Russians) for the Bushehr reactor. However, the plant would not necessarily operate at full capacity all the time; output would be largely determined by demand in the commercial market.

We have estimated a possible range of capital costs for building these options in Iran, see the table below, based on the admittedly sketchy information publicly available. It appears, from our estimates, that the relative ease of manufacturing Russian centrifuges compared to the older URENCO TC-12 design—even with their increased capability per machine—is the more cost effective solution of those two choices.

Table 1: Estimated Capital Costs for Various Scenarios

Number of Reactors Sustained	Cascade Capacity SWU-kg/yr	TC-12 (Current URENCO Centrifuges)		TC-21 (Next Generation URENCO Centrifuges)		Russian Generation 6 (?) Centrifuges	
		Number of Centrifuges	Total Capital Investment Required	Number of Centrifuges	Total Capital Investment Required	Number of Centrifuges	Total Capital Investment Required
1	120,000	3,000	$56M - $84M	1,200	$45M - $67M	48,000[1]	$66M - $82M[2]
20	2,400,000	21,000	$1.1B - $1.7B	21,000	$0.9B - $1.3B	960,000	$1.3B - $1.6B
42	5,000,000	50,000	$2.3B - $3.5B	50,000	$1.9B - $2.8B	2,000,000	$2.7B - $3.4B

Our estimating techniques are too crude to facilitate a choice between Russian centrifuges and the more advanced URENCO TC-21's based on economic considerations alone. We note, however, that the TC-21 is still undergoing production engineering and the cost savings per SWU-kg envisioned here might not materialize (or could, of course, be even greater).

We do not claim expert knowledge of the costs involved in any of the three options discussed: URENCO TC-12s, URENCO TC-21s, and Russian centrifuges. Nevertheless, it may be useful to set out estimates—based on what limited information is publicly available—as in Table 1.

3. Detecting and Deterring Covert Enrichment Facilities

The problem of detecting and deterring covert enrichment facilities in Iran is common to all the proposed schemes for settling the Iranian nuclear crisis. Unfortunately, there are significant technical barriers to detecting such facilities. For instance, conceptual plans for using wide area environmental sampling (WAES) techniques—basically instituting a permanent chain of air and water sampling stations through a suspect country to pickup particles containing small amounts of enriched uranium—have highlighted how small are the annual amounts of uranium that might be released. An IAEA report estimates that a centrifuge enrichment facility would release at most one gram of uranium per year [3] and possibly much less. One independent estimate [4] of what such a network in Iran might look like suggested 400 stations would be needed with samples collected twice a week. And to get the number down to that "manageable" size, the author had to increase the spacing between stations to ten times the spacing of the optimal network.

Even slightly enriched uranium, if diverted to a covert weapons program, would considerably facilitate its operation. This greatly reduces the chance that a covert enrichment facility would be detected. To illustrate, the enrichment facility needed to take uranium already enriched to 5% up to weapons grade uranium could be less than one fifth the size of a facility that started with natural uranium. Not only does this allow placing the enrichment plant in a much smaller building, such as an urban warehouse, but it also greatly eases the problems associated with preventing the accidental release of uranium hexafluoride (UF_6). For instance, one of the most likely mechanisms for releasing UF_6 is from the regular changing of feed cylinders. By using LEU, a covert facility would need to change these cylinders much less often since much less feed stock would be required to produce a nuclear bomb.

Given these difficulties in detecting covert enrichment facilities, are there any other mechanisms that might be put in place to increase the probability of detecting undeclared facilities? Yes; one based on the experience gained in inspecting and monitoring Iraqi WMD programs. Through their frequent inspections in Iraq, weapons inspectors got to know who was important and capable so that when those people moved to other facilities red flags were raised, especially when several with complementary weapons production skills were present. The Forden-Thomson proposal has this mechanism built into it, only to a much greater extent than was used in Iraq.

Iranian technicians and scientists working at the joint facility would, almost by definition, become the local experts on enrichment. Western technicians would be working side-by-side with the Iranian technicians and scientists and would come to know their skills and capabilities. Furthermore, Western bookkeepers would, through their normal business activities, know who was taking time off and how often. Key workers, both Iranian and Western, would have to leave an address where they could be found and a contact phone number when they were on vacation. This would be required so that they could be contacted in case of emergency and they were needed back at the plant. However, it would act as an additional safeguard since the information could also be used to spot the movement patterns of key employees, where they went and when.

Western managers and bookkeepers would also know who came to replace broken P1 centrifuges during the early phases of operation, before the more capable URENCO centrifuges replaced the less economical Iranian machines. This information could be used to follow centrifuge development work outside of the joint facility.

It is, of course, possible that Iran would set up covert enrichment and conversion facilities with no contact with their technicians and scientists working in the joint facility. However, they would almost certainly have to do it without the key scientists and technicians already working at the Natanz pilot plant enrichment facility. If some of those key workers did not join the joint facility, it would raise too many red flags about a possible covert facility. Thus, any new covert facility would have to start from scratch and without much of the information and skills they have so painfully and expensively—both in money and in political baggage—learned since February 2006.

4. Developing Self-Destruct Mechanisms

It is understandable that many would feel uncomfortable about installing a massive enrichment facility, using some of the world's most capable centrifuges, in Iran. They would naturally worry about Iran expropriating them for weapons production. While we believe that if Iran agreed to this joint facility, there would be little risk that they intended to nationalize it; doing so would provoke the wrath of some of the world's most powerful military powers and uniting the world in condemning its actions. Nevertheless, there are technical measures that can be taken to reassure the world that this facility would never be used for military purposes.

It is important to note that the facility would be built above ground. While done for safety reasons—it is dangerous to build underground a facility that could possibly release large amounts of even a neutrally buoyant, highly toxic and corrosive aerosol such as uranium hexafluoride and its decomposition products—it would represent an easy target for bombing. Of course, bombing the facility raises a whole series of issues such as danger to the pilots from air defenses and might encourage hostage taking so that Western workers could be used as human shields. Nevertheless, it is an easy and effective way to destroy a potential weapons capability should self-destruct mechanisms fail to operate.

A safe and reliable self-destruct mechanism can be built, we believe, into each and every centrifuge in the joint enrichment facility. This can, it seems, be accomplished without explosive charges or other crude forms of destruction that would represent a risk to workers during their normal activities. The destructive power is automatically present since a spinning centrifuge rotor has almost the same magnitude of energy per kilogram as a stick of dynamite. In fact, one of the important design problems that had to be worked out early in the development of centrifuges was a way of ensuring that shrapnel from a "crashed" centrifuge did not destroy near by centrifuges and start a domino effect of destruction.

No centrifuge manufactured today has a self-destruct mechanism built into it and so no matter what solution is found, there will have to be a development program. However, we believe there are a number of possibilities for quickly modifying almost any centrifuge design so that it could incorporate a self-destruct mechanism. One such possibility, that we feel deserves thought by engineers familiar with the secret designs of centrifuges, is to add an additional circuit to the induction motor that rotates the centrifuge's rotor. When activated, this circuit would use existing electromagnets in the stationary part of the motor (the "stator") to create a large, asymmetric torque on the rotor, causing it to crash catastrophically. If this idea proves impractical for any reason, we feel confident that there are other ways of destroying these finely balanced machines that, after all, can be so easily crashed inadvertently by an inexperienced user.

5. Conclusions

Our scheme would satisfy both the Iranian and the West's bottom lines: it would allow uranium enrichment on Iranian soil and it would prevent Iran from obtaining a nuclear weapon. By placing Western workers permanently in the facility, it would have a number of practical monitoring advantages over other proposed policies; in particular it would have an increased ability to detect and deter clandestine enrichment facilities. While do this, it would keep critical secrets of the Urenco enrichment process from the Iranians. The Iranians would gain, no doubt, from performing sophisticated tasks alongside Western technicians — but it would not lead automatically or quickly to nuclear sophistication. Nor would it necessarily remove American sanctions against Iran.

To be sure, for some Iranians a multilateral project would be a poor second-best choice to a civil national program that could later be converted into a military one. These people will argue that Iran should not put itself in the hands of "neo-imperialists" and "Western exploiters." But other Iranians will see collaboration with the EU-3 as an indication that Iran has been accepted into a respected position and as a symbol of the country's emerging scientific prowess.

Those in Tehran who feel it is truly important for Iran to have a significant nuclear arsenal will not like our scheme. The penalties for either a breakout via expropriation or a clandestine program would be both high and virtually certain, and the latter would be operationally difficult. These critics in Iran would prefer no scheme at all — in other words, liberty to pursue their existing program, perhaps with a clandestine program on the side. It appears to us that this is where the current crisis is heading if the West does not change direction.

Much depends upon difficult-to-predict internal developments in Iran. Where there is a choice, the West should be careful to reinforce the position of the moderates. It is undesirable to challenge the Iranian nation in a way that intensifies nationalism. At the same time, it is desirable to make use of the Iranian sense of honor and their repeated claims that they seek no weapons and would welcome multilateral operations in Iran.

We do not argue that our scheme is ideal, merely that is likely to be the best available option in difficult circumstances. Three years of a fairly consistent Western policy seem to be leading to a choice between military action and tacit acquiescence in the Iranians doing as they please. Both choices mean failure and defeat.

Are the risks of pressing on with a failing policy acceptable? Or should we modify the policy? If so, are the risks involved in our proposal not less than those of the alternatives?

After all, multilateral operations in Iran involving Iranian experts mean that the IAEA and the international personnel will have a thorough understanding of what the Iranians are doing. For this reason, a clandestine program is harder under our scheme than under any other. Expropriation is feasible, and cannot be dismissed. But it is not likely.

If the Iranians are determined to make nuclear weapons, they would do better not to agree to our scheme. To overthrow a treaty, seize the property of powerful governments, expel the IAEA and effectively announce a race to a bomb creates immediate and serious dangers which otherwise need not be experienced.

Iran is a specific example of a multinational nuclear agreement. We are also concerned with the health and effectiveness of the global non-proliferation regime. The Nonproliferation Treaty has always depended on a balance between measures to prevent the emergence of new nuclear-armed states and those aimed at delivering the benefits of nuclear technology to states that have foresworn the quest for nuclear weapons.

We who live in states that do have nuclear weapons must remember that, important though we are, we are still a small minority in the international community. If we are going to prevent proliferation, we have to persuade the "have-nots" to cooperate.

The Iranian case underlines the importance of keeping to a minimum the number of countries with enrichment and reprocessing facilities. Under the Nonproliferation Treaty, all countries legally have a claim to such facilities. So we have to be inventive and fairly generous to the vast majority of states that are not nuclear armed, in order to convince them to permanently forgo enriching and reprocessing on a national basis.

6. Bibliography

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